RIGA TECHNICAL UNIVERSITY

FACULTY OF POWER AND ELECTRICAL ENGINEERING
INSTITUTE OF INDUSTRIAL ELECTRONICS
AND ELECTRICAL ENGINEERING

COLLECTED ABSTRACTS

INTERNATIONAL SYMPOSIUM AND DOCTORAL SCHOOL OF ELECTRICAL ENGINEERING

Dedicated to the 150th Anniversary of Michael Dolivo-Dobrovolsky

Ronishi, Latvia

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COLLECTED ABSTRACTS OF INTERNATIONAL SYMPOSIUM AND DOCTORAL SCHOOL OF

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Faculty of Power and Electrical Engineering

Institute of Industrial Electronics and Electrical Engineering

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FOREWORD

On behalf of Riga Technical University (RTU) Faculty of Power and Electrical Engineering Institute of Industrial Electronics and Electrical Engineering and Organizing Committee I have a great pleasure to welcome you at the International Symposium and Doctoral School of Electrical Engineering.

I am pleased to welcome the participants in the year of the 150th anniversary of the University. This Symposium is dedicated also to the 150th Anniversary of Michael Dolivo-Dobrovolsky, the inventor of 3 phase AC machines and transformers. He had been studying in Riga Polytechnic Institute (now RTU) for 3 years since the 1st of September 1878. In the year 1887 M.O. Dolivo – Dobrovolsky was invited to company AEG (Allgemeine Elektricitats-Geselschaft), where he had been working all his life from the position of an electrician to the director of the company. In incredibly short terms he developed 3 phase power supply system as well as asynchronous motor, the construction of which remains almost the same nowadays. It is an excellent opportunity to share our knowledge and experience with new generation of scientists - PhD students, as well as to generate new ideas, exchange results of ongoing projects with colleagues, to give presentations, to have discussions and help PhD students to be successful researchers in the field of electrical engineering and especially power electronics.

The Symposium programme is accompanied by the technical presentation of Latvian power supply company – concern Latvenergo.

I would like to express my gratitude to the invited speakers for their time and efforts during the Symposium.

Many thanks to the members of Scientific and Organizing Committees of the Symposium.

My best wishes in your scientific work

Rector of Riga Technical University,
Director IEEI EEF,
Full Member of the
Latvian Academy of Sciences
professor, Dr. habil.sc.ing.

Leonids Ribickis

LATVENERGO RESEARCH, PERSPECTIVE DIRECTIONS OF POWER SUPPLAY

LATVENERGO PĒTIJUMI, PERSPEKTĪVIE ENERĢĒTIKAS VIRZIENI

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Latvenergo ievērojamu uzmanību pievērš perspektīviem pētījumiem. Tas ir saistīts gan ar Eiropas Parlamenta un Padomes direktīvu 2009/72/EK par nepieciešamību izanalizēt iespēju ieviest viedos skaitītājus, gan kopumā ar stabilas kompānijas ilgtermiņa attīstības būtību.

AS „Latvenergo" ir uzsācis energoefektivitātes pilotprojektu. Šī projekta mērķis ir uzstādīt viedos elektroenerģijas skaitītājus mājsaimniecībās, nodrošināt slodžu profila nolasījumus un nodrošināt nolasīto datu attēlošanu klientu portālā. Tas ļaus izpētīt mājsaimniecību reakciju un patēriņa paradumu maiņu, ja tām tiek sniegta iespēja saņemt ievērojami vairāk un detalizētāku informāciju par savu elektroenerģijas patēriņu. Iegūtā informācija noderēs, lai varētu precīzāk definēt jaunus elektroenerģijas produktus un pakalpojumus gala patērētājiem. Šī informācija ir nepieciešama arī, lai ieviestu inovatīvo viedo tīklu tehnoloģijas.

Projekta ietvaros plānots iegādāties un uzstādīt viedos elektroenerģijas skaitītājus ar nolasīšanas iespējām, slodzes limitēšanas funkciju un attālinātās atslēgšanas iespēju 500 mājsaimniecībām. Daļai klientu tiks uzstādīti arī mājas energomonitori ar lokālā patēriņa uzskaites un vadības iekārtām.

Projekta realizācijas rezultātā tiks veicināta klientu energoefektivitāte, vietām samazināts elektrības patēriņš un daļēji izlīdzināta diennakts maksimālās slodzes līkne. Veikto pasākumu gaitā ir sagaidāms CO2 izmešu samazinājums. Apgūto tehnoloģiju rezultātā valstī noteikti attīstīsies ekspertīze viedo uzskaites sistēmu un mājas automatizācijas tehnoloģiju jomā. Tiks radītas

Latvenergo draws significant attention to prospective researches. This is due to the European Parliament and Council Directive 2009/72/EK of the need to analyze the possibility of implementing smart counters and stable long-term development of the whole company.

"Latvenergo" has launched a pilot project for energy efficiency. This project aims to install smart electricity counters in households to provide load profile readings and display all the data online at customers' profile, using special web-portal.

This will allow exploring households' reactions and behavior changes, when they have the opportunity to get much more and detailed information about their electricity consumption.

The obtained information will be useful to give a clearer definition of new energy products and services to final consumers. This information is also needed to implement innovative smart grid technologies.

The project is planned to purchase and install a smart electricity counters with reading capabilities, load limitation feature and remote disconnection to 500 households. For some of the clients in-home-energy-monitors will be installed, with local counting and control equipment.

It is expected that the project will promote customers energy efficiency, reduced electricity consumption in some areas and partially adjusted the maximum daily load curve. Enforcement activities are expected to decrease CO2 emissions. As a result of acquired technology some expertise will be developed in country in

jaunas darba vietas un biznesa iespējas Latvijas informācijas tehnoloģiju kompānijām.

Vienlaikus, tiks izstrādātas procedūras iespējamo risku un problēmu novēršanai, piemēram, teorētisku kibernoziegumu identificēšanai un novēršanai.

Projektu realizēs AS „Sadales tīkls" Rīgas pilsētas un Centrālajā reģionā.

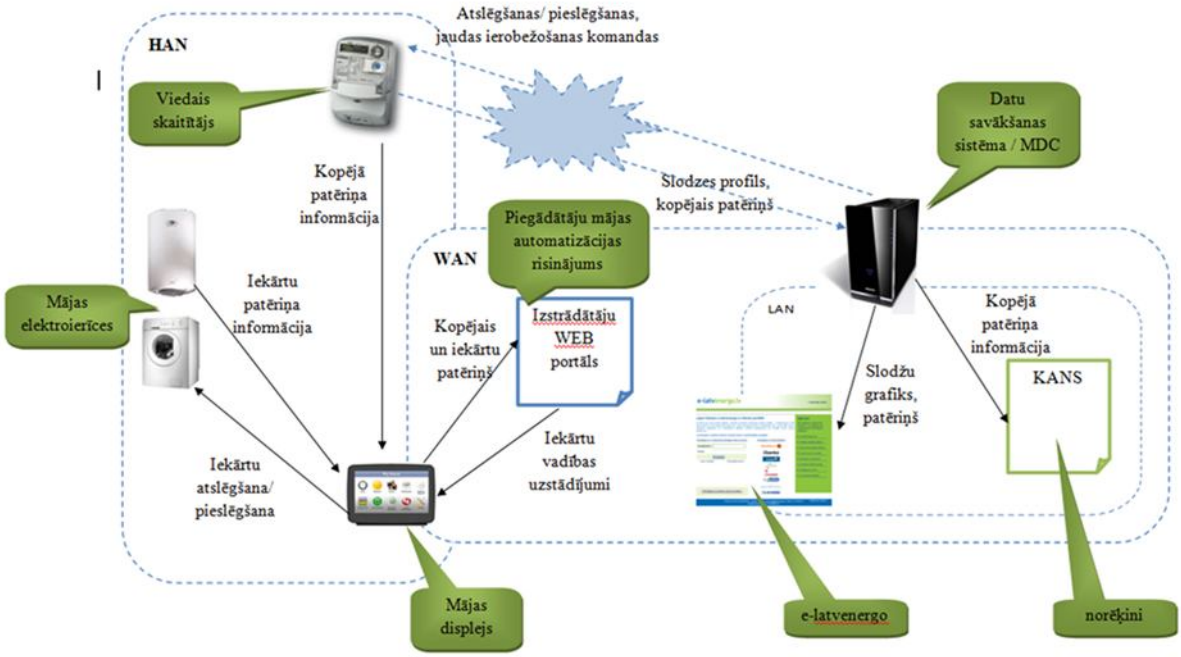
Projekta vīzija:

smart counting systems and home automation technologies. This will bring new jobs and business opportunities for Latvian information technology companies.

At the same time, will be devised procedures for the preventing potential risks and problems, such as identification and prevention of cyber-crime.

The project will be implemented in Riga city and in Central region by the company AS „Sadales tīkls".

Project vision:



AS „Latvenergo" ir noslēgts jumta līgums par sadarbību ar Rīgas Tehnisko universitāti un Latvijas Lauksaimniecības universitāti. Sadarbības darba tēmas aptver enerģijas ražošanu, elektroenerģijas pārvadi un sadali, kā arī normatīvo dokumentu izstrādi. Šobrīd ir noslēgti seši līgumi par izpētes darbiem, no tiem pieci – ar RTU un viens – ar LLU. Kā piemēru var minēt izpēti „20 kV gaisvadu EPL mehāniskās noturības robežu analīze un ekspertīze ekstremālos klimatiskos apstākļos". Šīs izpētes rezultāti tiks izmantoti, ekspluatējot vidsprieguma EPL, kā arī kalpos kā ekspertīzes slēdziens.

Interesants līgums bija noslēgts ar LLU 2011.gadā. Tā ietvaros tika izpildīta Latvenergo piederošā elektroautomobiļa Fiat Fiorino Elettrico testēšana. Tā paredzēja arī uzlādes parametru pārbaudi. Izgatavotājrūpnīcas norādītie parametri tika sasniegti, kā arī iegūta vērtīga analīze par tehniskajiem raksturlielumiem.

Latvenergo speciālisti kopā ar Latvijas

"Latvenergo" has an agreement on cooperation with the Riga Technical University and the Latvian University of Agriculture. Collaborative working themes covering power generation, electricity transmission and distribution, and regulatory texts. There are now signed six contracts for exploration, five of them - with RTU and one - the LLU. An example is the study of "20 kV overhead line mechanical stability limit of the analysis and expertise in extreme climatic conditions." These research results will be used in the operation of medium voltage overhead line, as well as serve as expert opinion.

An interesting contract was signed in 2011 with LLU. It was completed within Latvenergo owned electric cars Fiat Fiorino Elettrica testing. It also provided for charging parameter checking. Manufacturer's specified parameters were met, as well as gain valuable analysis of the technical specifications.

Latvenergo specialists together with the Latvian University and several Estonian universities

Universitāti un vairākām Igaunijas universitātēm piedalās starptautiskajā projektā GORWIND. Projekta mērķis- sniegt informāciju par jūras vēju, kas iegūta no augstas izšķirtspējas attālinātu mērījumu datiem, krasta vēja mērījumiem, kā arī reģionālajiem klimata modeļiem. Papildus tiks sagatavota informācija par roņu izplatības vietām, putnu ziemošanas, migrēšanas un vairošanās apvidiem.

Latvenergo Personālvadība organizēja stipendiātu konkursu. Tā rezultātā stipendijas tika piešķirtas astoņiem studentiem – četri rakstīs bakalauru darbus un četri maģistra darbus. Ar šiem studentiem ir noslēgti līgumi, un viņi saņems Latvenergo stipendijas līdz 2012.g. jūnijam – bakalaura grāda pretendenti, bet – līdz 2013.g. vasarai. Bakalauranti par darba izpildi Latvenergo sniedz atskaites reizi divos mēnešos, bet maģistranti – reizi trijos mēnešos. Stipendiātu darbu tēmu loks ir ļoti plašs un aptver Latvenergo darbības sfēru.

participating in the international project GORWIND. -The project aims to provide information on offshore wind, derived from high resolution remote measurements, the offshore wind measurements, as well as regional climate models. Additional information will be prepared for the location of seals, birds wintering, migration and breeding areas.

Latvenergo Human recourses held a Fellowship competition. As a result, grants were awarded to eight students - four articles undergraduate work and four master's thesis. With these students have contracted, and they will receive grants of up to 2012 Latvenergo June - Bachelor's degree candidates, but - by 2013 summer. Bachelor’s students the performance Latvenergo provides reports every two months, but the masters - every three months. Fellows work in the range of topics is very broad and includes Latvenergo scope.

Chapter I
Presentation of PhD
Poster session

LESLIE ROBERT ADRIAN

Promocijas darba nosaukums: Mobilo robotu brīva ceļa sekošanas sistēmu izstrāde un izpēte

PhD title: Research and development of obstacle avoidance systems for robotics

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Leonīds Ribickis

Scientific adviser:
Dr.Habil.Sc.ing., professor Leonids Ribickis

Pētījuma kopsavilkums

Pētījuma mērķis ir izveidot Sensoru sistēmu tīrā ceļa robotu tehnikai. Sistēmai ir vairāki slāņi pirmais slānis sastāv no 24x sensoriem/3600 fotovoltāžas matrica tiek konvertēta speciālā masīvā aptvertā spektrālā diapazonā aptuveni no λ=200nm līdz λ=1100nm un nepārtraukti skenē apkārtējo vidi. Kustības matrica tiek sastādīta ar notikumu gaismas sensoru palīdzību, kas pastāvīgi kontrolē un pielāgo kritēriju sensoru mērījumu svaru koeficientus. Signālu pastiprināšana eksistē šajā līmenī. Otrā līmenī notiek pastiprinājuma mērījumu nolasīšana un, izmantojot izplūdušo loģiku mikroprocesorus, nodrošina tūlītēju atbildi vai nodrošina signāla nodošanu nākamā līmeņa mikrokontrollerim, nodrošinot nepārtrauktu datu uzglabāšanu un pozicionēšanas datu izmantošanu. Tiešajā līmenī tiek izmantots iebūvētais piroelektriskais sensors (PIR), kas tiek speciāli izmantots, lai nodrošinātu iespēju izvairīties no šķēršļiem (OA), izmantojot gandrīz infrasarkana spektra skenēšanu. PIR sensori ir pa tiešo savienoti ar analogo shēmu, kas vada robota galvenās piedziņas sistēmu, kas ir robota svarīgākā daļa. Tādēļ sistēma kopumā iekļauj sevī sensoru sekcijas, pastiprinājumu, modulāciju, izplūdušas loģikas algoritmu, izšķirtspēju, mikrokontrollera apakš sistēmu, galvenās sistēmas mikrokontrolleri un ātrdarbīgu analogo mehānismu mobilitātes nodrošināšanai. Sistēma var būt arī paplašināta, lai fotogalvaniskos datus varētu izmantot pozicionēšanai apkārtējā vidē.

Summary of the research

The goal of the research is the development of a Clear Path Sensory System for robotics in general. The system is multilayered with the first layer consisting of a 24x sensor/3600 photovoltaic array covering a spectral range of approximately λ=200nm to λ=1100nm and continuously scanning the robot environment. This array is completed with an incident light sensor which recurrently monitors and adjusts the weighting system of the sensors. Amplification of signal occurs in this layer. The second layer delivers the amplified readings to a fuzzification/defuzzification microprocessor for immediate response and/or transfer to the second level microcontroller for subsequent storage or mapping usage. The third layer refers to the peripherally mounted modified pyroelectric (PIR) sensors which are specifically arranged to handle obstacle avoidance (OA) utilizing near infrared spectrum detection. The PIR sensors, connected directly to analogue logic circuitry, control the main drive systems of the robot yet may be overridden by the main microprocessor when or if required. Therefore the overall system incorporates sensor selection, amplification, modulation, fuzzy logic algorithm refinement, sub-system microcontroller, main system microcontroller and high speed analogue response mechanisms for mobility. The system may also be expanded to utilize the photovoltaic data retrieval for environment mapping.

Pētījuma novitāte

Pētījuma novitātes labākai izprašanai jāmin, ka eksistē vairākas iekārtas, kas lielākoties ir izstrādes stadijā vai ražošanas stadijā, kas nodrošina dažādu šķēršļu noteikšanu un autonomo robotu pozicionēšanu apkārtējā vidē. Lielākā daļa no šiem risinājumiem ir būvēta pēc vienota principa, ka robots izstaro zināma rakstura radiāciju vai radio signālu. Hidrolokatoru, infrasarkano un ultraskaņas attāluma mērītāji ir tikai daži no šādu tehnoloģiju izmantošanas piemēriem. Tas ir veidots, lai izstrādātu modeli, kas izmanto esošos traucējumus, troksni vai dabā sastopamo radiāciju, lai ļautu autonomam aģentam (robotam) izvairīties no šķēršļiem un veiksmīgi pārvietoties attiecīgā vidē, neizdalot radiācijas izstarojumus.

a) Projektējamais robots nav aprīkots ar izstarojošām ierīcēm;

b) Autors modificējis PIR sensorus un to izmanto;

c) Izmēģinājuma rajona kartes sastādīšanu veic, izmantojot tikai apkopotos fotogalvaniskos datus, neizmantojot CCD attēlveidošanas tehnoloģijas.

Sasniegtie rezultāti

a) Piemērotu sensoru izvēle. Modelēšana programmatūras vidē un provizorisko tehnisko prasību definēšana ir pabeigta. Matemātiskais formulējums tiek balstīts uz problēmas matemātisku atrisināšanu ar pastiprinājuma un sistēmas svara kritēriju definējumu.

b) Primārās pamata mobilās platformas montāža (veiksmīga testēšana). Pamata sensoru masīva montāža (veiksmīga testēšana). Gala PCB pastiprināšanas shēmas modificēšana (paveikta). Elektromotora piedziņas un loģiskās shēmas modifikācija (paveikta). Apakš – mikrokontrollera arhitektūras izvēle;

c) Sensoru masīva loģiskās vadības sistēmas modelēšana, ar izplūdušās loģikas izmantošanu programēšanas vidē (veiksmīgs). Izplūdušās loģikas algoritms (procesā). Jauna sensoru masīva adaptācija (procesā). Jauna pastiprinātāja PCB izgatavošana (procesā). Apakš- kontrolleris Atmega 16 ieskaitot PCB (paveikta). Vēsturisko datu salīdzināšanas masīvs PCB (procesā);

d) Tika uzsākta izpēte par RGB Color frekvences sensora iekļaušanu sensoru masīvā. Šī sensora izmantošana ir ārkārtīgi lietderīga, un tas tiks izmantots kopā ar sensoru masīvu, stiprinot kopējo sistēmu.

Novelty of the research

To better understand the novelty of the project it should be noted that there are many devices under development or offered as a final solution for mapping and obstacle avoidance in autonomous robotics. Most have one thing in common in that the robot is emitting or transmitting some type of radiation or signal. Sonar, infrared and ultrasonic range finders are but a few. It is envisioned to develop a model that utilises existing disturbances, noise or naturally occurring radiation, already present in the environment, to enable an autonomous agent (robot) to avoid obstacles and to move unobstructed throughout any given environment with a high degree of success and without need to emit its own radiant sources.

a) The project robot is devoid of any emitting devices.

b) PIR sensors modified by the author are utilized.

c) Attempting area mapping using only gathered photovoltaic data without use of CCD imaging technologies.

Achieved results

a) Selection of appropriate sensors. Software simulation, amplification simulation and preliminary design requirements completed. Solving mathematical problems associated with amplification and weighting of system.

b) Assembly of the first basic mobile platform (successful testing). Assembly of basic sensor array (successful testing). Re-design of final amplification PCB circuitry (completed). Re-design of motor drive and logic circuitry (Completed). Selection of sub-microcontroller architecture.

c) Software simulation of sensor array Fuzzy Logic control system (successfully completed). FL algorithm (in progress). Assembly of new sensor array (in progress). New amplification PCB production (in progress). Sub-microcontroller Atmega 16 including PCB (completed). Legacy comparator array PCB (in progress).

d) Commenced investigation for inclusion of an RGB Color frequency sensor. This inclusion is imminent and will operate in conjunction with the array sensor unit strengthening the whole system.

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UĢIS SIRMELIS

Promocijas darba nosaukums: Intelektuālo enerģijas uzkrājēju vadības algoritmu izstrāde sabiedriskā elektriskā transporta enerģijas patēriņa optimizēšanai

PhD title: Development of intelligent control algorithms for energy storage systems to optimize the energy consumption of public electrical transport

Zinātniskais vadītājs:
Dr.Sc.ing., asoc. prof. Leonards Latkovkis

Scientific adviser:
Dr.Sc.ing., assoc. prof. Leonards Latkovkis

Pētījuma kopsavilkums

Aprīkojot sabiedriskā elektriskā transporta sistēmu ar superkondesatoru enerģijas uzkrājējiem, ir iespējams paaugstināt tās efektivitāti, jo tiek saglabāta transportlīdzekļu bremzēšanas enerģija. Enerģijas uzkrājējam var uzstādīt dažādus uzdevumus, piemēram, atmaksāšanās laikam jābūt pēc iespējas īsākam, maksimāli jāsaglabā bremzēšanas enerģiju, jānolīdzina jaudas maksimumus no apakšstacijas utt. Realizējot kādu no šiem uzdevumiem, jāņem vērā ir gan transportlīdzekļu kursēšanas grafiks, gan kontakttīkla, vilces apakšstacijas un enerģijas uzkrājēja parametrus (energoietilpība, jaudas spēja, kalpošanas ilgums, pieļaujamā temperatūra), gan elektroenerģijas cenu politiku.

Izmantojot elektriskā transporta sistēmas matemātisko modeli un eksperimentāli nomērītas transportlīdzekļu jaudas diagrammas, datorsimulāciju ceļā iespējams gan veikt optimālu enerģijas uzkrājēja dimensionēšanu, gan izveidot optimālu vadības algoritmu izvēlētajam uzdevumam.

Pētījuma novitāte

Superkondensatoru kā enerģijas uzkrājēju pielietojums elektriskajā transportā starptautiski ir atzīts par ļoti perspektīvu nākotnes tehnoloģiju. Taču pagaidām ir tikai daži eksperimentālu iekārtu uzstādīšanas piemēri. Lai sasniegtu maksimālo enerģijas uzkrājēju uzstādīšanas efektivitāti, vilces apakšstacijas, līdzstrāvas kontakttīkli ar transportlīdzekļiem un uzstādītās rekuperatīvās enerģijas uzkrāšanas iekārtas tiks

Summary of the research

Installation of energy storage devices in a public electrical transport system allows recovering the braking energy of vehicles, thus increasing system efficiency. Energy storage device can have various tasks for example: payback period must be as short as possible, save all the braking energy, limit the power peaks from substation, etc. Besides to reach the maximum efficiency for selected goal, vehicle schedule, parameters of DC transmission lines, traction substations and ESSS (energy and power capability, cyclability, temperature) and price of electrical energy and power must be taken into account.

Using of the mathematical model of electrical transport system and experimentally measured vehicle power diagrams makes possible to perform optimal sizing and energy management of energy storage device to provide its maximum efficiency for selected goal.

Novelty of the research

Application of supercapacitor based energy storage systems in electrical transport is recognized as a very perspective technology for recovery of regenerated energy. However only few energy storage systems have been installed in real life. To maximize the performance of energy storage devices, the overall efficiency of the system containing traction substation, DC transmission lines, vehicles and energy storage devices will be examined. Besides to simulate vehicles operation, experimentally measured

pētītas kā vienota energosistēma, turklāt transportlīdzekļu simulēšanā tiks izmantotas eksperimentāli nomērītas jaudas diagrammas. Attiecīgi uzstādītajam enerģijas uzkrājēja uzdevumam tiks veikta enerģijas uzkrājēja dimensionēšana, veidoti intelektuāli algoritmi un pārbaudītas intelektuālo vadības metožu (neironu tīkli, faziloģika) pielietošanas iespējas.

Sasniegtie rezultāti

Ir izstrādāts sabiedriskā elektriskā transporta sistēmas matemātiskais modelis. Modelis ir veidots Matlab/Simulink vidē un ietver sevī tramvaju, kontakttīklu, vilces apakšstaciju un superkondesatoru enerģijas uzkrājēju.

Ar eksperimentāli nomērītām tramvaja jaudas diagrammām veikta zudumu novērtēšana Rīgas 10. barošanas apakšstacijas robežās.

Dalība projektos

Projekta izpildītājs, projektā: „Eiropas energotehnoloģiju stratēģiskā plāna Latvijas aktivitāšu atbalsta zinātniskā grupa”

Līguma numurs: 2009/0213/1DP/1.1.1.2.0/09/APIA/VIAA/027

Projekta izpildes termiņš: 2010. gada 1. janvāris – 2012. gada 31. decembris

Projekts tiek izpildīts Fizikālās enerģētikas institūtā, LV900021289.

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power diagrams will be used. According to the goal of energy storage device optimal its sizing will be made and optimal control algorithm developed. The use of intelligent control methods (fuzzy logic, neural networks) will be investigated as well.

Achieved results

A mathematical model of the electrical transport system is developed in Matlab/Simulink. It includes DC transmission lines, vehicles, traction substation and supercapacitive energy storage device.

Energy losses in the feeding zone of 10th traction substation (Riga) have been evaluated by simulating the model with experimentally measured tram power diagrams.

Participation in projects

The project contractor, project: "European Strategic Energy Technology Plan supports the activities of Latvian research group"

Contract Number: 2009/0213/1DP/1.1.1.2.0/09/APIA/VIAA/027

Project completion date: 2010. On the first January - 2012. On the 31st December.

The project is being executed at the Institute of Physical Energetics, LV900021289.

GUNDARS AŠMANIS

Promocijas darba nosaukums: Trīsfāžu EMI filtru augstfrekvences parazītiskie parametri

PhD title: High Frequency Effects of Parasitic Parameters of Three Phase EMI Filters

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Leonīds Ribickis

Scientific adviser:
Dr.Habil.Sc.ing., professor Leonids Ribickis

Pētījuma kopsavilkums

Pētījums ietver trīsfāžu EMI filtru parazītisko augstfrekvences parametru izpēti un kompensēšanu frekvenču diapazonā 150kHz-30MHz. EMI filtri, kas paredzēti vadāmības traucējumu ierobežošanai sastāv galvenokārt no kapacitatīviem un induktīviem komponentiem. Ir labi zināms, ka šo komponentu augstfrekvences parazītiskie parametri iespaido EMI filtru vājinājumu, taču pastāv arī komponenšu starp parazītiskie parametri - parazītiskā kapacitāte un mijinduktivitāte, kas parasti tiek ignorēta. Šī pētījuma gaitā šie parazītiskie parametri tiek izvērtēti un analizēti. Šo parametru tieša mērīšana nav iespējama to izkliedētā rakstura dēļ, tādēļ jaunas metodes un metodika tiek izstrādāta trīsfāžu EMI filtru parazītisko parametru netiešai mērīšanai.

Pētījuma novitāte

Trīsfāžu EMI filtri tiek pirmo reizi tiek raksturoti, izmantojot S-parametrus. Filtru starpkomponenšu parazītiskie parametri tiek netieši mērīti, izmantojot S-parametru mērījumus un to sakarību ar Z-parametriem attiecībā uz T-veida divpoliem. S-parametru mērījumi tiek izmantoti trīsfāžu EMI filtru vājinājuma aprēķināšanai un tā atkarības noteikšanai no starpkomponenšu parazītiskajiem parametriem, komponenšu parazītiskajiem parametriem un filtra topoloģijas. Viskritiskākie starpkomponenšu parazītiskie parametri, kas iespaido EMI filtra augstfrekvences parametrus, tiek noteikti un analizēti.

Summary of the research

The research is devoted to three phase EMI filters parasitic parameter extraction and elimination in frequency range 150kHz-30MHz. EMI filters for conducted emission suppression consist of capacitors and inductors. It is a well known fact that each component, especially in high frequency range, has parasitics that have impact on filters insertion loss. Therefore, there exist couplings between components- capacitive and inductive, that usually are ignored. Those most important of them are discovered and analyzed. Direct measurement of inter-component parasitics is impossible because of their dispersed character, thus new indirect techniques are developed for three phase filter parasitic extraction.

Novelty of the research

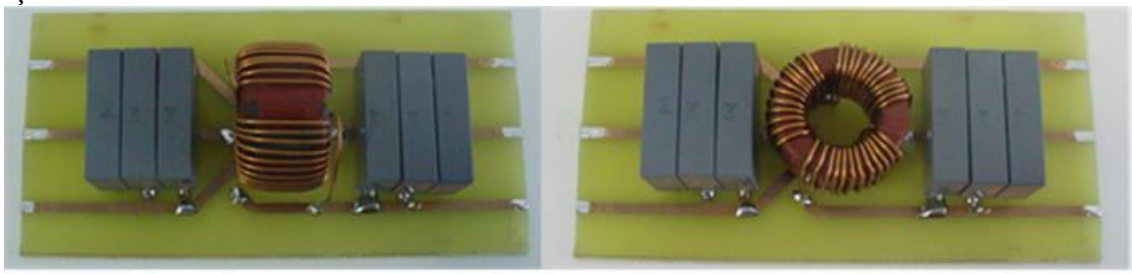
The three phase EMI filter is first time characterized by scattering parameters. Mutual couplings between the filter components are extracted using scattering parameter measurements and their relationships with Z-parameters for two port T-networks. S-parameters are used to predict filter insertion loss and its dependence on filters layout configuration and mutual couplings and filter component self-parasitic parameters. The most important mutual couplings that distort high frequency insertion loss of three phase filter are discovered and analyzed.

Sasniegtie rezultāti

Izstrādāta metodoloģija trīsfāžu EMI filtru starpkomponentu parazītisko parametru aprēķināšanai un izvērtēšanai.

Achieved results

Developed methodology for three phase EMI filters mutual coupling extraction and analysis.



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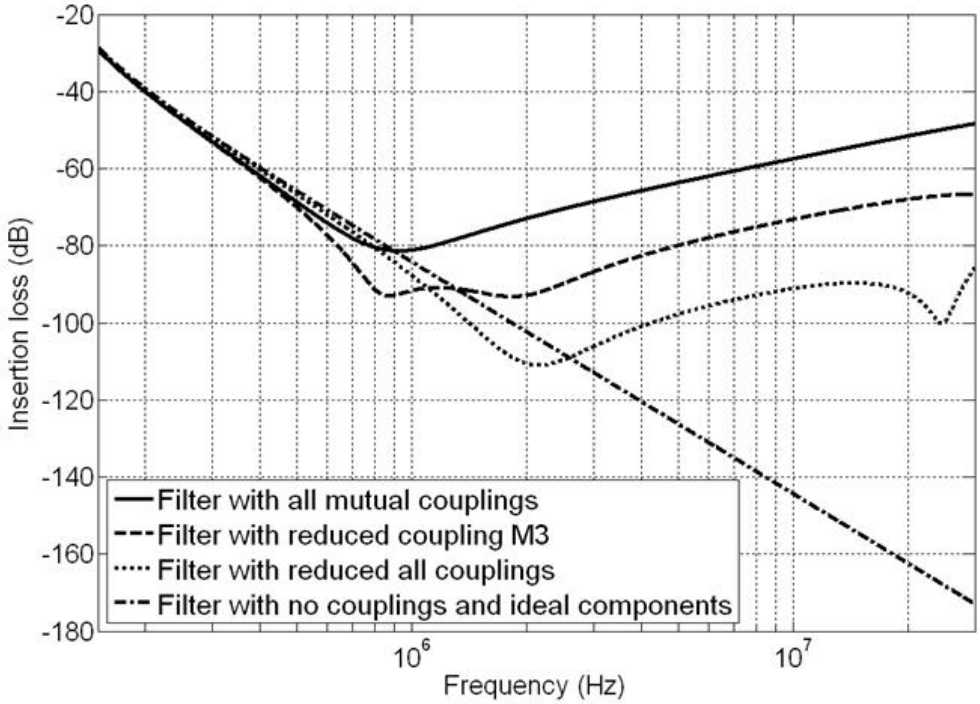

Dalība projektos

- Starptautiskais Era-Net projekts: „Power Quality and Safety Requirements for People and Electrical Equipment in Smart Grid Customer Domain" (Tēma L7678). Darba uzdevums: Izstrādāt līdzekļus STATCOM pārveidotājiem saistošo izstaroto traucējumu elektromagnētiskās savietojamības normatīvu ievērošanai.
- ES 7.IP ICT for energy efficiency and sustainibility in urban areas, Līgums Nr. 238916, LITES (Led-based Intelligent street lighting for Energy Saving). 2009.-2013. gads. Darba uzdevums: Pētīt LITES shēmu elektromagnētisko savietojamību.
- VPP-V7640 (Valsts pētījumu programmas) projekts Nr.6 „Energoelektronikas tehnoloģiju izstrāde elektroenerģijas patēriņa samazināšanai un atjaunojamo enerģijas avotu

Participation in projects

- The International Era-Net project "Power Quality and Safety Requirements for Electrical Equipment and People in the Smart Grid Customer Domain" (Subject L7678). Terms of reference: Development of tools STATCOM converters binding interference radiated electromagnetic compatibility comply with regulations.
- EU 7.IP ICT for Energy Efficiency and sustainibility in Urban Areas, Contract No. 238916, Lite (LED-based intelligent street lighting for the Energy Saving). 2009 to 2013. year. Terms of reference: To explore the LITE circuit electromagnetic compatibility.
- PPP-V7640 (National Research Programme) project No. 6 'power electronic technologies to reduce consumption and

izmantošanas veicināšanai Latvijā". 2010. - 2013.g. (Tēma 2011.gadā – Nr. 7682) Darba uzdevums: Izstrādāt elektromagnētiskās savietojamības filtrus daudzlīmeņu invertora laboratorijas modelim.

renewable energy sources in Latvian. "The 2010th -2013.g. (Subject 2011 - No. 7682) The role: Develop EMC filters multi-level invertor laboratory model.

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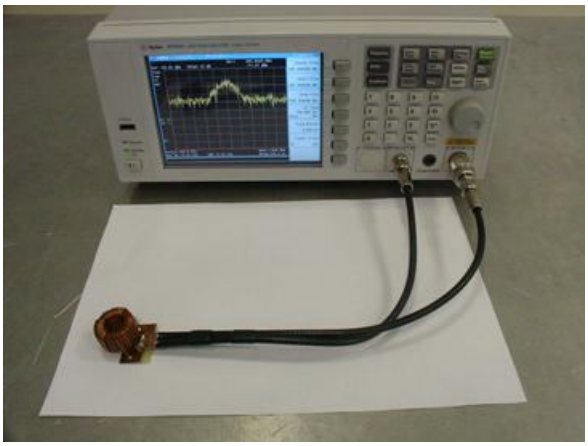


VLADIMIRS KAREVS

Promocijas darba nosaukums: Dzelzceļa automātikas un telemātikas sistēmas monitoringa un diagnosticēšanas metožu izpēte un izstrāde

PhD title: Investigation and development of monitoring and diagnostic methods for railway automatic and telematic systems

Zinātniskais vadītājs:
Dr.Sc.ing., asoc. prof. Mareks Mezītis

Scientific adviser:
Dr.Sc.ing., assoc. prof. Mareks Mezitis

Pētījuma kopsavilkums

Dzelzceļa automātikas un telemātikas sistēmai nepieciešams augsta līmeņa drošums un drošība, ko apliecina IEC EN un ГОСТ, ОСТ prasības. Apkalpošanas stratēģijas izvēles mērķis ir nepārtraukta sistēmas darbība ar minimālām izmaksām. Pētījumā aplūkoti instrumenti, kas ļauj uzbūvēt monitoringa un diagnostikas apakšsistēmu un kritēriji apakšsistēmas kvalitātes novērošanai. Informācijas plūsmas apjoma optimizēšanai un iespējai veikt informācijas apstrādi bez mērvienības lielumos „konveijera" tipa procesā ar definēto rezultāta izveidošanas laiku, definēts stāvokļa funkcijas jēdziens. Pētījumā izstrādāta monitoringa un diagnostikas metode specializētiem automātikas un telemātikas sistēmas elementiem, un aprēķināts metodes sasniegtais dziļums.

Pētījuma novitāte

Pētījumā pirmo reizi izskatīts drošs mērinstrumenta izmantošanas algoritms; piedāvāti skaitliskie kritēriji monitoringa un diagnostikas apakšsistēmas uzbūves kvalitātes un funkcionēšanas novērtēšanai; izskatīts adaptēta gatavības koeficienta jēdziens; izstrādāts matemātiskais pamats elementa stāvokļa funkcijas pēc parametru kopuma aprēķināšanai; piedāvāta metode impulsu releju atkārtotāju elektromehāniskās sistēmas diagnosticēšanai; veidota paplašināta ekvivalenta releju shēma; izstrādāta elektromehāniskā ceļa kodu transmittera elektroniskais prototips drošas uzbūves metodoloģijai; piedāvāta metode

Summary of the research

Railway automatic and telematic equipment require high level of safety and reliability (IEC EN, ГОСТ, ОСТ). Commonly used for railway systems is availability factor. Thev selection of maintenance strategy of a device is a way for protection from sudden failure and faulty and define cost of maintenance. Research proposes instruments for monitoring and diagnostic subsystem design with criteria for processing quality. For high quality and validity of monitoring and diagnostic results processing in research is applied state function of element state definition. State function performing is dimensionless processing engine with predictable decision accepting time. Research kernel is methods for state function estimation for concrete railway automatic and telematic element with penetration of depth estimation.

Novelty of the research

The research first time introduced and developed: safety measurement algorithm for handheld instrument; numerical criteria for monitoring and diagnostic subsystem; adopted availability factor for system; mathematical base for state function of element estimation via number of parameters; impulse relay repeater anchor and contact group diagnostic time based method; extended equivalent circuit of relay with anchor effect including; design prototype with self diagnostic for electromechanical code transmitter; method for storage battery state monitoring and diagnostic via internal resistance

akumulatoru baterijas stāvokļa funkcijas noteikšana, izmantojot slodzes ģenerāciju.

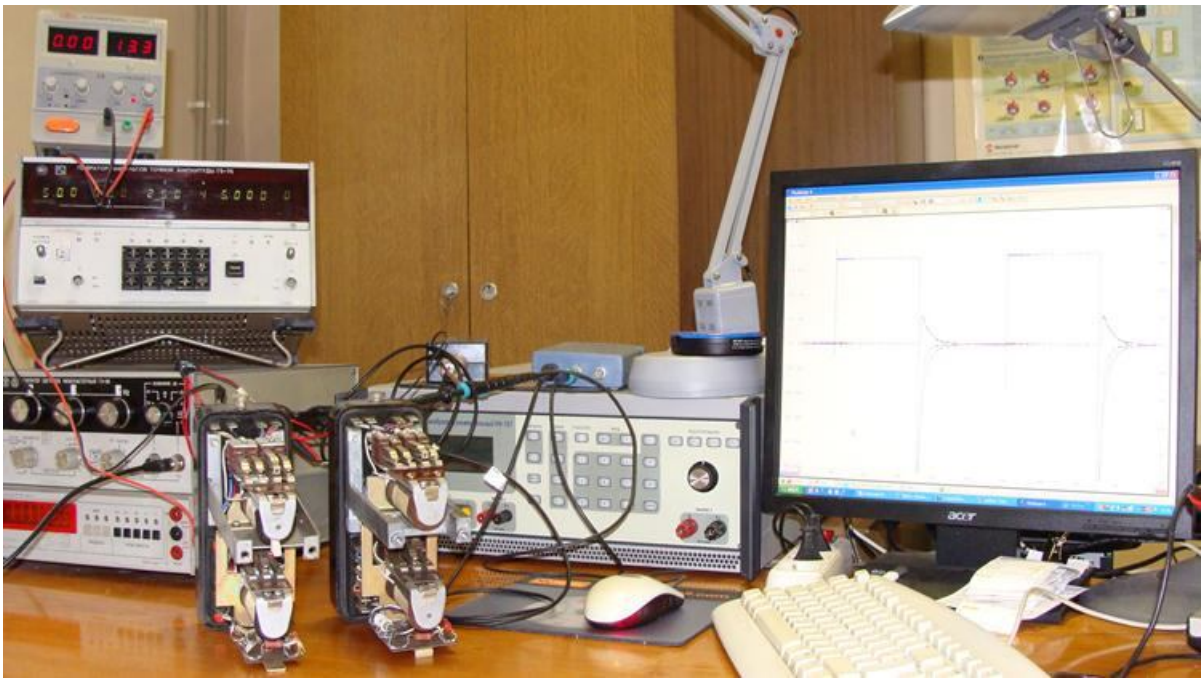
Sasniegtie rezultāti

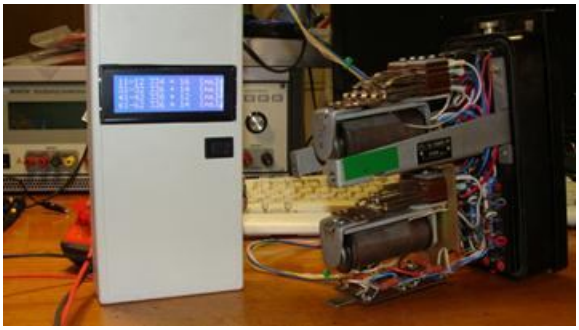
Praktiskie rezultāti ir: elektromehāniskā kodu transmittera aizvietošanai ECT prototipa (P-11-161) КПТ-Э ar aprēķinātu MTBF 6.4 gadi SIL 3 drošuma pakāpe izveidošana; impulsu releju monitoringa un diagnostikas metode ar diagnosticēšanas dziļumu PD = 35%; baterijas stāvokļa noteikšanas metodoloģija (P-11-160).

with tracing load generator.

Achieved results

Practical results are: ECT (patent application P-11-161) for old electromechanical transmitter direct replacement with high reliability MTBF 6.4 year and SIL 3(IEC EN 61508, EN 50128, EN 50129); impulse relay testing based on anchor presence effect for electromechanical system wearing achieved PD = 35%; battery state monitoring and diagnostic via internal resistance measurement prepares patent application P-11-160.





TST-2

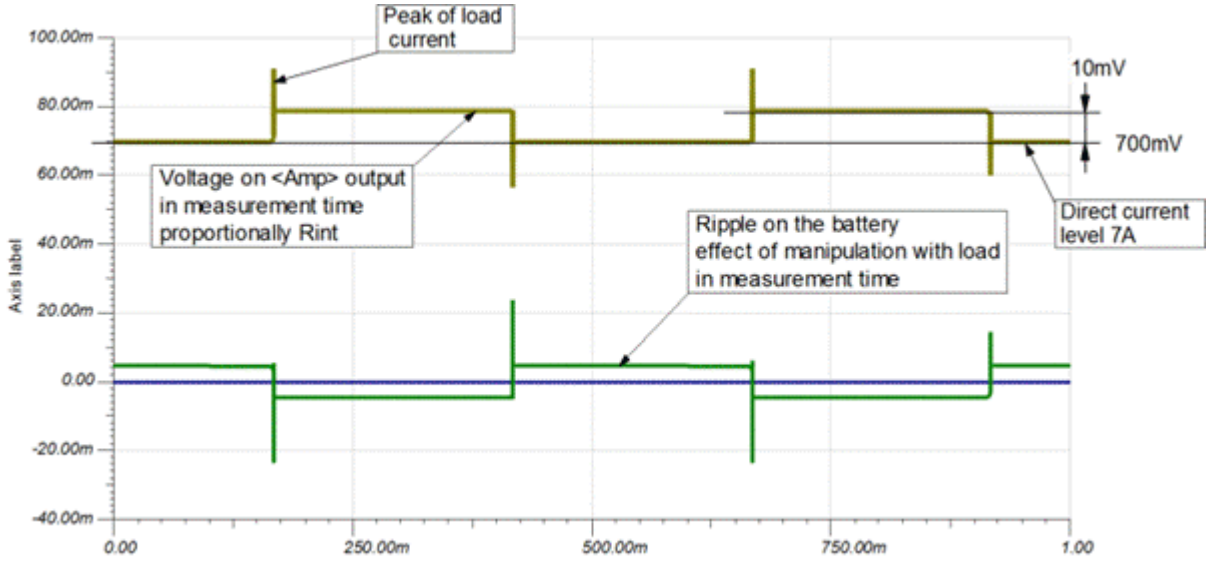
ECT КПТ-Э

Dalība projektos

RTU DzTI „Drošu dzelzceļa transporta vadības algoritmu izpēte”.

Participation in projects

RTU Institute of Railway Transport “Research of safety control algorithm for railway transport”.



Baterijas diagnosticēšana Battery testing

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ANDREJS POTAPOVS

Promocijas darba nosaukums: Elektriskā transporta adaptīvās sistēmas un iebūvētās intelektuālās iekārtas

PhD title: Adaptive Systems and Built-in Intelligent Devices of Electric Transport

Zinātniskais vadītājs:
Dr.Sc.ing., profesors Anatolijs Ļevčenkovs

Scientific adviser:
Dr.Sc.ing., professor Anatoly Levchenkov

Pētījuma kopsavilkums

Iebūvēto intelektuālo ierīču izmantošana paver lielas iespējas dažādu sarežģītu un dinamisku vadības sistēmu uzlabošanā, to ātrdarbības, precizitātes un automatizācijas līmeņa paaugstināšanai.

Tiek izvirzīts pieņēmums, ka tieši iebūvēto intelektuālo ierīču pielietošana, izmantojot bezvadu datu pārsūtīšanas sistēmas, dos iespēju sasniegt izvirzīto darba mērķi un īstenot uzstādītos darba uzdevumus.

Promocijas darba galvenais mērķis ir izstrādāt jaunas dzelzceļa elektriskā transporta bremžu sistēmas vadības ierīces, kuras darbosies balstoties uz adaptīviem vadības algoritmiem un strādās uz iebūvēto intelektuālo iekārtu bāzes. Tas dos iespēju palielināt dzelzceļa elektrotransporta maršrutēšanas drošību un energoefektivitāti.

Pētījuma novitāte

Tā kā pēdējā laikā kļūst arvien aktuālāki kļūst jautājumi, kas ir saistīti ar dzelzceļa transporta maršrutēšanas energoefektivitātes uzlabošanu un tās vadības sistēmu automatizācijas līmeņa celšanu, var teikt, ka izvēlētais promocijas darba izvēlētā tēma risinās šos aktuālos jautājumus.

Adaptīvo vadības algoritmu izmantošana vadības sistēmās ievērojami palielina to darbības efektivitāti un precizitāti, līdz ar to palielinot kopējo vadāmā objekta energoefektivitāti un citus svarīgus raksturlielumus. Savukārt bezvadu sakaru sistēmas pielietošana paver lielas iespējas datu apmaiņas procesā, līdz ar to paaugstinot

Summary of the research

Use of built-in intelligent devices opens up great opportunities in improving various complex and dynamic control systems, for the purpose of increasing their speed, precision and automation levels.

It is assumed that exactly the application of built-in intelligent devices, using wireless data transmission systems, will provide an opportunity for reaching the goal set for the research, and for realizing the research tasks.

The main goal of the promotion paper is to develop new control devices of a braking system for railway electric transport, which will work grounding on adaptive control algorithms, and will operate on the basis of built-in intelligent equipment. This will give a possibility to increase the safety and energy efficiency of electric rail transport routing.

Novelty of the research

Because of the matters concerning the improvement of energy efficiency of rail transport routing and raising automation level of its control systems have become more pending recently, it can be said that the chosen topic of the promotion thesis will address these specified pending issues.

The application of the adaptive control algorithms in the control systems noticeably increases their operation efficiency and other important characteristic values. Moreover, application of the wireless communication systems opens up great opportunities for the

kopējo vadības sistēmas automatizācijas līmeni. Visas iepriekšminētās tehnoloģijas pēdējā laikā ir pierādījušas savu lielo potenciālu transporta industrijas attīstībā.

Sasniegtie rezultāti

Pēc adaptīvo vadības algoritmu un dzelzceļa transporta maršrutēšanas drošību paaugstinošo izgudrojumu analīzes, tika izstrādāts jauns adaptācijas algoritms, kurš ir paredzēts jaunajai dzelzceļa drošības sistēmai. Šīs sistēmas uzdevumos ietilpst dzelzceļa ritošā sastāva bremžu sistēmas vadība, lai realizētu dzelzceļa ritošā sastāva laidenu un precīzu apstādināšanu nepieciešamajā punktā, kā arī dzelzceļa ritošā sastāva apturēšanu pirms neparedzētiem šķēršļiem. Tika izstrādāts jaunās dzelzceļa ritošā sastāva adaptīvās vadības sistēmas datormodelis. Šis modelis ļauj testēt izstrādāto adaptīvo vadības algoritmu laboratorijas apstākļos un analizēt tā darbības efektivitāti, vadot speciāli izstrādāto dzelzceļa ritošā sastāva kustības datormodeli. Rezultātā tiek iegūti teorētiskie dati par ritošā sastāva apstāšanās precizitāti un vadāmo parametru (esošais, reālais un teorētiskais kustības ātrums, distance līdz objektam, bremzēšanas paātrinājums u.c.) vērtības katrā bremzēšanas procesa laika vienībā un to atkarību no teorētiski uzdotajiem dzelzceļa ritošā sastāva kustības modeļa parametriem. Tika veikta arī izstrādātās iekārtas prototipa testēšana reālajos darba apstākļos, kur tika pierādīts, ka laboratorijā sasniegtie iekārtas darbības rezultāti atbilst reāliem datiem, vadot īstu lokomotīvi.

Dalība projektos

- FLPP-2010/34 „Ritošā sastāva jaunas diagnostikas iekārtas
drošuma testēšana avārijas situācijās".
- FLPP-2010/32 „Ritošā sastāva jauno kustības vadības iekārtu drošuma testēšana avārijas situācijās".
- FLPP-2011/13 „Vilciena bremzēšanas ceļa noteikšanas patentētās iekārtas un vilciena kustības posmu pārbaudes patentētās iekārtas starptautiskais patentmeklējums".
- FLPP-2011/14 „Dzelzceļa pārbrauktuvju intelektuālo drošības iekārtu un algoritmu izstrāde".
- 2-04829, 06.10.2011. pSAFECER (1.posms)

process of data exchange, along with increasing the general automation level of the control system. All the earlier mentioned technologies have recently demonstrated their great potential for the development of the transport industry.

Achieved results

After having analyzed the adaptive control algorithms and the safety increasing devices for the rail transport routing, a new adaptation algorithm, meant for a new railway safety system, was developed. The objectives of this system involve the control of a braking system of a railway rolling stock, for the purpose of performing smooth and precise stopping of the railway rolling stock at the required place, as well as, an emergency stopping of the railway rolling stock before unforeseen obstacles. A computer model of a new adaptive control system for a railway rolling stock was developed. This model allows testing of the developed adaptive control algorithms under laboratory conditions and analyzing its operational efficiency, controlling a specially developed computer model of a railway rolling stock movement. As a result the theoretical data was achieved about a precision of the railway rolling stock stopping and the values of controllable parameters (a current real and theoretical movement speed, a distance till the object, braking acceleration, etc.) in a time unit of every braking process and their dependence from the theoretically set parameters of a railway rolling stock movement model. In addition, testing of a prototype of the developed device was carried out in real conditions, and it was proved that the results of the device operation achieved in the laboratory correspond to the real data controlling a real locomotive.

Participation in projects

- FLPP-2010/34, „Testing of Reliability of New Diagnostic Equipment of Rolling Stock in Emergency Situations".
- FLPP-2010/32, „ Testing of Reliability of New Movement Control Equipment of Rolling Stock in Emergency Situations".
- FLPP-2011/13, „International Patent Search of Train Stopping Distance Determination Patented Equipment and Train Movement Section Testing Patented Equipment".
- FLPP-2011/14, „Development of

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Railway Level Crossings Intellectual Safety Equipment and Algorithms".

- 2-04829, 06.10.2011 pSAFECER (Stage 1)

JURIS EGLE

Promocijas darba nosaukums: Jonizējošās radiācijas dozimetru, ar Geigera-Millera skaitītājiem, mērīšanas metožu, shēmu un algoritmu izpēte, optimizācija, izstrāde un realizācija

PhD title: Ionizing radiation dosimeter, with a Geiger-Muller counters, measuring techniques, schemes and algorithms research, optimization, development and realization

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Ivars Raņķis

Scientific adviser:
Dr.Habil.Sc.ing., professor Ivars Rankis

Pētījuma kopsavilkums

Darbā ir izpētīta jonizējošā starojuma fizikālie pamati, esošās mērīšanas metodes, shēmas un algoritmi. Pamatojoties uz šiem pētījumiem, tika veikti uzlabojumi, izstrādāts un izgatavots dozimetra prototips, izmantojot firmas Microchip mikrokontrolleri PIC18F4220. Prototipā tika pārbaudīti un uzlaboti mikrokontrollera darbības algoritmi. Pamatojoties uz Salaspils radiācijas laboratorijas mērījumu rezultātiem, mikrokontrollera aprēķinu formulās lietotās konstantes tika precizētas.

Pētījuma novitāte

Apvienotas vienā shēmā abas tradicionālās mērīšanas metodes: strāvas mērīšana caur Geigera-Millera skaitītāju un izlādes impulsu frekvences mērīšana.

Lielākā daļa no funkcijām, kuras tradicionāli veica diskrēti elektroniskie elementi, tika pārnesti uz mikrokontrolleri, kas ļāva samazināt elementu skaitu, dozimetra pašizmaksu, kā arī būtiski uzlabot ierīces modificēšanu, izmantojot tikai mikrokontrollera programmas modificēšanu.

Izstrādāts pilnīgi jauns aprēķinu algoritms, kas ļauj dozimetram automātiski izvēlēties precīzāko mērīšanas metodi atkarībā no jonizējošā starojuma intensitātes.

Sasniegtie rezultāti

Pamatojoties uz pētījumu rezultātiem tika izgatavoti dozimetra paraugi, tie tika testēti elektromagnētiskās savietojamības un radiācijas

Summary of the research

The research the physical grounds of ionizing radiation, as well as measurement methods, schemes and algorithms. Based on these studies, the improvements were made. The dosimeter prototype was designed and produced, using "Microchip PIC18F4220" microcontroller. The prototype was tested and microcontroller's algorithms have been improved for better performance. Based on radiation measurement results taken from the laboratory in Salaspils, some constants used in microcontroller's calculation formulas were specified.

Novelty of the research

Combined into one scheme, the two traditional methods of measurement: current measurement through a Geiger-Muller counter and pulse-frequency discharge measurement;

Most of the functions traditionally carried out by discreetly electronic components, was transferred to the microcontroller. This allows to reduce the number of items, as well as to reduce the cost of dosimeter and give the possibility to improve modification of the device by using microcontroller's program modifications only;

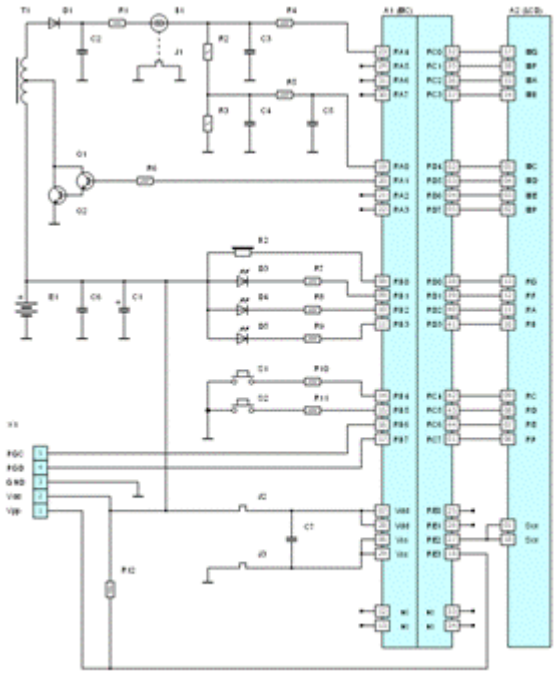
A new calculation algorithm was developed allowing the dosimeter automatically choose the best method of measurement, depending on the ionizing radiation intensity.

Achieved results

Based on the research results, dosimeter

laboratorijās. Dozimetrs ir ieviests ražošanā uzņēmumā „ICD electronics” ar nosaukumu RD01 un tam ir piešķirts Eiropas sertifikāts. Tehnoloģija un atļauja arī ražot izstrādāto dozimetru, ar nosaukumu DX3 vai DX4, tika pārdota ASV firmai „Industrial test systems”.

samples were designed and tested in electromagnetic compatibility and radiation laboratories. Designed dosimeter is put into production on enterprise "ICD electronics" with the official name - RD01. It received a European certificate. The Technology and licence to produce the dosimeters with names DX3 or DX4 was sold to U.S. company "Industrial test systems ".



Dozimetra RD01 principiālā shēma / Principal schematic of dosimeter RD01

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ANATOLIJS ZABAŠTA

Promocijas darba nosaukums: Kritiskās infrastruktūras datorvadības metožu izstrāde

PhD title: Development of computer control techniques for Critical infrastructure

Zinātniskais vadītājs:
Dr.Sc.ing., asoc. prof. Nadežda Kuņicina

Scientific adviser:
Dr.Sc.ing., assoc. prof. Nadezhda Kunicina

Pētījuma kopsavilkums

Tiek izanalizēti literatūras avoti par kritiskajām infrastruktūrām un to savstarpējo ietekmi un atkarību. Ir apskatītas metodes, ar kurām var vērtēt kritiskās infrastruktūras savstarpējo ietekmi. Tiek salīdzinātas pielietotās metodes un tiek izvēlēta atbilstošā metode, lai veiktu infrastruktūras savstarpējās ietekmes analīzi. Ir izpētīta metode, ar kuru izveido novērtēšanas metrikas un darbības rādītājus savstarpēji atkarīgajām kritiskajām infrastruktūrām, pamatojoties uz to informācijas saturu, ekspertu viedokļiem un riska analīzes rezultātiem.

Pētījuma novitāte

Pētījumā ir izklāstīta pieeja, kas ļauj uzraudzīt un kontrolēt kritiskās infrastruktūras, apsverot CI sniegto pakalpojumu stāvokli, kā arī savstarpēji saistīto CI pakalpojumu stāvokli. Tādēļ mērījumi, kas apraksta katras kritiskās infrastruktūras stāvokli un pakalpojumus, tiek abstrahēti par vienotiem parametriem, kas varētu būt izplatīti starp savstarpēji atkarīgajām kritiskajām infrastruktūrām. Šāda pieeja ļauj konkrētas infrastruktūras ekspertiem novērtēt citu saistīto CI ietekmi uz savu CI un uz tās sniegtajiem pakalpojumiem.

Sasniegtie rezultāti

Ir izpētīta teorētiskā pieeja un ir apskatīts piemērs, kurā tiek modelēta ūdensapgādes un telekomunikāciju pakalpojumu atkarība no pārtraukumiem elektriskajā tīklā, izmantojot

Summary of the research

The literature on critical infrastructures and the mutual influence and dependence has been analyzed. The methods for the evaluation of mutual influence of the critical infrastructures have been observed. The methods used have been compared and the appropriate method is chosen to make the infrastructures interdependences analysis. A method of establishing evaluation metrics and performance indices of interdependent critical infrastructures, based on their content, expert opinions and risk analysis has been researched.

Novelty of the research

The study presents an approach to monitor and control critical infrastructures, considering the CI services provided by its own CI, as well as interdependent CI services conditions. With that objective measurements that describe the state of each critical infrastructure and services are abstracted by means of the common indicators that could be distributed between the interdependent critical infrastructures. This approach allows particular infrastructure experts to evaluate the impact brought by other related CI on their CI and on the services it provides.

Achieved results

The theoretical approach and outlines have been studied. An example of dependence of water supply and telecommunication services from the outages happened in power greed has been described using unified modelling language

universālo modelēšanas valodu (UML).

Dalība projektos

- COST Action 0806 IntelliCIS, Kritiskās infrastruktūras sistēmu gudrā uzraudzība, vadība un drošība", 200.9 -2013.g.
- „Inovatīvi e-pakalpojumi ūdens apgādes vadībai" (E-Water), 2010-2012, Latvijas – Lietuvas pārrobežu programma 2007. – 2013.g.
- „Smart Metering", 2012 – 2013.g, Latvijas – Lietuvas pārrobežu programma 2007 – 2013.g.

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(UML).

Participation in projects

- COST Action 0806 IntelliCIS, Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems, 2009 – 2013.
- Innovative e-services for water supply management (E-Water), 2010 – 2012.g., Latvian – Lithuanian Cross-border cooperation program 2007-2013.
- Smart Metering, 2012 – 2013.g., Latvian – Lithuanian Cross-border cooperation program 2007-2013.

GLEBS GOLUBOVS

Promocijas darba nosaukums: Maiņstrāvas piedziņas ar frekvences pārveidotāju vadības sistēmu optimizācija

PhD title: AC drive with frequency converter control system optimization

Zinātniskais vadītājs:
Dr.Sc.ing., asoc. prof. Anastasija Žiravecka

Scientific adviser:
Dr.Sc.ing., assoc. prof. Anastasija Zhiravecka

Pētījuma kopsavilkums

Pētījums ietver detalizētu asinhronās piedziņas vektoriālās vadības sistēmu izpēti un to turpmāko optimizāciju. Tika izanalizēta vektoriālās vadības metožu klasifikācija, apskatīti un arī analizēti galvenie parametri, pēc kuriem tika veikti šīs vadības pieejas pētījumi. Uz to bāzes tika piedāvāta arī kritēriju sistēmas ideja, kuru tiek plānots detalizēti izanalizēt pēc katra vadības apakšveida, salīdzināt to, atrast vektoriālās vadības optimizācijas iespējas.

Pētījuma novitāte

Asinhronie dzinēji ar frekvenču pārveidotājiem tiek plaši pielietoti, it īpaši sistēmās, kuras prasa augstu vadības precizitāti un vismazākās izmaksas. Arvien pieaugošais pieprasījums pēc asinhronajiem dzinējiem ar frekvenču pārveidotāju vadību prasa detalizētu šādu sistēmu izpēti un jaunu vadības metožu radīšanu.

Sasniegtie rezultāti

- Tika veikta asinhronas vektoriālajai piedziņai pakārtotas regulēšanas izpēte un optimizācija.
- Tika noteikti galvenie optimizācijas kritēriji un attīstīta kritēriju sistēma (1. attēls), pēc kuras ir iespējams novērtēt, analizēt un salīdzināt esošās un jaunas vadības pieeju.
- Tika izanalizēta vektoriālās vadības metožu klasifikācija, apskatīti un arī analizēti galvenie parametri, pēc kuriem tika veikti šīs vadības pieejas pētījumi. Uz to bāzes tika piedāvāta arī

Summary of the research

The research includes a detailed investigation of field-oriented control system of asynchronous drive and its further optimization. The classification of the control approach types is analyzed as well as main parameters are considered and analyzed according to which the control method was observed. An idea of the criteria system is proposed for further planning of deep analysis according to each type of control, compare it and search for opportunities of further optimization of the control.

Novelty of the research

Induction motors with frequency converters are widely applied especially in the systems requiring high accuracy of control and lower expenses resulting in further deeper investigation of these system and development of new control approaches.

The achieved results

- The opportunities of cascade control of induction motors vector systems and its optimization were investigated.
- The basic optimization criteria were determined and a criteria system was developed (fig.1) according to which it is possible to evaluate, analyze and compare the existing and new control approaches.
- The classification of the control methods was analyzed, the main parameters of them were considered. On this basis an idea of the criteria system is proposed for further planning of deep analysis according to each type of control,

kritēriju sistēmas ideja, kuru plānots detalizēti izanalizēt pēc katra vadības apakšveida, to salīdzināt un sistematizēt informāciju.

compare it and search for opportunities of further optimization of the control.

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VIESTURS VECKALNS

Promocijas darba nosaukums: Elektrodinamikas metodes elektromagnētiskās saderības problēmu risinājumos

PhD title: Methods of Electrodynamics in Problems of Electromagnetic Compatibility

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Leonīds Ribickis

Scientific adviser:
Dr.Habil.Sc.ing., professor Leonids Ribickis

Pētījuma kopsavilkums

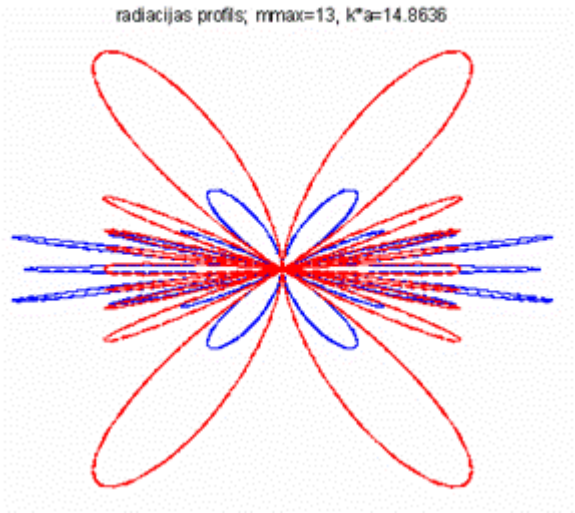
Staroto emisiju analīze:

- emisiju avoti;
- EM viļņu izplatīšanās un viļņu modas;
- EM viļņu izplatīšanās un izkliede.

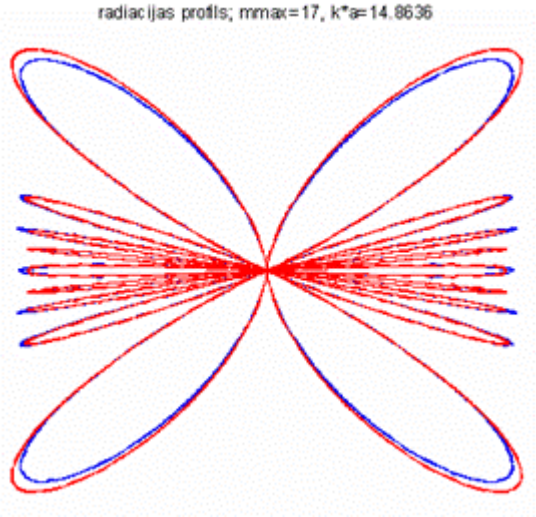
Summary of the research

Analysis of radiated emissions:

- sources;
- propagation and modes of EM waves;
- scattering and diffraction of EM waves.



Emisiju avotu izpēte (a)
Emission sources diagramm (a)



Emisiju avotu izpēte (b)
Emission sources diagramm (b)

Magnētiskā dipola starojuma analīze ar ortogonāliem multipoliem. Attēlos ar sarkano krāsu ilustrēts precīzs starojuma profils, bet ar zilo krāsu – multipolu komponentu summa. Attēlā b) izmantoti augstāki multipoli nekā attēlā a), tādēļ attēlā b) multipolu komponentu summa ir tuvāka precīzajam starojumam.

Emission analysis with orthogonal multipoles. The red contours correspond to the exact radiation profile, whilst the sum of the multipole components is marked by the blue contours. Higher multipole orders are used in b), hence the multipole sum bears closer resemlance to the exact profile.

Pētījuma novitāte

Jaunas elektrodinamiskās metodes

Novelty of the research

Novel electrodynamic methods in

elektromagnētiskajā saderībā.

Sasniegtie rezultāti

Teorijas apguve, piemēru apskats.

Dalība projektos

Vēja un ūdeņraža elektroapgādes autonomā sistēma.

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electromagnetic compatibility.

Achieved results

Theoretical research, case studies.

Participation in projects

Stand-alone system of hydrogen and wind energy.

ANTONS PATĻINS

Promocijas darba nosaukums: Integrētā sistēmas risinājuma izstrādāšana sabiedriskā transporta ilgtspējīgai attīstībai

PhD title: Integrated system solution development for public transport sustainability

Zinātniskais vadītājs:
Dr.Sc.ing., asoc. prof. Nadežda Kuņicina

Scientific adviser:
Dr.Sc.ing., assoc. prof. Nadezhda Kunicina

Pētījuma kopsavilkums

Darba ietvaros sabiedriskā transporta sistēma ir apskatīta kā liela mēroga dinamiska sistēma un ir piedāvāts tās vadīšanu organizēt, balstoties uz sistēmu teorijas pamatiem.

Apkopotas ilgtspējīgas attīstības definīcijas un definēti transporta ilgtspējīgas attīstības principi, izveidots indikatoru saraksts, kas ļauj novērtēt transporta ietekmi uz apkārtējo vidi, piedāvāts algoritms šo indikatoru apstrādei, ka arī piedāvātas metodes saliktu vides ietekmes indikatoru novērtēšanai.

Izpētītas LIDAR tehnoloģijas un analizēta iespēja izmantot LIDAR sabiedriskā transporta sistēmā, lai palielinātu drošību, transportlīdzeklim veicot ārkārtas bremzēšanu.

Piedāvāts risinājumus sabiedriskā transporta sistēmas drošības paaugstināšanai, izmantojot videokameras gan transporta līdzekļos, gan arī ārpus transportlīdzekļiem.

Piedāvāts algoritms un bloku shēma trauksmes signalizācijas sistēmas risinājumam ārkārtas gadījumiem transporta sistēmā.

Tiek piedāvāts vienots trīslīmeņu sabiedriskā transporta vadības sistēmas risinājums.

Piedāvāts trīslīmeņu sabiedriskā transporta vadības sistēmas risinājums, kas nodrošinātu transporta sistēmas kā vienotas lielas sistēmas vadību.

Pētījuma novitāte

Promocijas darba zinātniskais jauninājums ir saistīts ar:

Integrētās transporta vadības sistēmas

Summary of the research

During this research the possibility to control public transport system from large scale dynamical system view was investigated and described. Different references are researched and definitions of sustainability are summarized. Principles of sustainable transport were summarized and environmental indicator list to assess transport impacts was proposed as well as environmental impact aggregation procedure was suggested. The possibility to jointly consider indicators was discovered and joint consideration algorithm was suggested. Methods for building aggregated or composite indicators are researched and suggested.

An overview towards the ITS-related aspects of development of urban transport systems provided. LIDAR sensing technology used in transport systems researched and solution for public transport safety to reduce “human factor” in the case of the need for vehicle emergency braking was offered.

Riga city public transport safety system solution development using camcorders and vision based traffic measurement system was suggested.

Alarming system solution for Riga city public transport system is suggested.

The three-level integrated control tools system solution for public transport system control is suggested.

Novelty of the research

Novelty of the work involves:

risinājuma izstrādi, ņemot vērā esošās lielās sistēmas monitoringa iespējas un statistikas datu apkopošanu, ilgtspējīgās attīstības kritērijus, sistēmas ģeogrāfiski sadalīto struktūru un sistēmas dinamiku, ņemot vērā ārkārtas situācijas un avārijas.

Tiek piedāvāts vienots trīslīmeņu sabiedriskā transporta vadības sistēmas risinājums.

Lielās sistēmas neatkarīgas darbības nodrošināšanai tiek piedāvāts trauksmes signalizācijas sistēmas risinājums, kas nodrošina paziņošanu par ārkārtas gadījumu sistēmā.

Sistēmas drošības rādītāju uzlabošanai ir izstrādāts ārkārtas bremzēšanas shēmas risinājums, kā arī video novērošanas integrēšanas risinājumus.

Sasniegtie rezultāti

LIDAR tehnoloģijas, kas var tikt veiksmīgi izmantotas sabiedriskajā transportā pilsētas apstākļos.

Videokameru izmantošana sabiedriskā transporta sistēmā un pārdomātas trauksmes signalizācijas sistēmas ieviešana.

Pasažieru uzskaites sistēmas risinājums.

Trīslīmeņu sabiedriskā transporta vadības sistēmas risinājums.

Veiktie pētījumi un to rezultāti uzlabo sabiedriskā transporta sistēmas darbību Rīgā.

Dalība projektos

- COST 356 - Towards the definition of a measurable environmentally sustainable transport (EST).
- COST IC0806: Intelligent Monitoring, Control and Security of Critical Infrastructure Systems.
- COST IC0902 “Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Network”.

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Integrated transportation control system solution development, taking into account the larger system monitoring capabilities and data collection, sustainable development criteria, geographically distributed system structure and dynamics of the system, taking into account the emergency situation.

It is proposed that a single three-tier public transport system management solution.

Large systems of independent operation of the proposed alarm system solution that provides for emergency notification system.

System security is designed to improve the rate of emergency braking circuit solution, as well as video surveillance integration solutions.

Achieved results

LIDAR technology can be successfully used in public transport.

Video camera to use the public transport system and alarm system.

Solution for passenger counting systems.

Three levels of public transport control system solution can provide a passenger transport system that a single large system.

The research results can improve public transport system in Riga city.

Participation in projects

- COST 356 - Towards the definition of a measurable environmentally sustainable transport (EST).
- COST IC0806: Intelligent Monitoring, Control and Security of Critical Infrastructure Systems.
- COST IC0902 “Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Network”.

IVARS ALPS

Promocijas darba nosaukums: Intelektuālā elektrotransporta vadības sistēmu sarakstu problēmu modelēšana neparedzētos gadījumos

PhD title: Modelling of scheduling for intelligent electrical transport control

Zinātniskais vadītājs:
Dr.Sc.ing., profesors Anatolijs Ļevčenkovs

Scientific adviser:
Dr.Sc.ing., professor Anatoly Levchenkov

Pētījuma kopsavilkums

Pētījumā izstrādātie algoritmi un piedāvātās transporta sistēmas vadības procedūras var tikt pielietotas pilsētas transporta, tai skaitā arī sabiedriskā elektrotransporta vienību vadības uzlabošanai. Algoritmi paaugstinās pilsētas transporta sistēmas krustojošos plūsmu vadīšanas drošuma pakāpi. Pielietojot izstrādātos algoritmus ir iespējams samazināt dīkstāves laiku. Tāpat izstrādātie algoritmi spēj nodrošināt sabiedriskā transporta kustības saraksta ievērošanu.

Pētījuma novitāte

Pētījumā tiek izstrādāti jauni matemātiskie modeļi, procedūras un algoritmi intelektuālās transporta sistēmas vadības daudzkritēriju uzdevumu risināšanai izmantojot evolucionāros algoritmus un sarakstu teoriju.

Sasniegtie rezultāti

Ir izstrādāts dzelzceļa transporta vadīšanas modelis ar sarakstu teorijas algoritmu izmantošanu summārā pārbrauktuvju atrašanās laika slēgtā stāvoklī samazināšanai un pilsētas transporta vadīšanas modelis ar iebūvēto iekārtu izmantošanu optimālai transporta vienību vadīšanai ievērojot kustības sarakstu un novēršot iespējamās sadursmes.

Dalība projektos

- ZP-2009/35 "Sliežu transporta

Summary of the research

The developed algorithms and the proposed procedures can improve the urban transport system, including public electric transport, control. The proposed algorithms increase the safety level of urban transport traffic control reliability, especially in intersecting of several transport flows. Using the developed algorithms can reduce downtime and could provide the public transport timetable compliance.

Novelty of the research

New mathematical models, procedures and algorithms to solve multi-criteria intelligent transport system control tasks using the evolutionary algorithms and the scheduling theory are developed in this study.

Achieved results

The railway transport control model for level crossing capacity increasing using the algorithms of scheduling theory and the city transport system control model using embedded devices to control public electric transport to follow the predefined schedule and to avoid possibility of vehicles collision has been designed.

Participation in projects

- ZP-2009/35 „The Immune System Modeling of Intelligent Control for Rolling Stock

intelektuālās vadības modelēšana neparedzētās situācijās ar imūnajām sistēmām".

- ZP-2009/36 " Sliežu transporta optimālās vadības ģenētisko algoritmu izstrāde un modelēšana."
- FLPP-2010/34 „Ritošā sastāva jaunas diagnostikas iekārtas
  drošuma testēšana avārijas situācijās".
- FLPP-2010/32 „Ritošā sastāva jauno kustības vadības iekārtu drošuma testēšana avārijas situācijās".
- FLPP-2011/13 „Vilciena bremzēšanas ceļa noteikšanas patentētās iekārtas un vilciena kustības posmu pārbaudes patentētās iekārtas starptautiskais patentmeklējums".
- FLPP-2011/14 „Dzelzceļa pārbrauktuvju intelektuālo drošības iekārtu un algoritmu izstrāde".
- LZP 09.1611. " Elektronisko iekārtu un sistēmu vadība un optimizācija"

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in Emergency Situations".

- ZP-2009/36 „The Developing and Modeling of Genetic Algorithm for Optimal Control for Rolling Stock"
- FLPP-2010/34 „Testing of Reliability of New Diagnostic Equipment of Rolling Stock in Emergency Situations".
- FLPP-2010/32 „Testing of Reliability of New Movement Control Equipment of Rolling Stock in Emergency Situations".
- FLPP-2011/13 „International Patent Search of Train Stopping Distance Determination Patented Equipment and Train Movement Section Testing Patented Equipment"
- FLPP-2011/14 „Development of Railway Level Crossings Intellectual Safety Equipment and Algorithms"
- LZP 09.1611. "The Optimization and Control Of Electronical Devices and Systems"

PĒTERIS APSE-APSĪTIS

Promocijas darba nosaukums: Publisko un bezvadu informācijas tīklu pielietojuma optimizācija elektrotehnoloģiju vadībai

PhD title: Optimisation of wireless and Internet network applications for computer controlled electro- technologies

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Leonīds Ribickis

Scientific adviser:
Dr.Habil.Sc.ing., professor Leonids Ribickis

Pētījuma kopsavilkums

Pētījuma mērķis ir optimizēt esošo publisko informācijas tīklu - interneta, WiFi, ZigBee - pielietojumu elektrotehnoloģiju - AC/DC elektrodzinēju, soļu un servodzinēju, konvertoru/invertoru, LED gaismas avotu u.c. - vadībai reālā laikā. Pētījums ietver vadībai nepieciešamās informācijas apjoma optimizāciju, lai palielinātu vadības ātrdarbību un nodrošinātu aizsardzību pret divvirzienu datu plūsmas pārtraukumiem. Pētījumā paredzēts definēt iespējas izmantot "cloud computing" un "network computing" principus elektrotehnoloģiju datorvadībā.

Pētījuma novitāte

Publisko un bezvadu informācijas tīklu pielietojuma apjoms nepārtraukti pieaug. Veidojot speciālus optimizētus programmatūras un iekārtu moduļus, ir iespējams veidot jauktu elektortehnoloģiju datorvadību - daļu uzdevumu risinot lokāli, daļu- izmantojot minētos tīklus.

Sasniegtie rezultāti

a) Izveidots e-Laboratorijas 1.posms, kurā studenti attālināti var veikt laboratorijas darbus uz reālām iekārtām, reālā laikā ar interneta starpniecību (1.att.);

b) Izveidots "data over wireless power line" modelis uz rotējošas dzinēja ass novietotu izpildmehānismu un sensoru vadībai un datu iegūšanai - ar datu plūsmu vadāms rezonanses konverteris (2.att.);

c) patērētāju elektroenerģijas patēriņa

Summary of the research

The task of the research is optimisation of wireless - WiFi, ZigBee - and Internet network applications for computer controlled electro-technologies - AC/DC drives, step and servo motors, converters/inverters. LED drivers - in real time. The research includes optimisation of data amount to increase data exchange speed as well as protection against data flow interruptions. Also research possibility to implement cloud computing and network computing solutions into electrical technologies.

Novelty of the research

Usage of interent and wireless is rapidly increasing. Specially designed equipment and software modules allow to implement mixed - partially on site, partially over network - electro-technologies control.

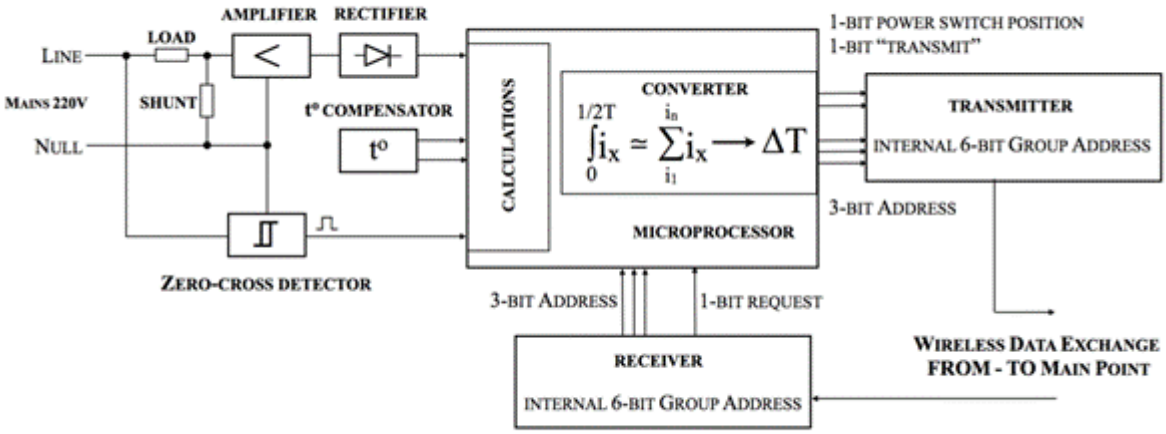
Achieved results

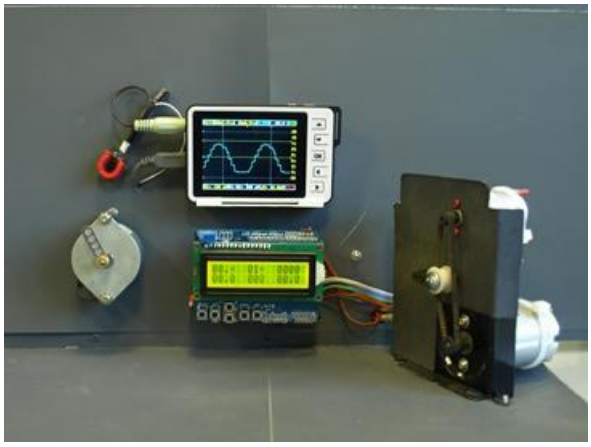
a) 1st part of the distance laboratory allows providing laboratory tasks via internet ir real time by means of real equipment. (Fig.1)

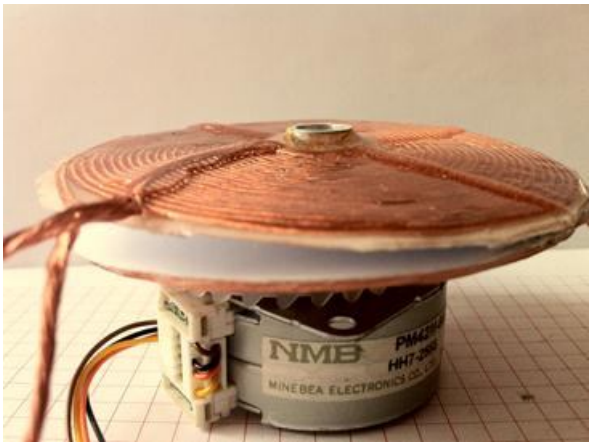
b) Experimental "data over wireless power line" model to get sensor data and power on rotating motor axle fixed actuators are designed and tested. (Fig.2)

c) Wireless data exchange energy consumption monitoring system is deployed. (Fig.3)

monitoringa sistēma, izmantojot bezvadu datu apmaiņu (3.att.).







Dalība projektos

• VPP-V7640 (Valsts pētījumu programmas) projekts Nr.6 „Energoelektronikas tehnoloģiju izstrāde elektroenerģijas patēriņa samazināšanai un atjaunojamo enerģijas avotu izmantošanas veicināšanai Latvijā". 2010. - 2013.g.

• ERAF 2010. -2013.g. „Uzņēmējdarbības un inovācijas" papildinājuma 2.1.1.1. aktivitātes „Atbalsts zinātnei un pētniecībai", projekts „Intelektuālu hibrīdo elektroģenerējošo iekārtu izstrāde un izpēte energoefektivitātes uzlabošanai" ar Identifikācijas Nr. 2DP/2.1.1.1.0/10/APIA/ VIAA/160. Brīvprātīga piedalīšanās ierīces izstrādē neviedu patērētāju pieslēgšanai pie viedā mikrotīkla.

• KPFI (Klimata pārmaiņu finanšu instrumenta) finansēto projektu „LED ielu apgaismošanas gaismekļu ar inteliģento vadības

Participation in projects

• PPP-V7640 (National Research Programme) project No. 6 'power electronic technologies to reduce consumption and renewable energy sources in Latvian. "The 2010th -2013.g.

• ERAF 2010th -2013.g. "Entrepreneurship and Innovation" in Appendix 2.1.1.1. activity "Support for science and research" project "Intellectual hybrid Generating equipment development and research to improve energy efficiency" with REF. 2DP/2.1.1.1.0/10/APIA / VIAA/160. Voluntary participation in the development of devices for connection to the consumer does not make smart micromesh.

• KPFI (climate change financial instrument) funded project "LED street lighting luminaires with intelligent management system

sistēmu prototipa izstrāde". Sadarbībā ar SIA „WestNord". Līguma Nr. KPFI-2/3. Gaismekļa elektroenerģijas patēriņa sensoru ierīces izstrāde.

• ZP-2010/9 - RTU 2010.gada fundamentālo un lietišķo pētījumu projekts: „Mūsdienu apgaismojuma tehnoloģiju izpēte, lai palielinātu energoefektivitāti Latvijas rūpniecības uzņēmumos."

• ARTEMIS projekts Nr.269265 pSafeCer 2011-2013; RTU PVS - 1571. pSAFECER)

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prototype." In cooperation with "WESTNORD". Contract no. KPFI-2/3. Luminaire power consumption sensor device development.

• The NC-2010/9 - 2010 Technical University of basic and applied research project: "Investigation of modern lighting technologies to Increase Energy Efficiency in Latvian manufacturing enterprises."

• The ARTEMIS project Nr.269265 pSafeCer 2011-2013, Technical University of PVA - the 1571st pSAFECER).

ALEKSANDRS SUZDAĻENKO

Promocijas darba nosaukums: Vadības līdzekļu izpēte un izstrāde intelektuālajiem sadales tīkliem ar regulējamām LED lampām

PhD title: Research and Development of Control Means for Intellectual Distribution Grids with Dimmable LED Lamps

Zinātniskais vadītājs:
Dr.Sc.ing., profesors Iļja Galkins

Scientific adviser:
Dr.Sc.ing., professor Ilya Galkin

Pētījuma kopsavilkums

Enerģija ir viens no galvenajiem resursiem, kas ļauj cilvēcei sekmīgi attīstīties, diemžēl tā izraisa arī globālas izmaiņas pasaulē – fosilā kurināmā ieguve ietekmē klimatu uz Zemes CO2 izmešiem. Vadošās pasaules valstis šo problēmu risināšanai ievieš energoefektivitātes plānus, pateicoties kuriem tiks samazināta CO2 gāzes emisija, paaugstināsies atjaunojamo energoresursu izmantošana, kā arī tiks modernizēti elektriskās enerģijas sadales tīkli, lai izveidotu brīvo elektroenerģijas tirgu, kurā cenas mainītos reālā laikā, un kas ļautu labāk izmantot esošos enerģijas resursus un samazināt enerģijas pieprasījuma maksimumu. Atsevišķās valsts programmas atbalsta gala lietotāju energoefektivitātes pasākumus, tādus kā: vēja ģeneratora vai Saules paneļu instalēšana. Tajā pašā laikā rodas perspektīva veidot intelektuālus enerģijas sadales tīklus, kas sastāv no enerģijas ģenerējošiem avotiem, uzkrājējiem un patērētājiem, kurus kontrolējot, būtu iespējams efektīvāk izmantot lokālos enerģijas resursus un kontrolēt slodzi. Tādu intelektuālo sadales tīklu ideja ir aprakstīta „Microgrid" koncepcijā, kur gala lietotājs tiek uzskatīts gan par elektriskās enerģijas patērētāju, gan par ražotāju. Tādēļ nepieciešami valdības līdzekļi, ar kuru palīdzību būtu iespējams realizēt šo koncepciju.

Pētījuma novitāte

Eksistējošo elektroenerģijas sadales tīklu intelektualizēšana ļautu elastīgāk un efektīvāk izmantot jau instalētos enerģijas resursus, kā arī motivētu ieviest atjaunojamās enerģijas avotus.

Summary of the research

Energy is a key resource that allows humanity to evolve successfully, but on the other hand it also causes global changes - fossil fuel acquisition, impact on the Earth's climate due to CO2 emissions. The leading world countries tackle these problems by introducing energy efficiency plans, which will be aimed to CO2 emissions reduction, increase the use of renewable energy resources, as well as upgrading electrical energy distribution networks, to make free electricity market in, where prices would be changeable in the real time, allowing better utilisation of existing energy powers and reducing energy demand peaks. Individual country programs support the end-user energy efficiency initiatives, such as: installation of wind generators or solar panels. At this point, there is a prospect to build an intelligent power distribution network, which consists of energy generators, storage elements and loads, controlling which would utilise more efficiently the existing energy resources and managed the total load. The idea of intellectual distribution grids is described in "Microgrid" concept, where the end user is considered both as electric energy consumer and a producer. For this purpose, control means are necessary to develop to realize this concept.

Novelty of the research

The intellectualisation of distribution power grids would better utilise the installed power resources, as well as would motivate end-users to install renewable energy sources. Dimmable LED

Viens no tipiskākajiem piemēriem patērētāji - izmantos regulējamās LED apgaismes lampas.

Sasniegtie rezultāti

Pētot LED gaismas regulēšanas metodes, tika konstatēts vienas metodes pārākums, kuru izmantojot, ir iespējams dabūt vislielāko efektivitāti. Kā arī tika analizētas vairākas iespējas komunikācijas organizēšanai starp LED lampām, tas tika atspoguļots vairākos zinātniskos rakstos, kas arī attiecās uz autonomo energosistēmu ieviešanas perspektīvām un priekšrocībām.

Dalība projektos

- KPFI (Klimata pārmaiņu finanšu instrumenta) finansēto projektu „Inteliģentais vējš". Sadarbībā ar SIA „HM Engineering". Līguma Nr. KPFI-2/31. Brīvprātīgais darbs – realizēt datu ierakstīšanas iekārtu ar rezerves barošanu.
- ERAF 2010. -2013.g. „Uzņēmējdarbības un inovācijas" papildinājuma 2.1.1.1. aktivitātes „Atbalsts zinātnei un pētniecībai", projekts „Intelektuālu hibrīdo elektroģenerējošo iekārtu izstrāde un izpēte energoefektivitātes uzlabošanai" ar Identifikācijas Nr. 2DP/2.1.1.1.0/10/APIA/ VIAA/160. Brīvprātīgais darbs – veidot elektroniskās iekārtas viedējam tīklam ar komunikācijām pa spēka vadiem.
- ES 7.IP ICT for energy efficiency and sustainibility in urban areas, Līgums Nr. 238916, LITES (Led-based Intelligent street lighting for Energy Saving). 2009.-2013. gads. Asistents: veidoju elektroniskās iekārtas, veicu eksperimentus, apstrādāju datus.
- Power Quality and Safety Requirements for People and Electrical Equipment in Smart Grid Customer Domain/Elektroenerģijas kvalitātes un drošuma prasības cilvēkiem un elektroiekārtām no viedo tīklu klientu perspektīvas (ERA-Net projekts). Asistents, veidoju elektroniskās iekārtas, veicu eksperimentus, apstrādāju datus.

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lamps are going to use as the typical load of intellectual distribution grid.

Achieved results

The experiments on LED lamp's supply methods, revealed the superior one, which allows getting higher efficacy values. As well as various techniques of LED lamp communication functions were discussed in the scientific papers. The same was made with the idea of autonomous energy systems.

Participation in projects

- Project supported by "Climate change financing instrument " - „Intelligent wind". In collaboration with „HM Engineering" Ltd. Contract Nr. KPFI-2/31. Volunteer –development of electronic data logger with reserve supply.
- ERAF 2010. -2013. project „Intellectual Hybrid Uninterruptible Power Systems and Component Development and Research to Improve Energy Efficiency" agreement No. 2010/0225/2DP/2.1.1.1.0/10/APIA/ VIAA/160. Volunteer – design of electronic control means with power line communication.
- ES 7.IP ICT for energy efficiency and sustainability in urban areas, Contract Nr. 238916, LITES (Led-based Intelligent street lighting for Energy Saving). 2009.-2013. Assistant: design of electronic equipment, make experiments, analyse data.
- Power Quality and Safety Requirements for People and Electrical Equipment in Smart Grid Customer Domain (ERA-Net project). Assistant: design of electronic equipment, make experiments, analyse data.

OĻEGS TETERVENOKS

Promocijas darba nosaukums: Apgaismošanas iekārtu un sistēmu izstrāde un optimizācija

PhD title: Development and Optimization of Lighting Equipment and Systems

Zinātniskais vadītājs
Dr.Sc.ing., profesors Iļja Galkins

Scientific adviser
Dr.Sc.ing., professor Ilya Galkin

Pētījuma kopsavilkums

Mūsdienu apgaismojums ir cieši saistīts ar gaismas diodēm (LED). Viena no LED priekšrocībām ir iespēja plūstoši regulēt apgaismojuma līmeni, kas paver plašas iespējas intelektuālā apgaismojuma jomā. Ir iespējami vairāki apgaismojuma regulēšanas paņēmieni gan ar savām priekšrocībām, gan trūkumiem: pakāpienveida regulēšana, PWM regulēšana un plūstošās strāvas regulēšana. Plūstošu apgaismojuma līmeņa regulēšanu ir iespējams sasniegt ar divām pēdējām metodēm. Tomēr PWM regulēšanas gadījumā var rasties nevēlamais stroboskopiskais efekts. LED apgaismojuma līmeņa regulēšanai ir ieteicams izmantot plūstošās strāvas metodi. Ja šīm nolūkam tiek izmantots sprieguma impulspārveidotājs, tad visā apgaismojuma līmeņu diapazonā vadības parametrs mainās ļoti šaurās robežās, kas sarežģī vadības realizāciju uz mikrokontrollera bāzes. Lai sasniegtu labas regulēšanas iespējas, ir nepieciešams izmantot shēmas, kurām vadības parametrs mainās plašās robežās. Gaismas diodēm šādas shēmas ir strāvas impulspārveidotāji.

Šā pētījuma ietvaros tiek apskatītas trīs strāvas impulspārveidotāju topoloģijas: pazeminošā, paaugstinošā un pazeminoši-paaugstinošā. Tika veikta visu iepriekšminēto topoloģiju shēmu modelēšana, kā arī eksperimentālo prototipu efektivitātes noteikšana pie mainīga vadības parametra. Eksperimentāli uzņemtās efektivitātes vērtības ir līdzīgas modelēšanas rezultātiem.

Summary of the research

Modern lighting systems are based on light-emitting diodes (LEDs). Ability of fluent light regulation is one of the LED advantages. This property of LEDs makes them an excellent light source for intelligent lighting. There are several LED dimming methods with their advantages and drawbacks: step regulation, PWM technique and fluent current regulation method. Fluent light regulation can be achieved by two last of them. But in the case of PWM regulation undesirable stroboscopic effect and flickering may appear, thus fluent current regulation technique is preferable. If voltage regulator is used for this purpose then there is a narrow range of changes of control parameter, making control process inconvenient for usage with microprocessor. To make control process more convenient it is necessary to use schematics where the control parameter is changed in wide range. For LEDs such schematics are current regulators.

In this study three different topologies of current regulators are examined: buck, boost, and buck-boost. The models of current regulators were analyzed and efficiency of experimental prototypes of regulators was examined in the whole range of control parameter. Experimental results are similar to simulation results.

Pētījuma novitāte

Šāda tipa shēmu izmantošana, kā arī to efektivitātes novērtēšana LED apgaismojuma līmeņa regulēšanai iepriekš literatūrā netika apskatīta.

Sasniegtie rezultāti

Ir sniegts efektivitātes novērtējums trim strāvas impulspārveidotāju topoloģijām, dots salīdzinājums ar sprieguma impulspārveidotājiem. Šāda tipa shēmās var atteikties no elektrolītiskiem kondensatoriem, tādejādi palielinot kalpošanas laiku.

Dalība projektos

- VPP-V7640 projekts Nr.6 „Energoelektronikas tehnoloģiju izstrāde elektroenerģijas patēriņa samazināšanai un atjaunojamo enerģijas avotu izmantošanas veicināšanai Latvijā". 2010. -2013.g. Amats: tehniķis.
- ERAF 2010.-2013.g. „Uzņēmējdarbības un inovācijas" papildinājuma 2.1.1.1. aktivitātes „Atbalsts zinātnei un pētniecībai", projekts „Vēja un ūdeņraža elektroapgādes autonomā sistēma", ar Identifikācijas Nr. 2DP/2.1.1.1.0/10/APIA/VIAA/031. Brīvprātīga piedalīšanās.
- ERAF 2010. -2013.g. „Uzņēmējdarbības un inovācijas" papildinājuma 2.1.1.1. aktivitātes „Atbalsts zinātnei un pētniecībai", projekts „Intelektuālu hibrīdo elektroģenerējošo iekārtu izstrāde un izpēte energoefektivitātes uzlabošanai" ar Identifikācijas Nr. 2DP/2.1.1.1.0/10/APIA/ VIAA/160. Brīvprātīgā piedalīšanās.
- KPFI (Klimata pārmaiņu finanšu instrumenta) finansēto projektu „LED ielu apgaismošanas gaismekļu ar inteliģento vadības sistēmu prototipa izstrāde". Sadarbībā ar SIA „WestNord". Līguma Nr. KPFI-2/3. 2010-2011.g. Amats: vecākais laborants zinātniskajā darbā.
- RTU 2010.gada fundamentālo un lietišķo pētījumu projekts: „Moderno apgaismošanas tehnoloģiju izpēte energoefektivitātes paaugstināšanai Latvijas ražošanas uzņēmumos" 2010-2011.g. Amats: vecākais laborants zinātniskajā darbā.
- RTU 2010.gada fundamentālo un lietišķo pētījumu projekts: „LED gaismekļa prototipa izstrāde ielu apgaismošanai". 2009-2010g. Amats: vecākais laborants zinātniskajā darbā.

Novelty of the research

There are no considerations in literature about using of such a type current regulators in LED dimming process.

Achieved results

The estimation of efficiency of three different current regulator topologies is given in comparison with voltage regulators. It is not necessary to use electrolytic capacitors for current regulators, thus increasing reliability of device.

Participation in projects

- VPP-V7640 Project No. 6 'power electronic technologies to reduce consumption and renewable energy sources in Latvian. "The 2010th -2013.g. Position: Technician.
- The ERDF 2010-2013 "Entrepreneurship and Innovation" in Appendix 2.1.1.1. activity Support for science and research project "Wind-hydrogen autonomous power system", REF. 2DP/2.1.1.1.0/10/APIA/VIAA/031. voluntary participation.
- ERAF 2010 -2013. "Entrepreneurship and Innovation" in Appendix 2.1.1.1. activity "Support for science and research" project "Intellectual hybrid Generating equipment development and research to improve energy efficiency" with REF. 2DP/2.1.1.1.0/10/APIA / VIAA/160. voluntary participation.
- KPFI (climate change financial instrument) funded project "LED street lighting luminaires with intelligent management system prototype." In cooperation with "WESTNORD". Contract no. KPFI-2/3. 2010-2011.g. Position: Senior laboratory assistant in scientific work.
- RTU 2010, basic and applied research project: "Modern lighting technology research to improve energy efficiency Latvian producers," 2010-2011.g. Position: Senior laboratory assistant in scientific work.
- RTU 2010, basic and applied research project: "Development of a prototype LED luminaire street lighting". 2009-2010g. Position: Senior laboratory assistant in scientific work.

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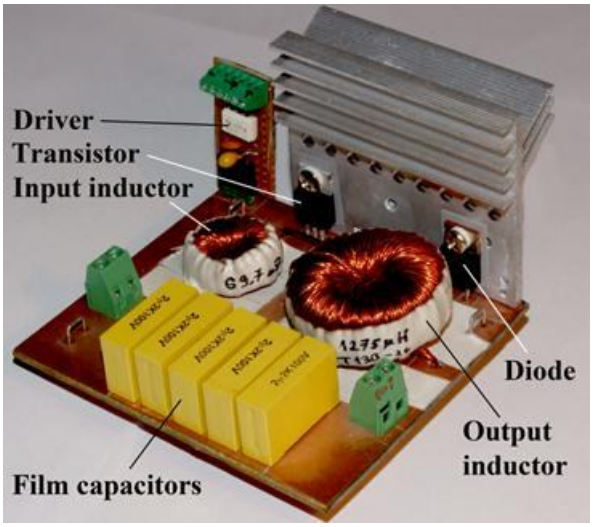

KRISTAPS VĪTOLS

Promocijas darba nosaukums: Vieglā elektriskā autotransporta piedziņa un tā elementu izstrāde un izpēte

PhD title: Research and development of car electric traction drive elements

Zinātniskais vadītājs:
Dr.Sc.ing., profesors Iļja Galkins

Scientific adviser:
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Pētījuma kopsavilkums

Pētījums aplūko galvenos vieglā elektriskā autotransporta elementus: vilces dzinējus, dzinēju vadību, kustības vadību, enerģijas avotus. Darba mērķis ir izstrādāt vieglā elektriskā autotransporta ekvivalentu modeli ar uzlabotām īpašībām. Tā kā kartings pēc savas būtības ir maza izmēra automašīna, tad tas arī ir izvēlēts par modeļa bāzi. Lai uzlabotu transportlīdzekļa sniegumu, tas ir aprīkots ar diviem vilces dzinējiem, kuri principā veido divas neatkarīgas piedziņas sistēmas. Katrs dzinējs piedzen vienu aizmugurējo riteni. Šādai sistēmai ir priekšrocība, ka nav nepieciešams mehāniskais diferenciālis, jo tā funkciju var izpildīt elektroniski. Ir nepieciešams mērīt stūres pozīciju un riteņu griešanās ātrumu. Tālāk, izmantojot iegūtos mērījumus, centrālais kustības vadības bloks izbraucamajam līkumam var aprēķināt vajadzīgo riteņu ātrumu diferenci un nosūtīt atbilstošu komandu uz dzinēju vadības blokiem. Šādam autotransportam ir samazināts svars un uzlabota veiktspēja. Kustības vadības bloku ir iespējams izmantot, lai panāktu vēl citas transportlīdzekļa vadību uzlabojošas īpašības.

Pētījuma novitāte

Pieaugot bažām par globālām klimata izmaiņām, tiek ieviesti dažādi pasākumi CO2 izmešu samazināšanai. Lai samazinātu degvielas patēriņu, automobiļu tirgū pamazām parādās jauni elektrisko transportlīdzekļu modeļi. Tirgus analītiķi paredz strauju elektrisko automobiļu pieaugumu. Šī situācija ir ļoti labvēlīga

Summary of the research

Research includes the main parts of electric vehicles: motors, drives, and motion control and power sources. The aim of this work is to develop a practical model of electric vehicle with improved performance. Kart was chosen as the base model since it is a lighter and more compact version of standard vehicle. To improve vehicle`s performance it is equipped with two traction motors. Each of them forms a separate drive and provides torque for one of the rear wheels. This system has an advantage – it does not need a mechanical differential, because its function can be achieved through electronic control. It is necessary to measure steering wheel angle and the speed of both traction wheels. Motion control block can use these measurements to calculate the appropriate rear wheel speed difference for correct movement in a road curve and produce command for the motor drives. Such vehicle has reduced weight and improved performance. Motion control block can be used to achieve other improvements in vehicle performance.

Novelty of the research

Due to the rise of concerns about global climate change different actions take place to reduce CO2 emissions. In order to improve fuel efficiency new electric cars are appearing in vehicle market. Analysts predict a rapid growth of the share of electric vehicles. This situation is favorable for development of electrical drives, thus it is necessary to perform new research about electrical drive usage in vehicle traction

elektriskās vilces piedziņas attīstībai, līdz ar to ir nepieciešams veikt jaunus pētījumus par elektriskās piedziņas pielietošanu vieglā transporta vilcē. Tā kā elektriskie dzinēji būtiski atšķiras no iekšdedzes motoriem, tad ir nepieciešams pētīt jaunus automobiļa uzbūves variantus – tādus, kuros ir vairāki vilces dzinēji, līdz ar to paverot iespējas uz uzlabotu transportlīdzekļa sniegumu un vadāmību.

Sasniegtie rezultāti

Izstrādāts kartings ar diviem līdzstrāvas vilces dzinējiem uz kura bāzes tālāk tiks realizēta dzinēju vadības sistēma. Ir izveidots divu dzinēju vadības modelis, kurš nodrošina elektroniskā diferenciāļa funkciju.

Dalība projektos

- RTU iekšējais zinātniskais projekts ZP-2009/1.
- Starptautiskais projekts Lites L7615.
- Nacionālais projekts 1522.
- VPP-V7640 projekts Nr.6 „Energoelektronikas tehnoloģiju izstrāde elektroenerģijas patēriņa samazināšanai un atjaunojamo enerģijas avotu izmantošanas veicināšanai Latvijā". 2010. -2013.g. Amats: tehniķis.

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systems. Since electric motors are significantly different from internal combustion engines it is necessary to explore new layouts of vehicles – with multiple traction motors. This provides new possibilities to better vehicle performance and improved control.

Achieved results

An electrical kart with two DC traction motors has been developed. Control system for kart traction is to be researched. Preliminary model of two motors control with electronic differential has been developed.

Participation in projects

- RTU's internal research project NC-2009/1
- The Internationale project Lites L7615
- National Project 1522
- VPP-V7640 Project No. 6 'power electronic technologies to reduce consumption and renewable energy sources in Latvian. "The 2010th -2013.g. Position: Technician.

ALEKSANDRS ANDREIČIKS

Promocijas darba nosaukums: Alternatīvo enerģijas avotu energoelektronikas pārveidotāju izpēte un optimizācija

PhD title: Power converter for alternative energy sources research and optimization

Zinātniskais vadītājs
Dr.Sc.ing., asoc. prof. Oskars Krievs

Scientific adviser
Dr.Sc.ing., assoc. prof. Oskars Krievs

Pētījuma kopsavilkums

Atjaunojamo enerģijas resursu izpētes kontekstā pasaulē strauji attīstās arī ūdeņraža enerģētika. Degvielas elements, kas enerģijas iegūšanai izmanto tikai ūdeņradi, ir pilnībā ekoloģiskas, jo ūdens ir vienīgais blakusprodukts, ko tas izdala apkārtēja vidē atšķirībā no t.s. metanola degvielas šūnām. Ūdeņraža degvielas elements (DE) ir augstas efektivitātes elektroķīmisks enerģijas pārveidotājs, kas katalizatora klātbūtnē spēj ražot elektrisko enerģiju, kā blakusproduktus radot siltumu un ūdeni.

Pasaulē plaši tiek pētīti pusvadītāju spēka pārveidotāji, kas spētu veikt šādu elektroenerģijas pārveidošanu, taču ūdeņraža degvielas elementa specifisko dinamisko parametru un zemā izejas sprieguma dēļ ir iespējami aizvien jauni, efektīvāki spēka pārveidotāja tehniskā risinājuma varianti. Tiek izstrādāti aizvien jauni spēka elektronikas pārveidotāji ūdeņraža degvielas šūnas pielietojumam elektrotransportā, alternatīvajā enerģētikā, kā arī daudzās citās sfērās, tostarp pat mobilo telefonu un klēpja datoru baterijās.

Pētījuma novitāte

Nākotnes alternatīvās enerģētikas komandai ir nepieciešams 10 kW DC / DC pārveidotājs, kurš būtu ļoti efektīvs un zemu izmaksu produkts. Starp visām pārveidotāju topoloģijām tikai daži spēj nodrošināt lielu jaudu un augstu efektivitāti. Lai to nodrošinātu tika izvēlēts LLC rezonanses pārveidotājas, kuram ir vairākas priekšrocības,

Summary of the research

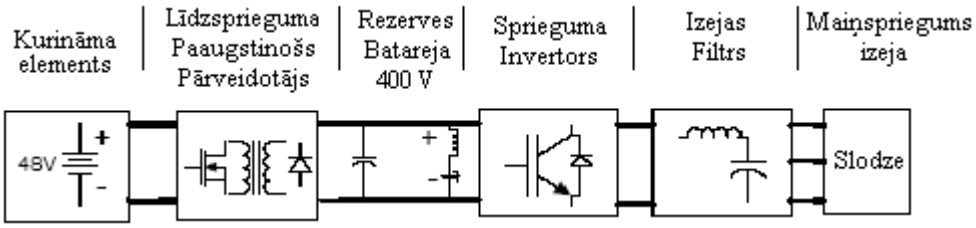
The renewable energy sources as well as the fuel cell have gained a growing interest during the recent years. Most of the applications, which involve these energy sources, are grid connected and thereby a power conditioning system must be utilized in order to transform the source energy parameters to be compatible with the grid. In order to use hydrogen fuel cells in domestic applications either as main power supply or backup source, their low DC output voltage has to be matched to the level and frequency of the utility grid AC voltage. Such power converter systems usually consist of a DC-DC converter and a DC-AC inverter. For this purpose new power electronic converters were developed. Hydrogen fuel cells are for the use in alternative energy, as well as in many areas, including even a cell phone and laptop computer batteries.

Novelty of the research

The future is looking towards alternative power sources all of which will need to be regulated in one form or another. Furthermore, the Future Energy Challenge team requires a 10 kW DC/DC converter for the competition. To make this possible, a highly efficient low cost product will have to be designed. Among all the different converter designs available, only a few are capable of providing high power with high efficiency. A design was proposed to provide this output with the lowest amount of losses. This design will be firstly verified by computer simulation, and then tested in the laboratory with

salīdzinot ar pārējām pārveidotāju shēmām – tas ļauj stabilizēt izejas spriegumu plašākam ieejas sprieguma un slodzes izmaiņu diapazonam pie salīdzinoši nelielām komutācijas frekvences izmaiņām, ir sasniedzama nulles sprieguma komutācija visā darba diapazonā, kā arī rezonanses procesā lietderīgi tiek izmantoti visi galvenie shēmas parazītiskie elementi.

the application of non-linear loading. With loading conditions, a 400V output voltage (with a differential of 10V) and a 5 kW power output must be maintained to achieve an acceptable final product.



DE enerģijas pārveidošanas sistēmas blokshēma

Sasniegtie rezultāti

Izveidots LLC rezonanses pārveidotāja spēka un vadības sistēmas datormodelis un veikts to komponentu aprēķins. Aprēķināts un uztīts transformators un uztaisīts LLC pārveidotāja plates projekts. Izgatavota un samontēta LLC pārveidotāja prototipa pirmā darba versija. Uzsākta pārveidotāja prototipa eksperimentālā izpēte. Veikta vadības sistēmas izstrāde uz DSpace platformas bāzes.

Dalība projektos

- RTU ERAF projekta „Vēja un ūdeņraža elektroapgādes autonoma sistēma”, Nr.2010/0188/2DP /2.1.1.1.0/ 10/APIA/ VIAA/031.
- Rīgas Tehniskā universitāte, Valsts pētījumu programmas Nr.1 projekts Nr.6 „Energoelektronikas tehnoloģiju izstrāde elektroenerģijas patēriņa samazināšanai un atjaunojamo enerģijas avotu izmantošanas veicināšanai Latvijā”
- Rīgas Tehniskā universitāte, projektā „PAM ūdeņraža degvielas šūnas energoelektronikas pārveidotāja izstrāde ar daudzlīmeņu invertoru”.

Achieved results

The LLC resonant converter power and control system computer simulation model are made. The power converter components are calculated. Transformer and LLC power converter circuit board design were developed. The first working prototype of the LLC converter was designed. Power converter prototype experimental investigation has been started. Control system development based on Dspace platform.

Participation in projects

- RTU ERAF project "Wind and hydrogen power autonomous system", Nr.2010/0188/2DP / 2.1.1.1.0 / 10/APIA / VIAA/031
- Riga Technical University, the National Research Programme Nr1. Project No. 6 'power electronic technologies to reduce consumption and renewable energy sources in Latvian "
- Riga Technical University, the project "PAM hydrogen fuel cells to power electronic converter design with multi-level inverter".

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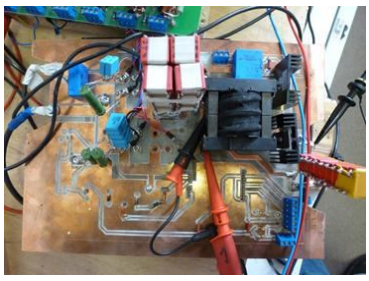

DĀVIS MEIKE

Promocijas darba nosaukums: Industriālo robotu energoefektivitātes paaugstināšanas metožu izstrāde

PhD title: Development of the Energy Efficiency Improvement Methods for Industrial Robots

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Leonīds Ribickis

Scientific adviser:
Dr.Habil.Sc.ing., professor Leonids Ribickis

Pētījuma kopsavilkums

Pētījumā apkopotas dažādas metodes industriālo robotu energoefektivitātes palielināšanai. Kā robotikas nozare kopumā, arī darbs ir multidisciplinārs un aptver gan elektrotehnikas un mehatronikas nozari, gan arī sniedzas kustību vadības plānošanā. Darbs ir orientēts uz praktiski realizējamiem ražošanas uzlabojumiem un visas minētās metodes ir eksperimentāli pārbaudītas.

Darbs sastāv no 4 daļām. Pirmā daļa sniedz pētījumu rezultātus par augstas un vidējas klases celtspējas robotu izmantošanas specifiku, robotu sistēmas komponentu energopatēriņu un to īpatsvaru ražošanā autoindustrijā. Šajā daļā analizēta optimāla robota tipa izvēle dažādiem ražošanas uzdevumiem.

Otrajā daļā apskatītas energoefektivitātes celšanas metodes, izmantojot uzlabotu programmu loģiku un optimizētus kustību vadības algoritmus. Sniegti priekšlikumi esošo robotu programmu optimizācijai un jaunu trajektoriju ģenerēšanai manipulatoriem, izmantojot mākslīgā intelekta elementus.

Trešajā daļā sniegti priekšlikumi rekuperatīvās enerģijas efektīvai izmantošanai. Standarta manipulatora kontrollera spēka elektronika atbalsta rekuperatīvo bremzēšanu, taču iegūtā enerģija līdz šim nav tikusi vadīta atpakaļ tīklā vai uzglabāta, piemēram, kondensatoru baterijās augsto izmaksu un maiņstrāvas tīkla kvalitātes saglabāšanas dēļ. Darbā veikta virkne eksperimentu ar vairāku robotu kontrolleru līdzstrāvas posmu

Summary of the research

This work summarizes various methods of the energy efficient use of medium and high payload industrial robots. As robotics in general also this is a multidisciplinary research that covers topics both in motion planning and the electrical/mechanical engineering.

The work consists of 4 parts. In the first part a detailed analysis of typical characteristics of industrial robot usage in the automobile production is evaluated. Here, the options of an appropriate robot selection for a particular application are investigated as well as a general overview of the energy consumers in robotic systems is given.

The second part deals with an intelligent motion planning of robotic manipulators. Optimization of existing robot programs and partial generation of fresh trajectories in workspace using artificial intelligence are distinguished. Also a cost efficiency analysis of the implementation in large scale factories is given.

The third part reveals the benefits of an effective use of recuperation. State of the art the drives of robot controller are capable to supply the regenerative energy from motors, however, it's rarely fed back to a network or stored locally due to quality issues or increased costs. Here a novel power converter enabling DC-Bus sharing among the robot power-team is proposed.

The fourth part emphasizes all the secondary consumers in the robotic system. The normal-close mechanical brakes of the motors are large

koplietošanu, izmantojot jauna tipa jaudas pārveidotāju.

Sekundāro patērētāju loma robotu sistēmās uzsvērta ceturtajā daļā. Šeit apskatītas iespējas samazināt robota manipulatora un tā kontrollera visu pasīvo patērētāju patēriņu. Sniegta detalizēta analīze motoru mehānisko bremžu vadībā gan reducējot to vidējo jaudu, gan aktīvi vadot ieslēgšanas režīmus, ņemot vērā kopējās ražošanas īpatnības.

Pētījuma novitāte

Auto industrijā ražošanas līnijas, kurās 80. gados tika izmantoti vien daži desmiti robotu, šodien ir gandrīz 98% automatizēti, kur uz vienu autoražošanas līniju ir vairāki simti industriālo robotu. Pateicoties spēka elektronikas un skaitļošanas tehnikas attīstībai, ir panākta augsta manipulatoru precizitāte, ātrums, celtspēja, drošums, funkcionalitāte un citas īpašības. Taču energoefektivitāte robotu sistēmās līdz šim bijusi sekundāra, atkarīga no pieejamām komponentēm un tēma nav tikusi analizēta no ražotāja skatupunkta. Akadēmiskajā vidē ir izstrādāti trajektoriju plānošanas algoritmi, taču vairums to ir pārāk teorētiski, lai vidējā termiņā tiktu ieviesti reālitātē. Pētījuma novitāte slēpjas detalizētā ražošanas specifikas analīzē un tehnoloģiju pārnesē industriālās robotikas kontekstā.

Sasniegtie rezultāti

Gandrīz visas optimizācijas metodes eksperimentāli pārbaudītas, no kurām vairākas ir pieteiktas Vācijas patentu valdē. Mehānisko bremžu vadības stratēģija pašlaik tiek ieviesta rūpnīcā, kas ietaupīs vidēji 2% no robotikas koppatēriņa.

Dalība projektos

- "Nākamās paaudzes robotika – Enerģijas efektīva izmantošana robotikas sistēmu VAS94307, Daimler AG/

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static consumers in the robotic system. Methods to release the brakes dynamically and to reduce their power are proposed.

Novelty of the research

Industrial robotics has a history of over 30 years, when the first hydraulic manipulators appeared. In 80's as much as 10 of robots per automobile production line used to be deployed. Along with the advancement of power electronics and computing capability, nowadays, in a premium class vehicle production around 1000 industrial robots are being used. The development of the robotics has largely been stressed on accuracy, speed, payload, reliability, functionality and other factors. Energy consumption has been rather secondary and strongly dependent on components. However, an overall analysis of the robotic hardware system and its software by energy means promise high economical and environmental benefits in a large scale highly automated production.

Achieved results

Most of the proposed approaches are already approved experimentally. Some of them are patent-pending. Factory rollout of the optimized mechanical brake usage is in progress in an automobile factory, that is about to save 2% of the overall robotics consumption.

Participation in projects

- "Next Generation Robotics– Energieeffizienter Einsatz von Robotersystemen"VAS94307, Daimler AG

GENADIJS ZAĻESKIS

Promocijas darba nosaukums: Elektrotransporta hibrīdā enerģijas uzkrājēja izpēte

PhD title: Research of the electrical transport hybrid energy storage system

Zinātniskais vadītājs
Dr. Sc.ing., asoc. prof. Viesturs Bražis

Scientific adviser
Dr.Sc.ing., assoc. prof. Viesturs Brazis

Pētījuma kopsavilkums

Pētījuma mērķis ir samazināt elektrotransporta enerģijas zudumus rekuperatīvās bremzēšanas laikā, nodrošinot visu elektriskās bremzēšanas enerģijas uzkrāšanu neatkarīgi no pieejamā barošanas avota veida, uzlabot vilces piedziņas palaišanas enerģijas patēriņa vienmērīgumu, uzlabot elektrotransporta kustības drošību.

Pētījuma novitāte

Zinātniskais jaunums saistīts ar elektrotransporta hibrīdā enerģijas uzkrājēja energoefektivitātes paaugstināšanas problēmas risinājumu, veicot enerģijas optimālu pārdali starp ierobežotas jaudas iebūvētā barošanas avotu, kombinētā uzkrājēja baterijām un kontakttīklu, atkarībā no citu patērētāju enerģijas patēriņa iespēju apjoma, izmaiņu dinamikas un bateriju uzlādes līmeņa.

Sasniegtie rezultāti

Tiek izstrādāts hibrīda enerģijas uzkrājēja stacionārais stends un tā datormodelis. Tika paveikta elektriskā transportlīdzekļa dažādu darbības režīmu datorsimulācija. Rezultāti liecina, ka stacionārais stends var nodrošināt transportlīdzekļa modelēšanas paātrinājuma, ieskrējiena un bremzēšanas režīmu tīkla un autonomās barošanas gadījumā un enerģijas rekuperāciju neatkarīgi no barošanas veida.

Dalība projektos

- Vēja un ūdeņraža elektroapgādes autonomā sistēma.

Summary of the research

The objective of the research is a decrease in losses of electric transport energy at recuperative braking, having provided accumulation of all brake energy irrespective of a type of the power supply, and also improvement of quality and traffic safety of a vehicle.

Novelty of the research

The innovation is connected with a solution of the electrical transport hybrid energy storage system power efficiency increasing problem, carrying out optimum distribution of energy between the built-in limited capacity power supply, batteries of the combined store and a contact network, depending on possibility energy consumption other consumers and level of a charge of batteries.

Achieved results

The stationary stand is developed for research of hybrid energy storage system and its computer model. Simulation of various modes of a vehicle is made. Results demonstrated that the stand can provide vehicle modeling at acceleration, run out and braking modes and also energy regeneration irrespective of power type.

Participation in projects

- Wind and Hydrogen Based Autonomous Energy Supply System

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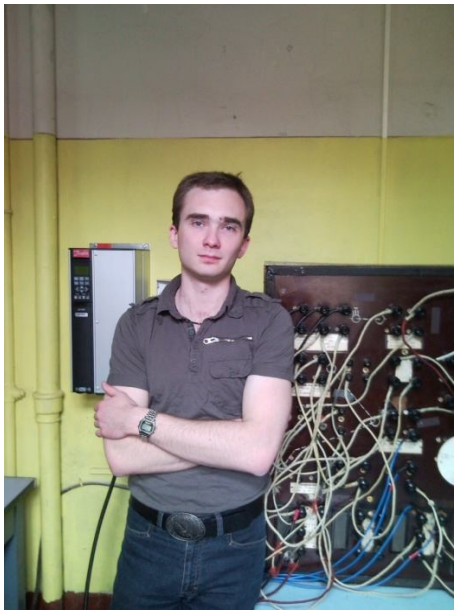

MIHAILS ŽILENKO

Promocijas darba nosaukums: Tehnoloģisko procesu vadības mikroprocesoru sistēmas izstrāde un izpēte iecirkņa un kravas stacijās

PhD title: Research and development of microprocessor-based process control system at local and cargo stations

Zinātniskais vadītājs
Dr.sc.ing., asoc.prof. Ludmila Sergejeva

Scientific adviser
Dr.Sc.ing. asoc.prof. Ludmila Sergejeva

Pētījuma kopsavilkums

Pētījums ietver kravas un iecirkņa dzelzceļa staciju tehnoloģisko procesu izpēti, optimizāciju un automatizāciju. Ir zināms, ka iecirkņa staciju manevru pārvietojumu automatizācijas situācijas analīze parāda, ka šie pārvietojumi nav pilnīgi automatizēti, taču vagonu apgrozības parka ātrumu paaugstināšanas kritiskais faktors ir katra vagona atrašanās laiks vilcienu formēšanas un izformēšanas stacijās. Šā pētījuma gaitā tiek piedāvāti un izanalizēti dažādi dzelzceļa kravu stacijas darba algoritmu varianti. Pētījumā izstrādātas stacijas un lokomotīves vadības kompleksās funkcionēšanas shēmas un to realizācija. Lai savienotu stacijas un lokomotīves iekārtas, salīdzināti dažādi sakaru kanālu organizēšanas veidi, pēc kā izvēlēts un aprēķināts sliežuvadu kanāls.

Pētījuma novitāte

Par informācijas nodošanas kanālu no stacijas ierīcēm uz lokomotīvi manevru automātiskās lokomotīvju signalizācijas (MALS) sistēmā tiek izmantots sliežuvadu kanāls, kas darbojas 1.000-2.000Hz diapazona frekvencē. Sistēmas sliežuvadu kanāls kopā ar augstražīgu datoru nodrošina lokomotīvju vadības operativitāti un kontrolē to atrašanās vietu, kas nav sasniedzams ar tradicionāliem līdzekļiem. Paredzēta informācijas saņemšanas iespējamība par stacijas elektriskās centralizācijas (EC) stāvokli, un informācijas par EC stāvokli nodošana šīm sistēmām. Savienojot MALS ar EC aparatūru, rodas iespēja noraidīt maršruta uzdevumu uz

Summary of the research

The study includes cargo station and railway station process research, optimization and automation. It is known that the circuit shunting the transfer station automation case study shows that these movements are not fully automated, but the car park circulation rate increases the critical factor is the location of each vehicle of the train formation and the phasing-out stations. This course of study shall be proposed and analyzed a variety of railway cargo station the algorithm variants. This paper develops a management of stations and locomotives complex functional circuits and their realization. To connect the station and locomotive equipment compares different forms of communication channels, after which the selected and calculated rail-wire channel.

Novelty of the research

As a communication channel from the stationary devices in the locomotive system is used automatic shunting locomotive signaling (ASLS) with rail-wire channel operating in the frequency range 1.000-2.000Hz. Rail-wire channel system and high-performance computer provides speed control locomotives and track their locations, inaccessible by traditional means. We can get information about the centralization of the station, and transfer of information on the status of centralized traffic control (CTC) stations for these systems. When docking ASLS with hardware EC is possible to route the transfer of jobs directly to locomotive from the station

lokomotīvi tieši no stacijas dežuranta automatizētās darba vietas (ADV), kas ļauj pilnīgi automatizēt manevrēšanas vadību dzelzceļa stacijā.

Sasniegtie rezultāti

Izstrādāti elektriskās centralizācijas un manevru lokomotīves darba algoritmi, aprēķināti sliežuvada kanāla parametri. Izvēlēta un izvērtēta sistēmas aparatūra.

Dalība projektos

Vilcienu kustības vadības automātisko sistēmu modernizācija (Latvijas Austrumu – Rietumu dzelzceļa koridors). Darba uzdevums: Piedalīšanās rūpnīcas un ekspluatācijas izmēģinājumos un pārbaudēs.

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operator workstation that allows you to fully automate the management of shunting work.

Achieved results

Algorithms for centralized traffic controls and shunting locomotives are developed; parameters of the rail-wire channel are designed. The systems equipment is selected and evaluated.

Participation in projects

Modernization of the signalling system (Latvian East – West rail corridor). Terms of reference: Participation in the factories and running the trials and tests.

JĀNIS DONIŅŠ

Promocijas darba nosaukums: Vienfāzes tiltveida kompensēto taisngriežu izpēte

PhD title: Single-phase Compensated Bridge Rectifier Research

Zinātniskais vadītājs:
Dr.Habil.Sc.ing., profesors Ivars Raņķis

Scientific adviser:
Dr.Habil.Sc.ing., professor Ivars Rankis

Pētījuma kopsavilkums

Tiek veikts literatūras pārskats un analīze par lielas jaudas elektropiedziņas taisngriežu līdzsprieguma gludināšanas metodēm. Tiek analizēta zināmo metožu efektivitāte un izvērtēts jaunu metožu pielietojums un esošo metožu pilnveidošanas iespējas. Pētījums paredz izveidot un izpētīt jaunas taisngriežu sistēmas, kurās tiek samazināts pusvadītāju sprieguma stress un uzlabotas izejas līdzsprieguma īpašības. Visas apskatītās sistēmas savā starpā tiek salīdzinātas.

Pētījuma novitāte

Pētījumā ir dotas principiāli jaunu taisngriežu shēmas ar izejas sprieguma gludināšanu un to pētījums. Pētījuma mērķis ir uzlabot lielas jaudas taisngriežu sistēmu izejas sprieguma formu un samazināt sistēmas pusvadītāju darba sprieguma līmeni.

Sasniegtie rezultāti

Ir izpētītas zināmās lielas jaudas taisngriežu sistēmas, sastādīts to apskats. Izveidotas kompensētu taisngriežu shēmas un veikta to teorētiskā izpēte.

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Summary of the research

Doing research is carried out a literature review and analysis of high-power DC rectifier output voltage smoothing methods. It provides analysis of the known methods and evaluated the effectiveness of new methods and applications of existing methods and improvement opportunities. The study provides the establishment and research of new rectifier system, which reduces the voltage stress in the semiconductor and improves output DC characteristics. All observed systems are compared with each other.

Novelty of the research

The study gives a new rectifier circuit with smoothing of the output voltage architecture and its research. The study aims to improve high power rectifier systems output voltage shape and reduce the system operating voltage level of the semiconductor.

Achieved results

High-power rectifier systems have been investigated, a review of these systems is created. Compensate Rectifier Circuits and their theoretical studies were designed.

ANDREJS MORS - JAROSLAVCEVS

Promocijas darba nosaukums: Intelektuālā elektrotransporta vadības sistēmu modelēšana ar imūnajiem algoritmiem

PhD title: Modeling of the electric transport intelligent control systems with immune algorithms

Zinātniskais vadītājs:
Dr.Sc.ing., profesors Anatolijs Ļevčenkovs

Scientific adviser:
Dr.Sc.ing., professor Anatoly Levchenkov

Pētījuma kopsavilkums

Pētījums ir saistīts ar intelektuālām iebūvētājām ierīcēm un to izmantošanu transporta vadības sistēmu uzlabošanā.

Darba mērķis ir izstrādāt jaunu intelektuālo dzelzceļa elektriskā transporta drošības vadības sistēmu, kura darbosies uz iebūvēto iekārtu bāzes un izmantos imūnos vadības algoritmus, dodot sliežu transportam iespēju izvairīties no avārijas situācijām un palielināt tā kustības drošību.

Pētījuma novitāte

Mākslīgās imūnās sistēmas ir salīdzinoši jauna tēma; tās izmanto evolucionāro datu apstrādes paradigmu, kura pamatojas uz bioloģiskām imūnajām sistēmām. Imūnie algoritmi tiek izmantoti anomāliju atpazīšanā, datu ievākšanai un analīzes uzdevumu risināšanai. No datu apstrādes viedokļa imūno sistēmu aktuālākās īpašības ir pašmācība, diversitātes uzturēšana un atmiņa.

Viena no galvenajām anomāliju atpazīšanas imūno sistēmu priekšrocībām ir to spēja atpazīt jaunas, līdz šim nezināmās, bīstamas situācijas. Izmantojot imūno atmiņu, šādas sistēmas var ne tikai dot atskaiti par radušos situāciju, bet arī sniegt informāciju par iespējamām sekām un automātiski veikt nepieciešamās darbības, lai izvairītos no tās.

Šīs tehnoloģijas tiek aktīvi pētītas un rāda lielo potenciālu to izmantošanai transporta un drošības nodrošināšanai.

Summary of the research

The research is about intelligent embedded devices and their usage for transport control systems improvement.

The research aims to design and develop a new inteligent railway safety control system based on embedded devices and immune algorithms, giving a way for the electric railway transport to avoid dangerous situations and enhance its safety.

Novelty of the research

Artificial immune systems are a relatively new topic; they use an evolutionary data processing paradigm based on biological immune systems. Immune algorithms are mainly used to solve anomaly recognition, data collection and analysis tasks. From the computational point of view immune systems' most interesting features are self-learning, diversity maintenance and memory.

One of the key advantages of immune anomaly detection systems is their ability to detect novel dangerous situation patterns for which no signature exists. Together with the immune memory feature such systems could also provide further information about the consequences of the encountered situation and perform possible future actions instead of simply reporting the happening.

The technology is being actively investigated and has shown great potential for transportation and safety.

Sasniegtie rezultāti

Tika analizēti imūnie algoritmi un to izmantošanas iespējas transporta un drošības nozarēs, kā arī esošās transporta drošības vadības sistēmas.

Tika izstrādāts dzelzceļa transporta intelektuālās drošības vadības sistēmas shēma, tās kopējais darbības algoritms un dažu tās sastāvdaļu datormodeļi. Šie modeļi ļauj pārbaudīt izstrādātos vadības algoritmus un analizēt to darbības efektivitāti.

Tika izstrādāts iekārtas prototips uz mikrokontrolleru bāzes ar bezvadu sakaru un pozicionēšanas moduļiem. Šis prototips tika pārbaudīts reālos darba apstākļos uz lokomotīves.

Dalība projektos

- ZP-2009/35. Sliežu transporta intelektuālās vadības modelēšana neparedzētās situācijās ar imūnajām sistēmām.
- ZP-2009/36. Sliežu transporta optimālās vadības ģenētisko algoritmu izstrāde un modelēšana.
- FLPP-2010/34. Ritošā sastāva jaunas diagnostikas iekārtas drošuma testēšana avārijas situācijās.
- FLPP-2010/32. Ritošā sastāva jauno kustības vadības iekārtu drošuma testēšana avārijas situācijās.
- FLPP -2011/14. Dzelzceļa pārbrauktuvju intelektuālo drošības iekārtu un algoritmu izstrāde.
- 2-04829, 06.10.2011 pSAFECER (1. posms).

Achieved results

The author has analyzed immune algorithms and possibilities for their use in transportation and safety industries, as well as existing transport safety control systems.

A scheme and a general algorithm of railway transport intelligent safety control system has been developed together with its modules' computer models which allow testing the developed control algorithms and analyze their effectiveness.

A device prototype based on microcontrollers with wireless communication and positioning modules has been developed and tested in real conditions on a locomotive

Participation in projects

- ZP-2009/35. Modeling the railway transport intelligent control with immune systems in emergency situations.
- ZP-2009/36. Development and modeling of genetic algorithms for railway transport optimal control.
- FLPP-2010/34. Testing the reliability of the new diagnostic equipment for rolling stock in emergency situations.
- FLPP-2010/32. Testing the reliability of new movement control equipment for rolling stock in emergency situations.
- FLPP -2011/14. Development of intellectual safety equipment and algorithms for railway level crossings.
- 2-04829, 06.10.2011 pSAFECER (Stage 1).

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OLGA PODSOSONNAJA

Promocijas darba nosaukums: Dzelzceļa sastāvu nolaišanas procesa kompleksās automatizācijas sistēmas modelēšana

PhD title: Modeling of the complex automatic system for the downtake of railway wagons system

Zinātniskais vadītājs
Dr. Sc.ing., asoc. prof. Mareks Mezitis

Scientific adviser
Dr.Sc.ing., assoc. prof. Mareks Mezitis

Pētījuma kopsavilkums

Promocijas darba specifiskie uzdevumi:

- Šķirošanas tehnoloģijas izvēles optimizācija ir atkarīga no vagonu bremzēšanas raksturlīknēm un uzkalniņu parametriem
- Šķirošanas uzkalniņa vertikālā pacēluma aprēķinu optimizācija;
- Prasības, kuras tiek uzstādītas šķirošanas uzkalniņu aprīkojumam.

Pētījuma novitāte

Pētījumu novitāte ir saistīta ar šādiem specifiskiem pētījuma mērķiem:

1. Vadības modelēšanas principu analīze sistēmā Modest Marshall, EFW, Prvni Signal;
2. Vienotu prasību šķirošanas staciju sistēmām adaptācijas programmas ieviešana šķirošanas stacijās ar sliežu platumu 1520 mm;
3. Salīdzināt prasības sistēmu izstrādei 1435 un 1520 mm sliežu platumam
4. Apakšsistēmu ieviešanas iespēju izpēte 1435 un 1520 mm sliežu platumam dzelzceļiem "vienotas sistēmas" izpratnē;
5. Publikācijas sagatavošana "Tehniskās prasības un regulas MSR32 sistēmas projektēšanai";
6. Patenta pieteikuma sagatavošana " "Tehnisko prasību specifikācija MSR32 sistēmas projektēšanai 1520 mm sliežu platuma dzelzceļu sistēmas".

Summary of the research

During the research the three main tasks are executed:

- Optimisation of choosing the hump technology in dependence on parameters of hump and of braking characteristics of the wagons
- Optimisation of calculation the hump elevation;
- Requirements for engineering of hump equipment

Novelty of the research

The following objectives to be achieved during the reaserch:

1. Analyze of the principles of control modeling in systems Modest Marshall, EFW, Prvni Signal
2. Implementation a program of adaptation of the united requirements for hump systems at gauge 1520mm
3. Compare of design regulations of systems for gauges 1435 and 1520 mm
4. Researching of the possibilities to implement subsystems for gauges 1435 and 1520 into the common system
5. Prepare a publication of the "Rules and regulations of design of system MSR32
6. Apply for the patent "Approval of design regulations of the system MSR32 for gauge 1520 mm".

Sasniegtie rezultāti

Paveikta vadības modelēšanas principu analīze sistēmā Modest Marshall, EFW, Prvni Signal.

Paveikta vienotu prasību izstrāde šķirošanas staciju sistēmu adaptācijas programmas ieviešanai šķirošanas stacijās ar sliežu platumu 1520 mm.

Salīdzinātas prasības sistēmu izstrādei 1435 un 1520 mm sliežu platumam

Paveikta apakšsistēmu ieviešanas iespēju izpēte 1435 un 1520 mm sliežu platumam dzelzceļiem " vienotas sistēmas" izpratnē

Sagatavota publikācija "Tehniskās prasības un regulas MSR32 sistēmas projektēšanai"

Sagatavots patenta pieteikums "Tehnisko prasību specifikācija MSR32 sistēmas projektēšanai 1520 mm sliežu platuma dzelzceļu sistēmas".

Institute of Railway Transport

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Achieved results

Analysis of the principles of control modeling in systems Modest Marshall, EFW, Prvni Signal

Implementation a program of adaptation of the united requirements for hump systems at gauge 1520mm

Compare of design regulations of systems for gauges 1435 and 1520 mm

Researching of the possibilities to implement subsystems for gauges 1435 and 1520 into the common system

Prepare a publication of the "Rules and regulations of design of system MSR32

Apply for the patent "Approval of design regulations of the system MSR32 for gauge 1520 mm

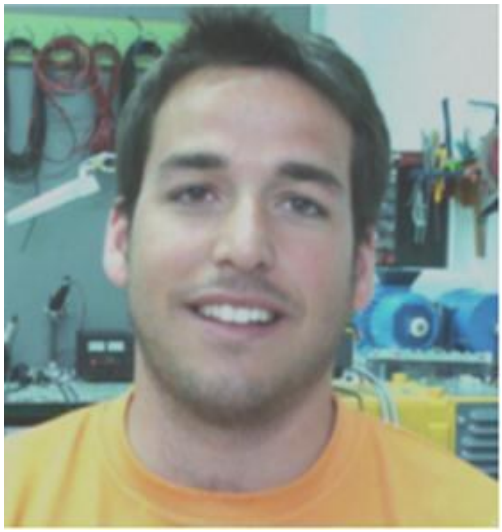
CARLOS RONCERO-CLEMENTE

Promocijas darba nosaukums: Intelektuālie parveidotāji sadalītiem enerģijas avotiem (SIDER)

PhD title: Smart Inverter for Distributed Energy Resources (SIDER)

Zinātniskais vadītājs
Profesors Enrique Romero-Cadaval

Scientific adviser
Professor Enrique Romero-Cadaval



Pētījuma kopsavilkums

Tradicionāli energosistēmas tiek būvētas pēc vertikāla principa, no augstsprieguma līdz zemsprieguma elektropārvades tīkliem. Elektroenerģija tiek ģenerēta lielās spēkstacijās, piemēram, kodolenerģijas, siltuma un hidroelektrostacijās, kas ir savstarpēji savienotas un enerģija tiek pārvada masveidā pa elektrisko tīklu. Visbeidzot, šī enerģija tiek sadalīta uz gala patērētājiem dažādos sprieguma līmeņos, izmantojot dažādu topoloģiju sadales tīklus, visbiežāk tiem ir radiālā struktūra. Izskatītajā scenārijā ir šādas galvenās iezīmes:

• Elektrostacijas ar vadības spējām, kurām ir skaidri definēta vienota vadības sistēmā, izejvielu uzkrājumi, degvielas/izejvielu cenas un stacijas jauda;

• Vienvirziena jaudas plūsma (izņemot pārvades sistēmas), kas vienkāršo sistēmas monitoringu un aizsardzības nodrošināšanu;

• Tīkla stabilitāte, kuru nodrošina lielās spēkstacijas, kas savukārt nodrošina aizsardzību pret īssavienojumiem un citiem tīkla pārtraukumiem, frekvences un sprieguma līmeņa stabilitāti, kas tiek nodrošināta ar reaktīvās enerģijas plūsmām;

• Tīkla atbalsts tiek nodrošināts, izmantojot rezerves elementus.

Sadalītā elektroenerģijas ražošana (tiek saukta arī par sadalītajiem elektroenerģijas resursiem (DER), sadalītajiem resursiem vai sadalīto jaudu (DP)). Šādi apzīmē elektroenerģijas ražošanu, kad tiek izmantotas maza mēroga enerģijas ražošanas tehnoloģijās, kas atrodas netālu no

Summary of the research

Conventional scenarios of power systems are configurated vertically. Energy is generated at large power plants such as nuclear, thermal and hydroelectric plants which are interconnected and the energy is transmitted massively through electrical grid. Finally, this energy is distributed to the end consumers at different voltage levels through radial or meshed networks, usually operated as radial ones. Main features of this scenario are:

•Power plants with management capabilities, in which the stock, fuel prices and the generator availability are well-known;

• One-way power flows (except in transmission system), which simplify the measurement and protection systems;

• Grid stability supported by the large power plants, which provide a high short circuit power levels, a stable frequency and the voltage level is controlled by reactive power flows;

• Network support is carried out by redundant elements.

Distributed generation, (also called distributed resources (DR), distributed energy resources (DER) or dispersed power (DP)) is the use of small-scale power generation technologies located close to the load being served. These technologies include reciprocating engines, microturbines, combustion gas turbines (including miniturbines), fuel cells, photovoltaic plants and wind turbines.

Solar energy is one of the most relevant distributed energy resources taking an important

slodzes/ patērētajiem, ko apkalpo. Šīs tehnoloģijas ietver dīzeļģeneratorus, mikroturbīnas, deggāzes turbīnas (ieskaitot miniturbīnas), degvielas šūnas, fotogalvaniskos paneļus un vēja turbīnas)).

Saules enerģija ir viens no svarīgākajiem sadalītajiem enerģijas avotiem, tai ir atvēlēta svarīga loma jaunajā scenārijā. Šis fakts rada vairākas problēmas un iespējas attiecībā uz elektroenerģijas ražošanas uzņēmumiem, kas cenšas ieviest optimālu tīkla vadību, uzlabot elektroenerģijas kvalitāti un nodrošināt elektroapgādes nepārtrauktību.

Sakarā ar plašu fotogalvanisko paneļu pielietošanu, jauna likumdošana un tehniskie noteikumi tika izstrādāti. Šie noteikumi galvenokārt nosaka prasības invertoriem, kas nodrošina elektroenerģijas kvalitāti un stabilitāti, nododot to no fotogalvaniskiem paneļiem tīklā, tai skaitā tīklu bojājumu gadījumos.

Vēl viens svarīgs aspekts ir pret – izolācijas principa nodrošināšana, invertori tiek izmantoti, lai atvienotu saules paneļus tīkla bojājumu gadījumā, un novērš lielākus bojājumus. Šo algoritmu zemā efektivitāte multi-invertoru vidē ir svarīgs izpētes jautājums, lai izstrādātu un ieviestu algoritmus, kas atbilst ilgtspējīgas attīstības principiem.

Pētījumam ir identificēti pieci galvenie mērķi:

• Sprieguma līmeņa vadība PCC (pamata komponentes un harmonikas), galvenokārt veicot sprieguma harmoniku filtrāciju;

• Plānot aktīvās un reaktīvās jaudas integrēšanu sadales tīklos;

• Nestandarta situāciju identificēšana un signalizācija, izmantojot integrētās telekomunikāciju sistēmas;

• Pret – izolācijas situāciju noteikšana daudzinvertoru vidē;

• Traucējumu identifikācija un apraksts un tīkla stāvokļa identifikācija.

Projekts būtībā sastāv no trīs galvenajām sadaļām.

Pirmā sadaļa saucas SIDER-PQH (aktīvā jauda, reaktīvā jauda un harmoniku kompensācija). Šajā apakšprojektā ir paredzēts izveidot jaunā invertora shēmu un prototipu, vadības shēmu ar topoloģiju, kontroles stratēģijām, atsauču sekošanas tehniku un kontroles signālu ģenerēšanu pusvadītājos. Šim pārveidotājam ir jānodrošina divas galvenās lietas: sprieguma līmeņa pie PCC (pamata komponentes un harmonikas) kontroles un saražotās enerģijas vadību.

part in this new scenario. This fact presents several challenges and opportunities for the electrical companies that try to achieve an optimum operation control of their grids in order to improve the power quality and to assure the power supply continuity.

Due to these high penetration levels of photovoltaic plants and their inverters, new regulations have been established. These regulations have as main deal that these inverters work providing support and stability during grid fault events and the necessity of injected reactive power in order to restore the voltage at the point of common coupling (PCC) should be noted when voltage sag occurs.

Another important aspect is the anti-islanding algorithms that inverters have incorporated in order to disconnect the photovoltaic plant when a grid fault occurs and prevents several damages. The low effectiveness of these algorithms in multi-inverter environments has to be important the study all of these factors achieving suitable control algorithms for the current situation.

The complete project has five fundamental aims:

• Controlling the voltage level at PCC (fundamental component and harmonic components), mainly during a voltage sag occurs.

• Planning the active and reactive injected power into the electrical grid.

• Detection of anomalous events though advanced protections using communication systems.

• Detection of anti-islanding in multi-inverter environments.

• Detection and description of disturbances and detect the state of the grid.

The structure of the project is divided into three parts.

The first part is called SIDER-PQH (active power, reactive power and harmonic compensation). This subproject has as main deal the design and the develop of the new inverter composed by the topology, control strategies, reference tracking technique and generation of control signals in the semiconductors. This inverter has to be of two principal capabilities: voltage at the PCC control and management of the generated power.

The second part is called SIDER-PROCOM (protection and communication) and it is focused on the provision of the inverter that will work in Smart Grid environment three capabilities: security, protection and communication. The

Otrā daļa saucas SIDER-PROCOM (aizsardzība un komunikācija), un tā ir vērsta uz invertora, kas strādās Smart Grid vidē, trīs iespēju noteikšanu: drošība, aizsardzība un sakari. Iespējamais risinājums ir balstīts uz fāžu sinhronizātoru. Galvenā pētījuma problēma šajā gadījumā ir sekcionēšanas parādības izpēte multi-invertoru vidē.

Trešā daļa ir SIDER-HOSAPQ (harmonikas kartības analīze un neironu tīkls), kas pētīs dažādus notikumus un anomālus notikumus, kas ietekmē piegādes kvalitāti. Lai sasniegtu šos rezultātus, tiks izmantota dažāda veida statistika, un šis process tiks automatizēts.

Pētījuma novitāte

Elektrisko tīklu topoloģija nepārtraukti tiek uzlabota. Sadalītās ražošanas un viedo tīklu izmantošana sniedz vairākus izaicinājumus un iespējas attiecībā uz elektroenerģijas pārvades uzņēmumiem, kas grib panākt optimālu darbību un sava tīkla vadību, lai uzlabotu elektroenerģijas kvalitāti un nodrošinātu elektroapgādes nepārtrauktību, tika izstrādāti jauni tehniskie nosacījumi un likumdošana. Jaunai tīkla topoloģijai ir nepieciešams attīstīt jaunas vadības stratēģijas, kas ļauj nodrošināt invertora darbību, ar augstu veiktspēju un uzticamību.

Pašlaik tiek veikta piedāvātās topoloģijas analīze, lai izstrādātu tās optimālu konfigurāciju. Šai topoloģijai ir trīs līmeņi, nulles punkts ir saistīts ar kvazi pretestība avotu, kas invertācijas rezultātā ļauj palielināt ieejas spriegumu, un tas ir ļoti noderīgi sadalītās energosistēmās, dažādu parametru svārstības dēļ.

Sasniegtie rezultāti

Vairums ierosināto pieeju jau apstiprinātas simulācijas pie nominālās skalas un arī neliela mērogaeksperimentos.

Vairākas starptautiskas konferences publikācijas un žurnālu publikācijas ir pieņemtas iespiešanai.

Dalība projektos

Projekts SIDER (Viedie invertori Sadalītiem Elektroenerģijas Avotiem) TEC2010-19242-C03 un grants BES-2011-043390.

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possible solution is based on syncrophasors. The principal situation to study is the islanding phenomena in multi-inverter environments.

The third part is SIDER-HOSAPQ (harmonic order analysis and neuronal network) that will study the different events and anomalous events that affect in the quality of supply. In order to achieve these deals, different statistics will be used and this process has to be automatated.

Novelty of the research

The electrical grid scenario is in continuous changes. Distributed generation and smart grids present several challenges and opportunities for the electrical companies that try to achieve an optimum operation control of their grids in order to improve the power quality and to assure the power supply continuity and new regulations have been published. Because of that, it is necessary to develop new suitable control strategies that allow the inverter operation with these new requirements and capabilities with high levels of performance and reliability.

At this moment, a new proposed topology is being studied as a possible improvement. This topology is a three level neutral point clamped quasi impedance source inverter allowing boost the input voltage and it is very useful in removable energies due to the high variability of the different parameters such as irradiance and temperature.

Achieved results

Most of the proposed approaches are already approved in simulation at nominal scale and also in experimental at small scale.

Several international conference publications and journal publications have been accepted.

Participation in projects

Project SIDER (Smart Inverter for Distributed Energy Resources) TEC2010-19242-C03 and grant BES-2011-043390.

ALEKSANDRS NIKOLAJEVS

Promocijas darba nosaukums: Dzelzceļa automātikas ierīces un apgrieztas vilces tīkla elektromagnētiskā savienojamība elektrificētos dzelzceļa posmos

PhD title: The electromagnetic compatibility of the railway automatic devices with back - draft network on the electrified sections of the railway

Zinātniskais vadītājs
Dr. Sc.ing., asoc. prof. Ļudmila Sergejeva

Scientific adviser
Dr.Sc.ing., assoc. prof. Ludmila Sergejeva

Pētījuma kopsavilkums

Sliežu ķēde ir galvenais elements vilcienu kustības intervāla regulēšanas sistēmā. Austrumu-rietumu koridors aktīvi tiek izmantots dzelzceļa kravu pārvadījumiem. Šis dzelzceļa posms ir aprīkots ar trešās paaudzes sliežu ķēdēm. Lai samazinātu izdevumus, augstākminētajā dzelzceļa posmā plānots izveidot maiņstrāvas tīklu. Vilciena kustībai tiek izmantota stipra strāva, kas var ietekmēt dzelzceļa automātiku. Pētījums ir aktuāls, jo ļaus laikus atklāt trūkumus sliežu ķēdes un automātiskas lokomotīvju signalizācijas darbībā.

Pētījuma novitāte

Apgrieztas vilces tīkla un automātiskās lokomotīvju signalizācijas matemātisku un datormodeļu izstrāde, trūkumu analīze un uzlabošanas metodes izveidošana.

Sasniegtie rezultāti

Literatūras analīze, aizvietošanas shēmas izveidošana, nepieciešamo programmatūru izvēle.

Institute of Railway Transport

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Summary of the research

The track circuits are the main elements in the system of interval regulation of the trains` traffic. The information about free sections of the railway lines and about the integrity of the railway`s track wires provides the interval regulation of trains` traffic. By track wires of track circuits, which at the same time is the floor channel of the automatic locomotive alarm, the information about traffic lights forward is given to the locomotive.

The east - west transit corridor is actively used for the cargo transport. This section is equipped by the system of tonal track circuits of the third generation. In order to reduce costs for the cargo transport it is planned to electrify the section by the alternating current.

Novelty of the research

The purpose of the modeling is to research the changes of the asymmetry coefficient of AC traction current under the coils of the automatic locomotive alarm, when the train moves on various railway track circuits. To implement such tests experimentally during operation is quite difficult; therefore, we propose to use software simulation in Matlab environment, as well as to check the values in the Electronics Workbench.

Achieved results

Analysis of literature, equivalent circuit diagram engineering, selection of the necessary software.

Chapter II
Regular papers

Comparison of different topologies of LED dimmers

Olegs Tetervenoks

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Abstract- This paper deals with assessment of efficiency of current switching regulator LED dimmers of three different topologies: buck, boost and buck-boost. SPICE models of circuits have been built, and the results obtained in these simulations are compared with experimental measurements. Estimation of power losses and controllability in comparison with voltage switching regulators is also presented in this paper.

INTRODUCTION

Nowadays intelligent lighting systems are becoming more popular. These systems are able to increase lighting efficiency by several orders in comparison with the conventional lighting system [1], [2]. For such a system LED lamp should be dimmable. LED produced light amount is proportional to the current flowing through it. Therefore smooth current regulation technique is vital feature for such a kind of LED lamps. There are several LED dimming methods with their advantages and drawbacks: step regulation, PWM technique and fluent current regulation method. Fluent light regulation can be achieved by two last of them. But in the case of PWM regulation undesirable stroboscopic effect and flickering may appear, thus fluent current regulation technique is preferable, it is advantageous from many points of view [3]…[6]. If voltage regulator is used for this purpose then there is narrow range of changes of control parameter, making control process inconvenient for usage with microprocessor. To make control process more convenient it is necessary to use schematics where the control parameter changes in wide range.

COMPARISON OF TOPOLOGIES

A. Description of Current Regulator Topologies

LEDs are current consumers and therefore to regulate the amount of produced light it would be easier to use a current regulator rather than voltage regulator. Topologies of voltage and current regulators discussed in this paper are summarized in Fig. 1.

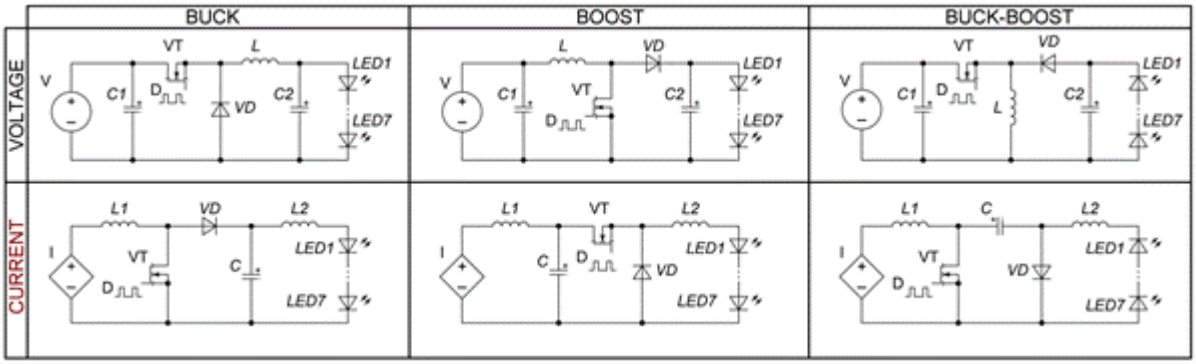


Fig. 1. Comparison of different topologies of LED dimmers

Here are three classical voltage regulators topologies. According to their likeness output value relation with duty cycle for current regulator also can be written as in Table I.

TABLE I. OUTPUT VALUE RELATION WITH DUTY CYCLE FOR DIFFERENT TOPOLOGIES

	Buck	Boost	Buck-boost
Voltage	$V_{out} = V_{in} \times D$	$V_{out} = \frac{V_{in}}{1-D}$	$V_{out} = \frac{-V_{in} \times D}{1-D}$
Current	$I_{out} = I_{in} \times (1-D)$	$I_{out} = \frac{I_{in}}{D}$	$I_{out} = \frac{-I_{in} \times (1-D)}{D}$

For current regulators inductors L1 and L2 are performed as current smoothing elements, capacitor C is energy storage, similar as capacitors C1 and C2 are voltage smoothing elements for voltage regulator and L is energy storage.

B. Comparison of Controllability

To make comparison of controllability of different topologies several experiments with prototypes were held on testbench shown in Fig. 2. To ensure in correct measurements the same components were used to make prototypes of different dimmer topologies, if it was possible. The LED lamp prototype was built from 7 10W W724C0 Seoul Semiconductor LEDs with 90 lumen/watt efficiency [7].

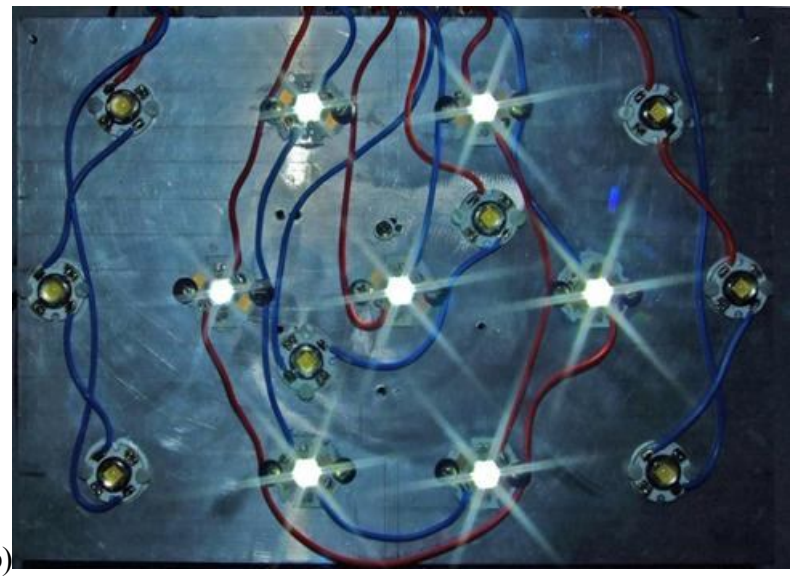
a)  b) 

Fig. 2. Testbench for experimental measurements for comparison of different LED dimmer topologies: a) testbench; b) LED lamp prototype

To characterize controllability process LED lamp prototype provided illuminance level at different duty cycles (control parameter values) were measured. The results of these experiments are summarized in Fig. 3, where both parameters are shown in relative units. Current regulator control parameter changes in a wider range. It can be concluded from this data that current regulators are more convenient from the controllability point of view.

Also it should be noted that it is quite difficult to achieve full regulation range for current regulator boost topology. In this case input current should be equal to current of smallest illumination level. This leads to significant input voltage increase to achieve required power for higher output current values.

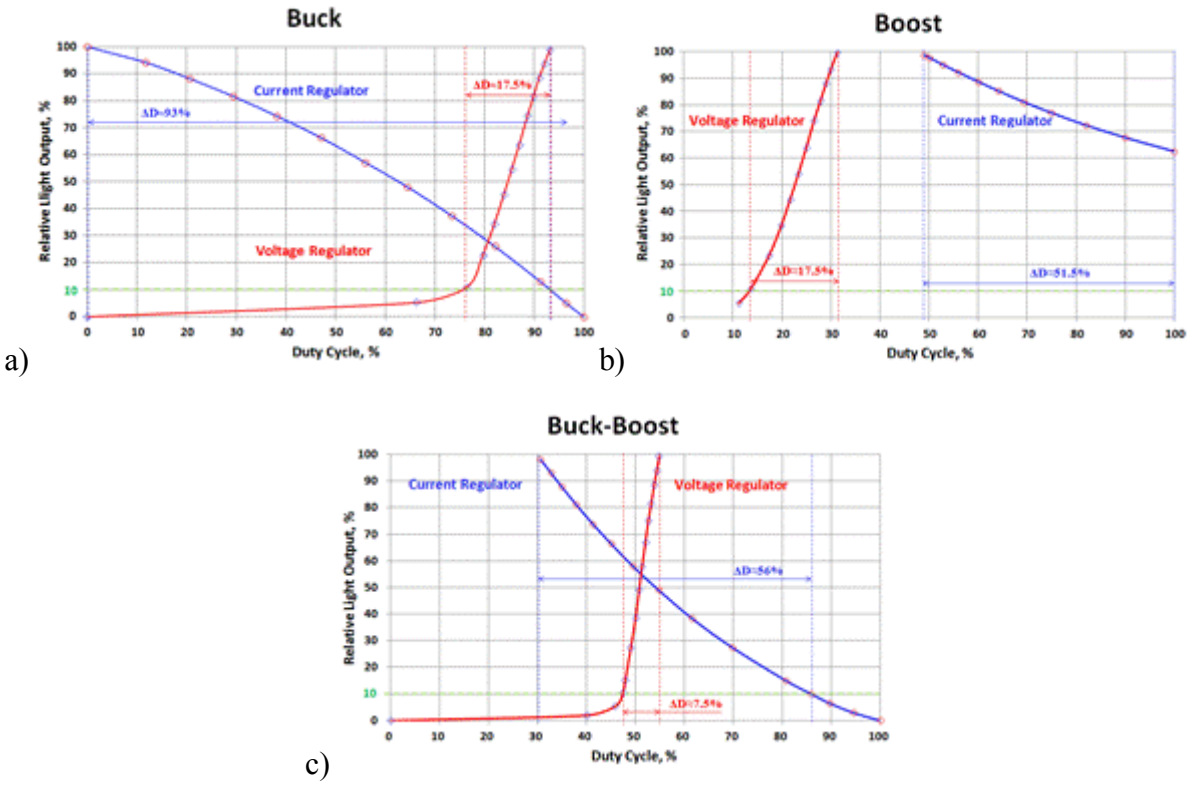


Fig. 3. Comparison of controllability of different topologies: a) buck topology; b) boost topology; c) buck-boost topology.

C. Comparison of Losses

The same testbench (Fig. 2) and LED dimmer prototypes were used for comparison of losses. The results are summarized in Fig 4. For buck topology efficiency of voltage regulator is significantly higher than the efficiency of current regulator. For good current smoothing inductance values of L1 and L2 should be relatively large that leads to additional losses. This is the main drawback of current regulators. It is quite difficult to evaluate losses of boost topology because of the problem described in previous section. But in the case of buck-boost topology the current regulator shows smaller losses.

Also for proper efficiency evaluation it is necessary to take into account losses of primary power supply, which is a topic for further researches.

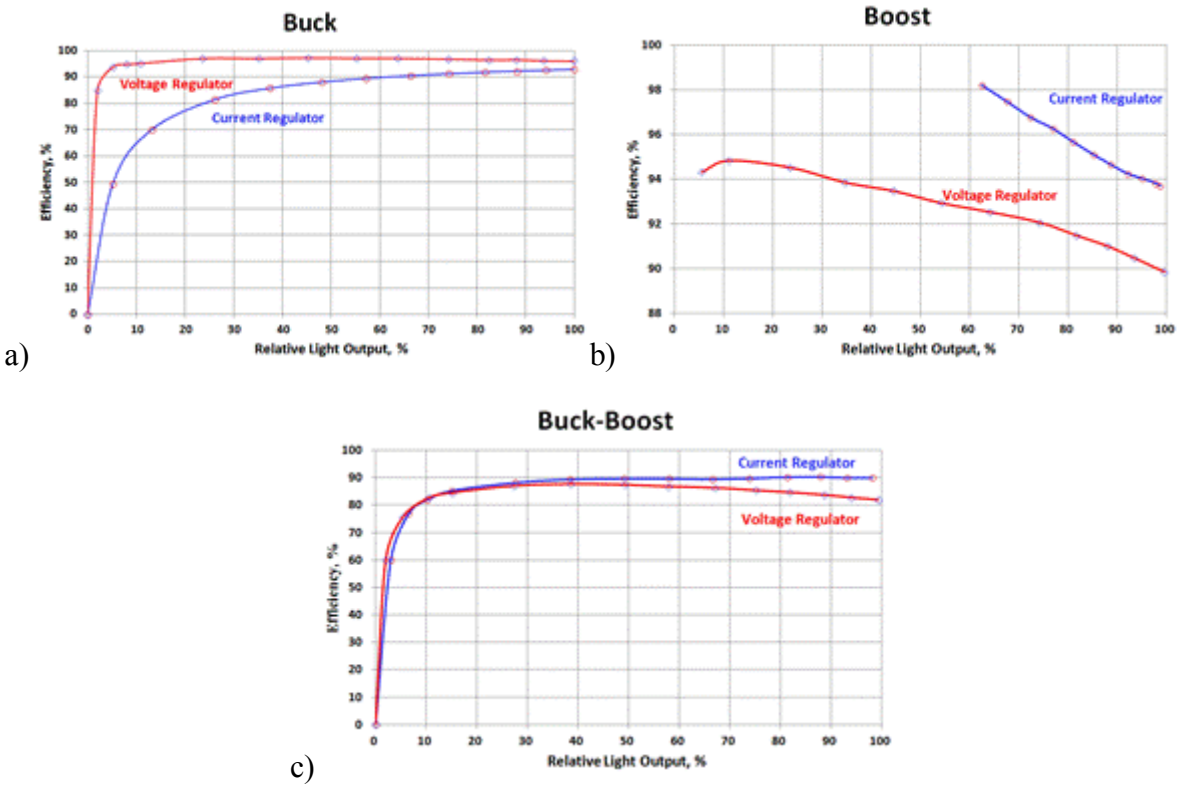


Fig. 4. Assessment of losses of different topologies: a) buck topology; b) boost topology; c) buck-boost topology.

REFERENCES

[1] H. Zeng, J. Qiu, X. Shen, G. Dai, P. Lui, S. Le, "Fuzzy control of LED tunnel lighting and energy conservation," School of Mechatronic Engineering, East China Jiaotong University, Nanchang, 330013, *China Mathematical and Computer Modelling*, Volume 54, Issue 3-4, August 2011, Pages 931-937

[2] Suzdalenko, A.; Galkin, I.; "Investigation of power supply methods for intelligent LED luminary," Power Electronics and Motion Control Conference *(EPE/PEMC), 2010 14th International* , vol., no., pp.T6-66-T6-69, 6-8 Sept. 2010

[3] Galkins I., Bisenieks L., Suzdaļenko A. "Impact of Pulse Modulation Method of LED Dimmer for Street Lighting on its Efficiency" // *Proceedings of the 4th European DSP Education & Research Conference*, France, Nica, 1.-2. December, 2010. - pp 160-164

[4] H.van der Broeck, G. Sauerlander, M. Wendt, "Power driver topologies and control schemes for LEDs", in Proc. of 22nd Applied Power Electronics Conference (APEC 2007), Anaheim, pp. 1319 – 1325, 25 Feb. – 1 Mar. 2007.

[5] J.R. de Britto, A. E. Demian Jr., L. C. de Freitas, V. J. Farias, E. A. A. Coelho, J. B. Vieira Jr., "A proposal of Led Lamp Driver for universal input using Cuk converter", in Proc. of 39th Power Electronics Specialists Conference (PESC2008), Rhodes, pp. 2640-2644, June 15-19, 2008.

[6] M. Schmid, D. Kuebrich, M. Weiland, T. Duerbaum, "Evaluation on the Efficiency of Power LEDs Driven with Currents Typical to Switch Mode Power Supplies", in Proc. of 42nd Industry Applications Society Annual Meeting (IAS2007), New Orleans (USA), pp. 1135-1140, October 15, 2007.

[7] Seoul Semiconductors, W724C0 DataSheet, 2008, available electronically at www.seoulsemicon.com, last checked on December,16 2011.

Optimal sizing of supercapacitor bank for on – board energy storage system

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Abstract - The paper considers the problem of choosing the optimum size for an on-board energy storage system (ESS) based on supercapacitors (SCs) taking into account both the braking energy and the braking power of an electrical vehicle. Numerical simulations on the ESS model allow the calculating of the saved braking energy vs. the SC number and their discharge depth thus it is possible to find a compromise solution between the ESS efficiency and its cost.

1. INTRODUCTION

In the literature, variously sized on-board ESSs for different types of electric vehicles are described. Most of them are sized for d=0.5 [1-5], which is recommended by SC manufacturers and gives the maximum available useful energy. This value of d is chosen taking into account only the energy requirements. However, at d=0.5 the power capability of the ESS in the discharged state $P_{ESS}=I_{Cmax}V_{SC,max}\cdot d$ is only a half that of a fully charged ESS. If the braking power exceeds P_{ESS}, a portion of the braking energy is lost, and the ESS energy capacity is not fully utilized. The situation can be improved by reducing the energy capacity and increasing the power capability if the discharge depth d is increased. Obviously, the optimum d value can be found for each braking process if the braking power profile is predictable. The necessity to take into account both the energy capacity and the power capability of the ESS in the stage of its sizing is accentuated in works [5, 6]. The authors of the former, have chosen the stationary ESS with the energy capacity of 20.55 MJ at d=0.7, while in [6] the SC discharge modes with a constant current and power are studied, with d=0.758 matching 90% energy efficiency. This paper is focused on the on-board ESS sizing taking into account both the energy capacity and the power capability of ESS when for this application a specific braking power profile [1, 4, 7, 8] is applied.

2. ESS MODEL AND SIMULATION RESULTS

To find optimal number of SCs and their discharge depth a simple mathematical model of the on-board ESS was developed and relevant simulations performed.

The model is described by the following equations:

$$-p_{br}\eta = i_C^2 R_C + v_C i_C , \quad (1)$$

$$v_C = \frac{1}{C}\int i_C dt + d\cdot V_{SC,\max} , \quad (2)$$

$$v_{SC} = v_C + i_C R_C \quad (3)$$

and constraints $i_C \le I_{C\max}$, $v_{SC} \le V_{SC,\max}$,

where p_{br} – vehicle braking power;

η – ESS power converter efficiency;

i_C – SC charging current;

v_C – SC capacitive voltage;

C – SC bank capacitance;

v_{SC} – SC bank voltage.

The *Matlab* algorithm of the model performs iterative calculations of Eqs (1), (2), (3) with the iteration step of 0.01s, and provides limitations on i_C and v_{SC} according to the constraints. The simulations were carried out for the braking power profile E_{br}=820kJ, $P_{br,max}$=236kW, t_{br}=6.9s, which characterizes fully loaded trolleybus Škoda 24Tr braking at the speed of 50km/h with the deceleration factor a=-2m/s^2. It was assumed that ESS bank contains Maxwell BCAP3000 SC cells (3000F) and ESS parameters are I_{Cmax}=400A and converter efficiency η=0.98.

Figure 1 shows the simulated saved energy (p.u.) as a function of *d* for three *N* values: 200; 250; 284.

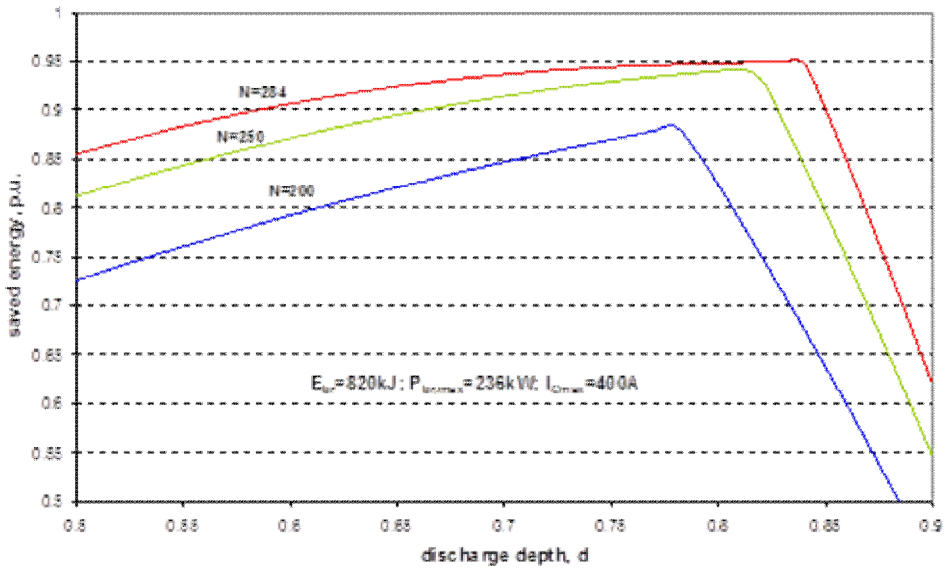

Fig. 1. Saved energy p.u. *vs.* discharge depth *d*.

For *N*=284 no current or voltage limitation in ESS operation is ensured in a comparatively wide range of *d*=0.77-0.84 with the maximum energy saved at d_{opt}=0.84. At *d*<0.77, current limitation occurs at the beginning of braking. For *d*>0.84, voltage limitation takes place at the end of braking, and the saved energy falls dramatically with increasing *d* value. For the reduced number of cells: *N*=250, *N*=200, the d_{opt} values are 0.81 and 0.78, respectively. The amount of saved energy is smaller and more sensitive to the *d* variations. At a reduced number of cells both current or voltage limitation is always present, and a portion of the braking energy is dissipated in the braking rheostat.

However, the reduced number of cells is of interest from the viewpoint of a compromise between the saved energy and the ESS cost. Figure 2 shows the saved energy per unit and per cell *vs.* the number of cells N for the optimum value $d_{opt}(N)$. As it is seen in the figure, with N increasing above 284 the saved energy grows slightly as the ESS efficiency grows due to reduced SC current. At the same time, per cell saved energy is small and decreases with N increasing. The cell number reduced below 284 might be an option for the cases when the ESS payback time is more important than the amount of energy saved. Therefore, e.g., reducing N by 30% (i.e. choosing N=200 instead of N=284) gives only 6.7% less saved energy while per cell it will increase by 23%.

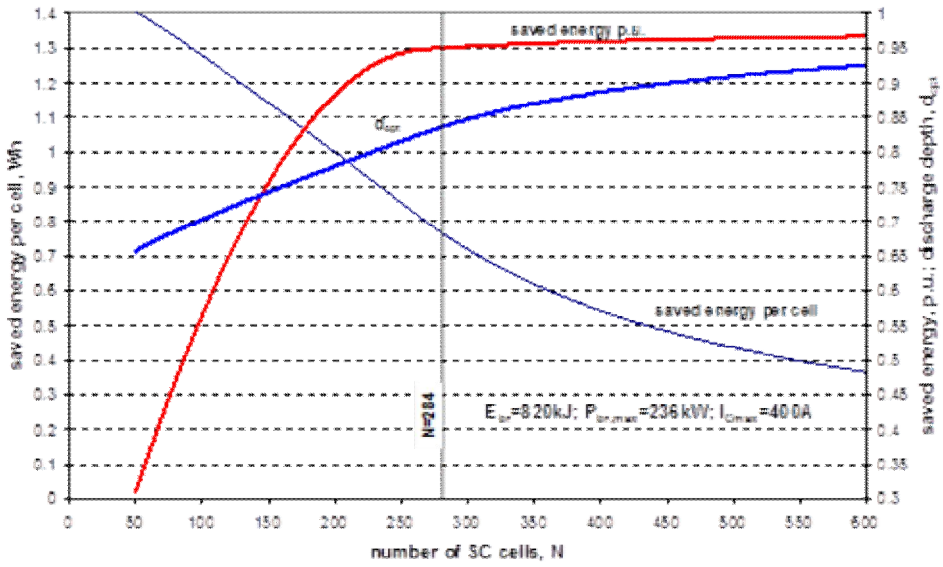

Fig. 2. Saved energy p.u., saved energy per cell and the optimum discharge depth *vs.* the number of SC cells

3. CONCLUSIONS

1. Sizing of the on-board ESS should be performed taking into account both the braking energy and the braking power of a vehicle.
2. The optimum discharge depth of supercapacitors in an on-board ESS in the most cases is in the range 0.75-0.85 instead of the widely recommended d=0.5.
3. The reduced number of cells could be proposed as a compromise solution in the cases when the payback time for ESS is more important than the amount of energy saved.

4. REFERENCES

1. Destraz, B., Barrade, P., Rufer, A., & Klohr, M. (2007). Study and Simulation of the Energy Balance of an Urban Transportation Network. *EPE 2007 Conf. Proceedings,* Aalborg.
2. Cheng, Y., Van Mierlo, J., *et al.* (2007). Configuration and Verification of the Supercapacitor Based Energy Storage as Peak Power Unit in Hybrid Electric Vehicles. *EPE 2007 Conf. Proceedings,* Aalborg.
3. Ciccarelli, F., Iannuzzi, D., & Tricoli, P. (2011) Speed-based Supercapacitor State of Charge Tracker for Light Railway Vehicles*, EPE 2011 Conf. Proceedings,* Birmingham.

4. Barrero, R., Tackoen, X., & Van Mierlo, J. (2008) Analysis and Configuration of Supercapacitor Based Storage System On-board Light Rail Vehicles. *EPE-PEMC 2008 Conf. Proceedings,* Poznan, pp. 1535-1540.
5. Barrade, P., & Rufer, A. (2004). The use of Supercapacitors for Energy Storage in Traction Systems. *EEE-VP04: Vehicular Power and Propulsion Symposium,* Paris.
6. Barrade, P., & Rufer, A. (2003) Current Capability and Power Density of Supercapacitors: Considerations on Energy Efficiency. *EPE 2003 Conf. Proceedings,* Tolouse, pp. P1-P10.
7. Barrero, R., Van Mierlo, J., & Tackoen, X. (2008). Enhanced Energy Storage Systems for Improved On-Board Light Rail Vehicle Efficiency. *IEEE Vehicular Technology Magazine, I Sept. 2008,* 26-36.
8. Meinert, M., Rechenberg, K., Hein, G., & Schmieder, A. (2008). Energy Efficient Solutions for the Complete Railway System, *Proceedings of the 8th World Congress on Railway Research*, Seoul, P1-P11.

Monitoring and diagnostic for railway automatic and telematic device research and development

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Railway automatics and telematics require high level of safety and reliability as a norm. Criteria for safety level and reliability is uptime, in other words to prolong operation lifetime. Availability factor is commonly used for railway systems.

Reliability or railway automatic and telematic device's based on maintenance approaches. We now approach with schedule maintenance and maintenance after real state notification. Both approaches elements are replaced and renewed. It is a way to protect from sudden failure and faulty

Maintenance after real state notification has the most economical efficiency. The state of the art maintenance approach requires necessary instruments, main additional equipment and software.

Introduced research accepts information streams integration from different information sources. First of all, in research proposed information stream direction dependently from "speed" of failure or faulty. Information direction switched between support and service staff.

For high quality and validity of monitoring and diagnostic results processing in research is applied three state function of element definition. Performance of three state function using is dimensionless processing engine with predictable decision accepting time.

For subsystem optimization in research proposed numerical criteria for subsystem. Numerical criteria for diagnostic subsystem allow the comparison of different subsystems. The PD penetration deep is most important criteria for approach used for element diagnostic.

The next important moment is maintenance necessity for monitoring and diagnostic subsystem. This criterion, named as direction, needs feedback from end user to subsystem.

Research kernel is three state function estimation for concrete railway automatic and telematic elements or elements group. Information validity is ultimate goal of all diagnostic. Diagnostic approaches from system producers in match cases technological secret and stays of copy right laws.

Practical results of research are diagnostic approach for impulse type of relay, electronic code transmitter with self diagnostic for old electromechanical transmitter with SIL 3, principles of storage battery state notification without disconnection in automatic mode.

Impulse relay testing based on anchor presence effect, then transient process depended of anchor, contact system wearing. The research introduces the reason for time based approach choice. In time based approach achieved PD = 35% for commonly used ТШ type of impulse relay. Approach realization may be similar as introduced testing device TST-2 for ТШ type of impulse relay shortening time measurement. TST-2 modernization to notification of anchor and contact system state is possible.

Electromechanical code transmitter, named КПТШ, according to schedule is replaced annualy. EMCT is an element with heavy weight and high cost of maintenance. Therefore the research proposes the direct replacement ECT with high reliability MTBF 6.4 year and SIL 3(IEC EN 61508, EN 50128, EN 50129). The research contains a reason for functional circuit with strong function detachment. Detachment allows realize hardware with high level of reliability and low level of logical errors on firmware. Both "west" and "east" philosophies

for reliability and safety are compared. ECT prototype, named as КПТ-Э, prepares patent application P- 11-161.

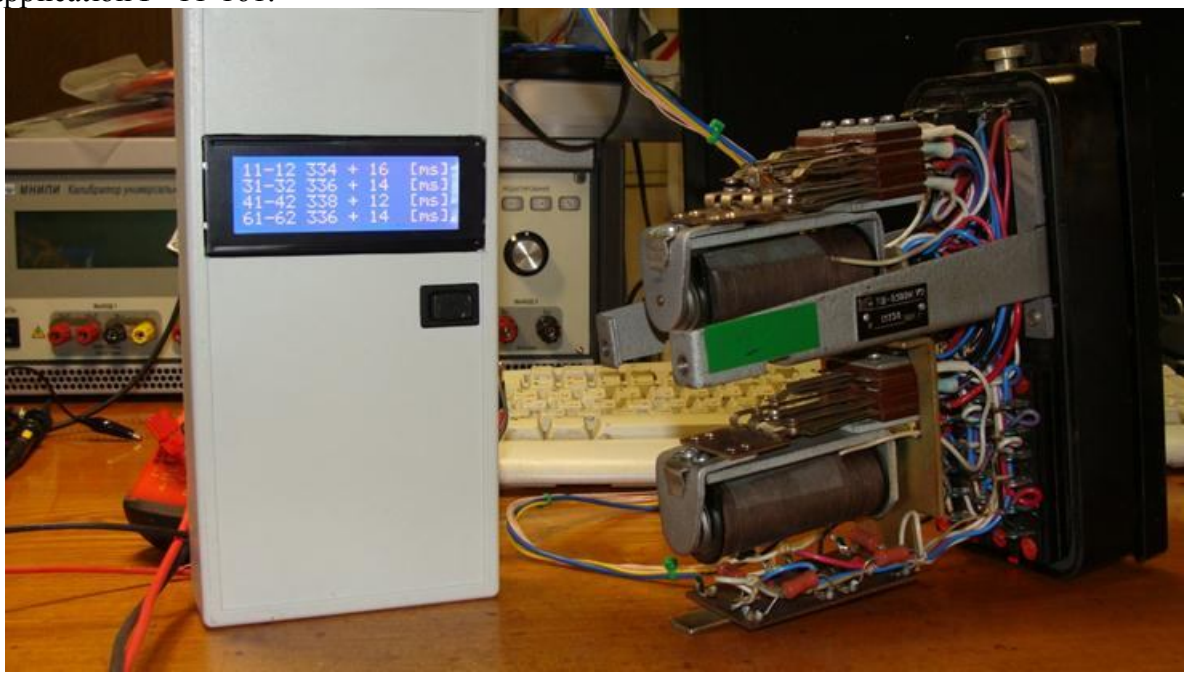

Figure 1. Experimental stend

Elements group monitoring and diagnostic and power efficiencies acceleration located on add on equipment design. For example in research proposed local power sources estimation and application. Performance of local power sources application is electrical parameters of elements stability with efficiency coefficient rising. Power option monitoring is a way for element group state notification. Local power source for direct current railway track, named IDM-MT, is introduced.

Storage battery of UPS at any time needs to be state in normal condition. In research introduced energy of battery estimation and state monitoring and diagnostic based on unique parameter such as internal resistance. Problematic of battery state monitoring is in railway automatic and telematic system layout. System equipment decentralization with staff load on maintenance time is second. In research automatic measurement of internal resistance of battery one disconnection with tracing load generator is proposed. Simulation result analyzing gives a necessary form of load current. Analog machine allows approach simplification. Add on equipment for power supply PS-2 for battery internal resistance measurement prepares patent application P- 11-160.

The power plane efficiency depended of power supply principle of operation shortly introduced. Result after power supply modernization gives efficiency rising up 25%. In this way it is same as local power source for elements group.

The practical result of research is promotion of maintenance after real state notification based on add on equipment design, direct replacement analog design with self diagnostic, normal operation condition of elements holdback.

Research and development of car electric traction drive elements

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Abstract- Basic structure of electronic differential for electric vehicle with two traction motors has been discussed. A differential model has been proposed and tested in simulation and necessary improvements for experimental testing are discussed.

Introduction

Electric vehicles are slowly appearing not only in fancy manufacturer showrooms but in car shops as well. One could say that electric vehicles are finally returning to the vehicle market. Electric vehicles are our new hope in better and greener future, because of the much more efficient drive system if compared to common internal combustion engine.
If vehicle is equipped with multiple drives it is possible to realize an electronic differential. One case is a vehicle with two motors - a drive for each rear wheel. Such a system has the advantage that mechanical differential can be replaced with electronic control, which could be called electronic differential. Since the mechanical differential is gone, the vehicle becomes lighter and more efficient. There is less maintenance. And the fact that everything is controlled by electronic – software, allows to achieve special, enhanced performance of the vehicle.
The aim of this article is to analyze the operation of electronic differential through the operation of the vehicle itself. This is the first step to build a laboratory prototype electric vehicle – an electric kart for studies in this field.

Electric kart

Two permanent magnet DC (PMDC) motors are used to achieve traction and drive the kart. Each motor is connected to one of the rear wheels through pulley sheave-belt coupling. The coupling reduces motor speed by ratio 3:1. Because each motor has its own power converter the speed and torque of individual wheel can be controlled separately, hence electronic differential can be implemented. Electrical energy is stored in two lead-acid battery packs. Each pack is used to supply individual power converter. Weight of the kart is approximately 230 kilograms. Assuming that average driver weights around 80 kilograms the total weight of the kart is 310 kilograms. From known parameters such as tire diameter, coupling ratio and motor speed, the maximal speed can be calculated to be 91 km/h. The average time of kart operation in steady state driving mode is estimated to be 15 minutes [1].
Since DC motor torque is proportional to motor current, sufficient control can be achieved using closed current loop regulator. By regulating current, the system can be protected from undesirable over current which can harm power converter. Each buck converter is operated by individual regulator circuit.
Regulator has two input signals. First signal is the desired motor current which can be interpreted as torque command or current command. Second signal is the feedback signal from the motor. Current transducer is used to measure motor current. Difference between current command and actual motor current produces current error, which is fed into PI regulator. PI regulator controls PWM generator. PWM signal is used to control buck converter power switches.

The kart can be controlled without electronic differential function. If so, then accelerator pedal is used to provide the same current command for both regulators, which in turn control power converters so that both motor currents achieve given current value. Under such operation both motor currents are equal and so are the torques.
In reality there are differences in motors, converters and mechanical systems. With no wheel speed feedback, it is highly probable that rear wheels will have different torques when the kart is driving straight forward. Such behavior is unacceptable.
Electronic differential is meant to regulate wheel speed difference according to steering wheel position [2][3].

Electronic differential

Most simple electronic differentials relay on multiple sensors. One of the most important is the steering wheel position sensors. An absolute value encoder could be used. Other option is to use linear displacement sensor, but it might be a bit more difficult to install such a device. The main purpose of steering wheel sensor is to provide curvature angle, out of which speed difference command can be calculated according to differential system equations [4].
Since electronic differential is assisting the driving process in curve, it in theory could do all the necessary "steering" so that front wheel turning is not necessary. Yet, such a system is more appealing in case of four traction motors – one for each wheel. A four wheeled traction vehicle has several advantages over traditional two wheel traction vehicles: since all four wheels provide traction, the main locomotive force is distributed to four wheels thus lowering the chances of slipping. If correct control is used the vehicle is able to turn without moving forward or backward – in a similar manner as a tank [5].
Other user input signal comes from accelerator pedal. To determine pedal position same sensors as for steering wheel could be used. One of most the traditional sensors is a double potentiometer. In current system accelerator pedal is used to generate current command value for both motor power converters. With electronic differential, the accelerator current command is to be altered specifically for each of the drives in order to achieve different torque and in turn different rotation speed.
Main feedback signals are speed signals from both wheels. Usually encoders are used to measure rotational speed. In this case it is better to use encoder to measure speed of the motor shaft rather than the speed of the wheel. Due to the fixed reduction ratio, motor will have three times larger speed. Placing an encoder on the motor shaft will provide better precision. Another approach is to measure front wheel speeds. This approach gives the correct speed of the vehicle even in the case if one or both rear wheels are slipping. But using signals from front wheels to determine rear wheel speed difference is more complex. For faster development and to ease the calculation, encoders are installed on the motor shaft for this particular kart. The vehicle can be upgraded by placing encoders on all wheels. Such system makes more sophisticated control, which can further improve vehicle performance.
To begin the analysis of the operation of the electronic differential control system (fig 1.) it is assumed that accelerator pedal is pressed and torque command is given to both drives. Kart is moving forward in straight trajectory with constant speed and steering wheel position angle is zero. Speed difference between two traction wheels is zero.

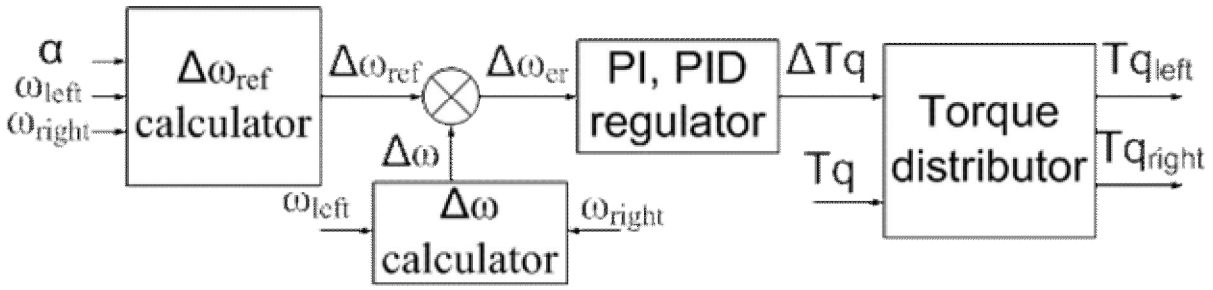

Fig. 1. Differential control system

The first block of the electronic differential is the reference speed difference calculator. It has three input signals: steering wheel position which is expressed as angle α and both motor speeds ωright and ωleft. All three values together with kart specific constants L and d are used to solve speed difference equation which product is to be used as desired speed difference command or just as reference speed difference Δωref [6].

Another block is used to calculate the actual speed difference. Signals from both encoders are subtracted one from another and resulting difference Δω is subtracted from reference speed difference. Resulting value is speed difference error Δωer which is used to calculate the necessary changes in each drive torque command to achieve correct differential operation. Some sort of regulator is required to achieve smooth regulation of torque command. Most usual a PI or PID regulator is selected for particular task [7].

Regulator output is providing torque difference ΔTq signal. In the final electronic block, torque difference value is added to one drive torque command and subtracted from other. Torque reference Tq is provided by accelerator pedal As a result one of the motors is providing less torque and it rotates slower, while other provides more torque and rotates faster.

Such system can provide stable speeds for both wheels under different loads as well as different wheel speeds when kart is moving through road curve (fig 2.).

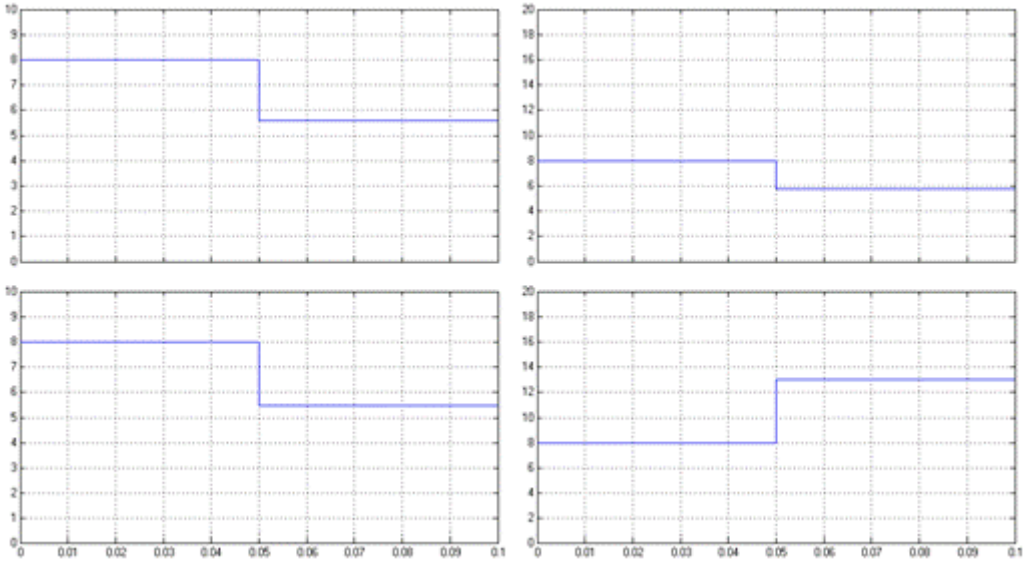

Fig. 2. Wheels speed with straight trajectory and step load (left) and with constant load and step steering angle command (right).

References

[1] K. Vitols, N. Reinberg, I. Galkin, A. Sokolovs, "Closed current loop regulator for electric kart DC motor torque stabilization", Compatibility and Power Electronics (CPE), 2011 7th International Conference-Workshop , vol., no., pp.377-381, 1-3 June 2011.

[2] S. Gair, A. Cruden, J. McDonald, B. Hredzak, "Electronic differential with sliding mode controller for a direct wheel drive electric vehicle," Mechatronics, 2004. ICM '04. Proceedings of the IEEE International Conference on , vol., no., pp. 98- 103, 3-5 June 2004.
[3] K. Hartani, M. Bourahla, Y. Miloud and M. Sekkour, "Direct torque control of an electronic differential for electric vehicle with separate wheel drives", JASE, 2008.
[4] M. Chaves, L. Perro, A. Roque, D. Prata, J. Maia, et al. "Control of an electrical kart with two independent motors", EPE, 2009.
[5] Zhou Yong, Li Shengjin, Zhou Xunqi, Fang Zongde, "The control strategy of electronic differential for EV with four in-wheel motors," Control and Decision Conference (CCDC), 2010 Chinese , vol., no., pp.4190-4195, 26-28 May 2010.
[6] R.P. de Castro, H.S. Oliveira, J.R. Soares, et al., "A new FPGA based control system for electrical propulsion with electronic differential," Power Electronics and Applications, 2007 European Conference on , vol., no., pp.1-10, 2-5 Sept. 2007.
[7] G.A. Magallan, C.H. De Angelo, G. Bisheimer, G. Garcia, "A neighborhood electric vehicle with electronic differential traction control," Industrial Electronics, 2008. IECON 2008. 34th Annual Conference of IEEE , vol., no., pp.2757-2763, 10-13 Nov. 2008.

Radiation and Diffraction by a Circular Aperture in a Conducting Sheet

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A plane wave with wave vector $\vec{k}_0$ is incident on a thin conducting sheet with a circular hole A of radius a in it (Fig. 1). If the wavelength of the incident radiation is comparable to the geometric parameters of the aperture, diffraction occurs. The incident radiation can be polarized parallel or perpendicular to the plane of incidence. Kirchhoff approximation of the scalar and vector diffraction theory can be applied. In the scalar diffraction theory the diffracted fields can be written as

$$\varphi(P) = \frac{k}{2\pi i}\int_A \frac{e^{ikr}}{r}\frac{e^{ikr'}}{r'}\mathrm{O}(\theta,\theta')da',$$

where $\mathrm{O}(\theta,\theta')$ is the obliquity factor , and P is the observation point.

The corresponding expression for the fields in the vector diffraction theory is

$$\vec{E}_{diff}\left(\vec{x}\right) = \frac{1}{2\pi}\nabla\times\int_A \vec{n}\times\vec{E}\frac{e^{ikR}}{R}da',$$

where $\vec{n}$ is the normal to the surface inscribed by the aperture, and R is the distance from the point of source to the point of observation.

When the point of observation is located far from the aperture the term kR can be expanded:

$$kR = kr - k\vec{n}\cdot\vec{x}' + \frac{k}{2r}\left[r'^2 - \left(\vec{n}\cdot\vec{x}'\right)^2\right] + \ldots$$

Fresnel diffraction occurs if the third term or higher terms are relevant, but to most systems Fraunhofer diffraction applies, where only the first two terms are relevant. In the case of polarisation in the plance of incidence, the Fraunhofer result for the diffracted fields in the Smythe-Kirchhoff approximation is:

$$\vec{E}\left(\vec{x}\right) = \frac{ie^{ikr}}{r}a^2E_0\cos\alpha\left(\vec{k}\times\vec{\varepsilon}_2\right)\frac{J_1(ka\xi)}{ka\xi}$$

where $\vec{\varepsilon}_2$ is the direction of the incident magnetic field, but ξ is an angular function:

$$\xi = \left(\sin^2\theta + \sin^2\alpha - 2\sin\theta\sin\alpha\cos\phi\right)^{\frac{1}{2}}$$

Other quantities of interest are the time averaged diffracted power per unit solid angle and the ratio of the transmitted power to the incident power.

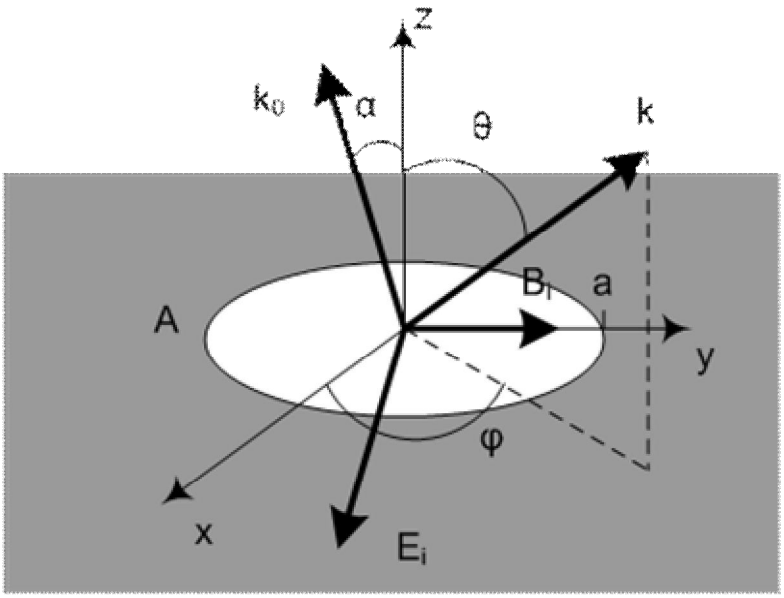

Fig. 1. Geometrical configuration for diffraction by a circular aperture

The author also analyses diffraction where the incident radiation is polarised perpendicular to the plane of incidence, as well as mixed polarization (both perpendicular and parallel). Also the Fraunhofer fields are analysed and the results from vector Kirchhoff approximation and the Smythe formula are compared.

Furthermore apertures in conducting sheets can be viewed as energy sources that produce radiation, as could be the case for an aperture in a waveguide. With the effective electric and magnetic dipole moments of the apertures, the radiated fields of the apertures can be analysed through multipole expansion.

Adaptive Systems and Built-in Intellectual Devices of Electric Transport

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Abstract – In this article the authors describe a possibility of use of the adaptive control algorithms for a braking system of a train.

The following assumption was put forward: a programmable logic controller with a control programme on the basis of an adaptive control algorithm and a current braking control system of a train allow to ensure an automatic smooth and precise braking of a train.

For this purpose, in the beginning of the article, a part of the available adaptive search algorithms is discussed and the most suitable and the most effective of them for this task was selected.

Further a control programme of a programmable logic controller (PLC) is designed and a motion model of a train is constructed in the Matlab environment, which makes it possible to carry out the first testing of the developed system.

In the conclusion of the article, an analysis of the results is carried out and an effectiveness of the selected control algorithms is evaluated.

Keywords – railway transport, adaptive control algorithms, programmable logic controllers.

I. INTRODUCTION

Nowadays the most topical questions are those, which are connected with safety routing of a rail transport and an observation of a train motion timetable. This is caused by such factor as an instant increase of train motion intensity and speed, which raises the demands for an observation of the train motion timetable and of an overall safety level of train motion.

The authors put forward an assumption that having combined a programmable logical controller (PLC) with a control programme based on an adaptive control algorithm and an existing train braking system, it is possible to create a new adaptive braking control system of a train, which will provide for an automatic smooth and, at the same time, precise (according to a stop point) braking of a train.

A development of the system based on an adaptive control algorithm is enabled exactly by the fact that it does not require considerable investments into the existing train braking control systems (pneumatic or electro-pneumatic), and does not require any modernization of a railway infrastructure (setting up of an additional transmitter is not necessary). The system does not need expensive elements or complex transmitters, because all the information necessary for calculations can be obtained from a global positioning system (GPS) and a mechanic speed detection unit existing in a train, and it can be reckoned in as a positive quality of the offered system.

Hence, the authors consider that it is necessary to perform a more profound investigation of the given system and a development of a necessary model, with the purpose to test the selected control algorithm under the laboratory conditions. For this purpose, a pneumatic braking control system of exactly freight trains is investigated more thoroughly.

II. GOAL FORMULATION

The goal of the present article is to analyse a possibility to apply the adaptive control algorithms in the management of a train braking system, with the purpose to accomplish a smooth and precise (according to a stop point) braking.

The objectives of the work are:

- To review and to analyse adaptive control algorithms;
- To select control algorithms according to the addressed goal;
- To develop a PLC control program on the basis of a selected algorithm;
- To design a train motion model in a Matlab environment;
- To test a designed adaptive braking algorithm under laboratory conditions and to generalise the results;
- To analyse the results and to evaluate an effectiveness.

III. REVIEW OF ADAPTIVE CONTROL ALGORITHMS

Before reviewing the adaptation algorithms, let us provide a definition of an adaptation. An adaptation process is an instrument of a self-organizing system for a targeted efficacy with the following objectives:

- To adjust the system to a fixed environmental or external factors conditions (a passive adaptation);
- To find the most suitable environment for the system operation (an environment search);
- To adjust the environment to the most effective functioning (an active adaptation).

Simple objects after each cycle should return to a control synthesis stage, where a new *U'* control should be defined depending on the changes of the environment, while a control of complex objects requires all control systems – adjustments of control stages, which are also an adaptation.

An adaptation as a specific control process contains several specific features:

- A stable nature of an adaptation goal (the preferable and the existing parameters of the object at each moment of the adaptation process are known);
- An extremizing criterion *Q* and a limitation *S* either do not change, or change slowly or rarely (a selected stop point of a train does not change in the process of braking);
- An adaptation is effective only with smaller changes of the object parameters (it follows that it is possible to use it effectively in the given task).

Furthermore, an adaptation can be divided into the following two types:

- Parametric adaptation – can be used in case when the change of a controlled object can be characterized using its parameters (Fig. 1).
- Structural adaptation – can be used in case when it is comfortable to change not the object parameters, but its structure.

Therefore, the type selected is the parametric adaptation (Fig. 1), because the structure of the object (a train) cannot be changed physically during the braking process.

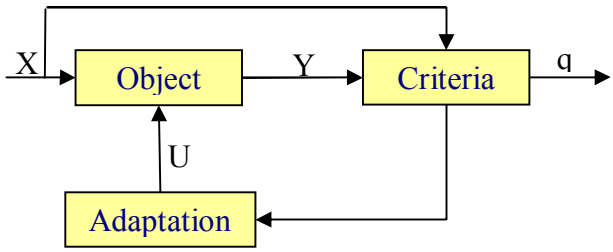

Fig.1. Principal Scheme of Parametric Adaptation Process

In the continuation, let us pay attention to the definite adaptive control algorithms, with the help of which it is possible to perform a parametric adaptation and which could be effectively used in the system under discussion.

Search with even attempts.
A formula of an algorithm:

$$u_{i+1} = u_i - a\ sign[Q(u_i + g) + Q(u_i - g)] \qquad (1)$$

where
u_i – a state of the object in the i^{th} search stage;
a – a size of a step according to the parameter u;
g – a size of a step not smaller than ε/2;
sign – a sign function.

$$sign\ y = \begin{cases} +1 & with\ y > \delta \\ 0 & with\ |y| < \delta \\ -1 & with\ y < \delta \end{cases}$$

δ – insensitivity zone.

The given algorithm requires a constant regulation of controllable parameters, because it is necessary to carry out an adjustment of the parameters within all the possible regulation limits of the parameters (for example, we decrease the braking acceleration and we increase the braking acceleration), in order to evaluate that other system parameters get changed (whether they approach the set theoretical value, or move away from it). Exactly because of that this algorithm is not the most optimal for the given system, because its use a braking system physical formation (a number of changes of control signals within the definite period of time is limited).

Search with odd attempts.

Let us scale down an even attempt algorithm to one attempt. The formula will be the following:

$$u_{i+1} = u_i - a\ F[Q(u_i + g) - Q(u_i)] \qquad (3)$$

where
u_i – a state of the object in the i^{th} search stage;
a – a size of a step according to the parameter u;
g – a size of a step not smaller than ε/2;
F – a sign function.

$$F(y) = \begin{cases} +1 & with\ y > \delta \\ 0 & with\ |y| < \delta \\ -1 & with\ y < \delta \end{cases} \qquad (4)$$

δ – insensitivity zone.

A search with the united attempt and work steps (Fig. 2).

In the algorithm with the united attempt and work steps, the work steps are taken at once and the object quality function is evaluated.

If a work function value reaches a theoretical value, then a previous work step is repeated, in its turn; if a work function deteriorates, then the step, which is opposite to the proceeding one, should be taken.

$$\Delta u_i = -\Delta u_{i-1}\, sign(\Delta Q_{i-1} + \delta) \qquad (5)$$

δ – a positive threshold (δ>0).

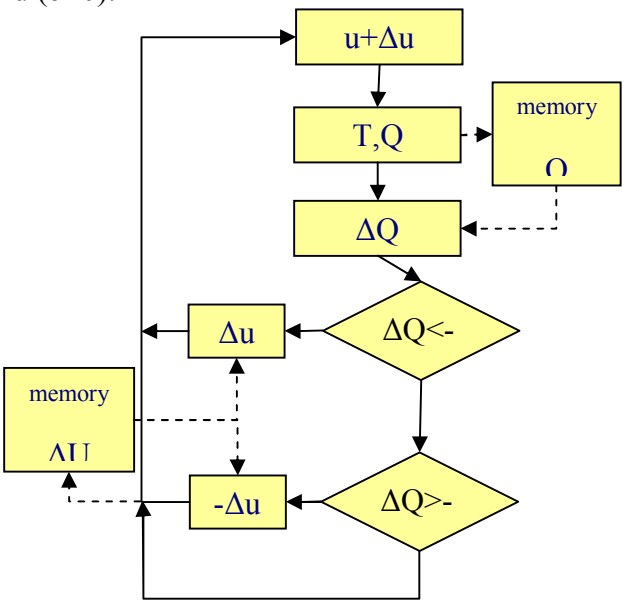

Fig.2. Adaptive Search Algorithm with United Attempt and Work Steps

This control algorithm is the most corresponding to the system under development from all the reviewed algorithms, and after some modernization it allows to achieve the best regulation efficacy and the best interaction with the existing train braking control system (corresponds the most to the existing conditions of a train braking system control).

An improvement of the algorithm manifests itself in an introduction of a differentiation unit (Fig. 3), which follows a change of the controllable parameters in a time, and makes a common system operation considerably effective (reduces the pulsations of the adjustable parameters, in relation to the theoretical values and increases the precision of a stop point).

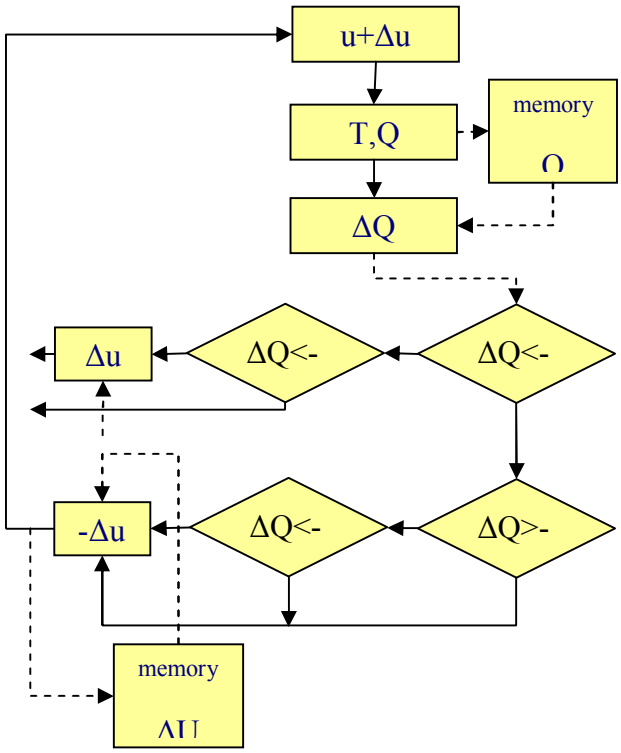

Fig. 3. Adaptive Search Algorithm with United Attempt and Work Steps with Differentiation Unit

IV. DEVELOPMENT OF PLC CONTROL PROGRAM ON BASIS OF CHOSEN ALGORITHM

A PLC control program was developed in the Step-7 programming environment, which was used for programming SIMATIC S7-200 series controllers.

```
Network 5
LD      M0.0
MOVR    T_real:VD112, t_br_count:VD58
-R      T_memor:VD32, t_br_count:VD58
Network 6
LD      M0.0
MOVR    a_breaking:VD14, AC0
*R      t_br_count:VD58, AC0
*R      -1.0, AC0
MOVR    V_memor:VD28, V_teoretiskais:VD104
-R      AC0, V_teoretiskais:VD104
MOVR    V_memor:VD28, AC1
*R      V_memor:VD28, AC1
MOVR    V_teoretiskais:VD104, AC3
*R      V_teoretiskais:VD104, AC3
MOVR    a_breaking:VD14, AC2
*R      2.0, AC2
*R      -1.0, AC2
MOVR    AC1, AC0
-R      AC3, AC0
/R      AC2, AC0
MOVR    X_memor:VD36, X_calc_moment:VD40
+R      AC0, X_calc_moment:VD40
```

Fig. 4. Excerpt of a Program Code

A control program consists of an initialization block, a calculation block of a theoretical bend (a road driven *S*, a current motion speed *V* and a current braking acceleration *a*) and an adaptation block which generates a control signal, which is sent to the model of a train control system.

Figure 4 demonstrates an excerpt of a PLC program code, where a train braking time and theoretical coordinates are being calculated.

V. DEVELOPMENT OF TRAIN MOTION MODEL IN MATLAB ENVIRONMENT

For a development of the train motion model it is necessary to investigate a train as a complex object. This object consists of a physical part, which includes locomotive engines and coaches (their inertia, resistance moments, etc.) and a braking system, which is characterized as a large set of variable parameters.

A model, which is depicted in Fig. 5, was used for a physical model of a train.

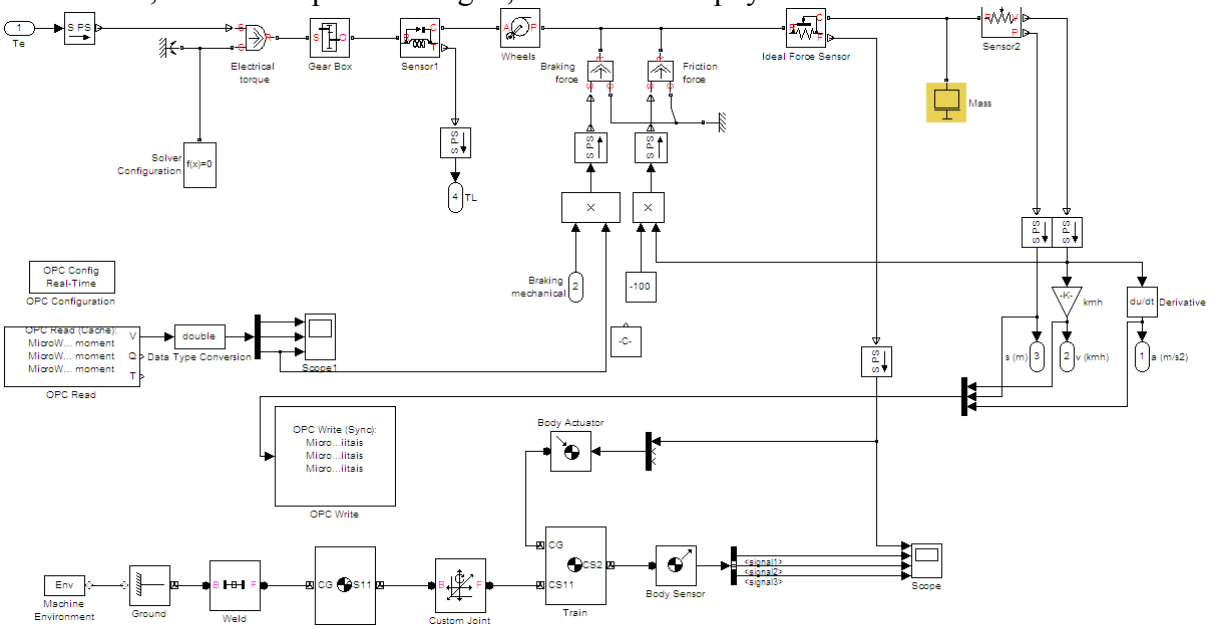

Fig. 5. Simplified Model of Physical Part of Train

In the model it is possible to set up the total mass of a train, the different motion resistance coefficients, the coefficients of adherence with rails, and the processing of a braking system control signal.

This model allows to find out a current train coordinate, speed and acceleration, which are necessary PLC control programs.

VI. TESTING OF DEVELOPED ADAPTIVE BRAKING ALGORITHM AND GENERALIZATION OF REZULTS

The testing of the developed control algorithm was carried out under the laboratory circumstances in the following way. The train motion model was launched in a Matlab environment, but the developed PLC control program was installed in a controller, which was connected with the mentioned train motion model in the Matlab environment through an OPC server.

During testing, the following situation was modelled – a train departs from the coordinates x=1500m. In the physical model of the train also an initial speed of the train motion is set up.

In its turn, in the PLC control program a desired braking acceleration *a*, and the following baselines of control elements (a driver's stop-device)of a bake system are set up:

II – a brake release,

IV – a crosspiece with a feeding,

V – a service brake.

On average, when performing modeling without a differentiation unit of the adjustable parameters, the results, which are illustrated in Figure 6, were obtained. In this figure the first graph represents the changes of the road *S* (m)driven by the train in relation to time, of the

speed V (m/s) of the train in relation to time and of the braking acceleration a_{br} (m/s^2) of the train in relation to time. Each value is represented by a theoretical (green) and real (blue) curve, which is obtained from the train motion model.

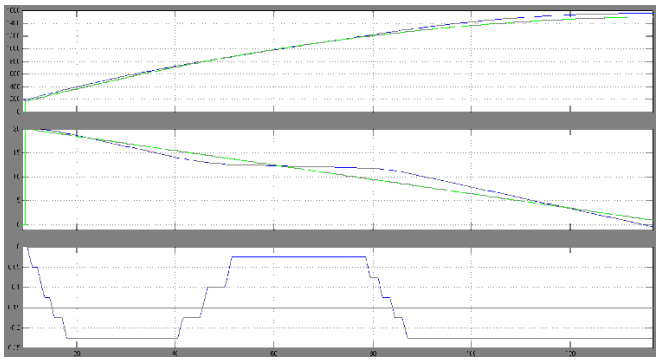

Fig. 6. Train Motion Parameters for Algorithm without Differentiation

This adaptation algorithm allowed to achieve the following results:

a) a train stops +- 25-45 m from a set point;
b) noticeable fluctuations of the adjustable parameters take place (the value of the road driven S fluctuates between +- 100m, the value of the current speed V fluctuates between +- 3m/s, the value of the current acceleration fluctuates between +- 0,15 ms^2)

On average, when performing modeling with a dynamic control of the adjustable parameters, the following results were obtained (Fig. 7.).

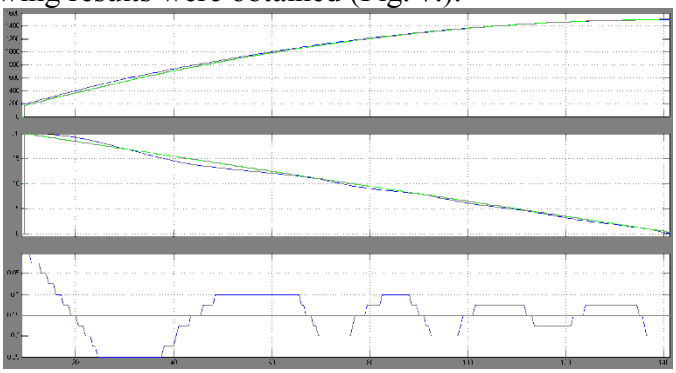

Fig. 7. Train Motion Parameters for Algorithm without Differentiation

On average, when modeling a motion with a dynamic control of the controllable parameters, it is possible to obtain the following results:

a) a train stops +- 2-7 m from a set point;
b) fluctuations of the adjustable parameters are much lower (the value of the road driven S fluctuates between +- 20m, the current motion speed V fluctuates +- 1 m/s, the current braking acceleration fluctuates between a_{br} +-0,7 ms^2).

VII. ANALYSIS OF RESULTS AND EVALUATION OF EFFICACY

The results obtained demonstrate that the developed PLC control program on the basis of an adaptive search algorithm allows to control the train motion model parameters agreeably with the set theoretical curves with the comparatively not big differences of the parameter values. For an evaluation of the efficacy of the operation of the algorithm it would be necessary to improve the train motion model, which would allow to achieve more precise modelling results.

VIII. CONCLUSIONS

The offered algorithm of adaptive and precise braking of a train operates sufficiently effectively, it would be useful to carry out its improvement also in the future.

The use of the developed algorithm allows to realize a sufficiently precise braking of the train model, regulating the values of a current road driven *S*, of a speed V and of a braking acceleration according to the set theoretical curves in the process of braking.

For a more precise testing of the PLC control program, a more thorough train model development is required, with an observation of delays of the braking system and moments of inertia, effectiveness in different operation modes, inertia of a train, a model of a pneumatic brake control system, etc.

An installation of a built-in intellectual equipment does not hamper an operation of the existing braking system and increases an efficacy of its operation.

After an improvement and testing of the PLC control program, an undertaking of the experiment using the given prototype in real work conditions or in similar to them (i.e. an experiment with the use of a car) should be considered.

REFERENCES

[1.] Altbergs T., Balckars P., Bukovskis V. un citi. *Dzelzceļi*. Vispārīgais kurss. Valsts akciju sabiedrība „Latvijas dzelzceļš ”. Rīga, 1996.

[2.] A. Ļevčenkovs, A. *Potapovs. Metodiskie norādījumi iekārtas „Safe-R 3” programmiskā nodrošinājuma izstrādē un eksperimentālo testu vadīšanā*. Rīga – 2010.

[3.] П.Т. Гребенюк, А.Н. Долганова, А.И. Скворцова. *Тяговые расчеты*. Справочник, 1987. – 273 с.

High Frequency Effects of Parasitic Parameters on Three Phase EMI Filters

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Abstract- In this paper, the three phase EMI filter is for the first time characterized by scattering parameters. Mutual couplings between the filter components are extracted using scattering parameter measurements and their relationships with Z-parameters for two port T-networks. S-parameters are used to predict filter insertion loss and its dependence on filters layout configuration and mutual couplings and filter component self-parasitic parameters. The most important mutual couplings that distort high frequency insertion loss of three phase filter are discovered and analyzed.

INTRODUCTION

Mains filters for conducted emission limitation are of great importance in three phase power electronic devices with reduced cost and reduced dimensions and high insertion loss, as well as in one phase devices. As commutation frequencies of power semiconductors rises endlessly, it is important to improve filters insertion loss in high frequency region. In electromagnetic interference (EMI) passive filter design, it is well known fact, that component parasitic parameters, such as parasitic inductance of capacitors and parasitic winding capacitance of chokes and their self-resonant effect, play an important role in filter performance, but mutual couplings between components can introduce more undesirable effects on filters insertion loss.

There have been proposed various models for one phase filter component mutual parasitics evaluation on filters performance [9], [12]. More scrupulous research on mutual coupling between chokes with various placements have been made in [13] and researched for coupling between capacitors in [11]. Inductive and capacitive coupling direct measurements are complicated because of the dispersed character and superposition of number of these parasitics at the same time, thus, few methods have been described for mutual coupling and parasitic capacitance extraction in [14] and more convenient in [5], [17].

Still there are no research devoted to three phase EMI filter mutual inductance and parasitic capacitance evaluation between components. Although three phase filter can be constructed from three separate one phase filters, the phase to phase symmetry, component placement and PCB layout gives a great contribution to filters insertion loss distortion, that can't be predicted basing only on upper mentioned papers. However, some articles are devoted to three phase inductive component self parasitic component cancelation [2], [15], [16].

In this paper three phase filters mutual couplings are analyzed, the most sensitive couplings are discovered and their contribution to filters high frequency IL characteristic are determined using Pspice simulations.

I. THREE PHASE EMI FILTERS MUTUAL COUPLINGS

For mutual coupling extraction, three-phase filter, shown in Fig. 1, are chosen, where capacitor branch C1 consists of capacitors C11 C12 C13 and capacitor branch C2 consists of capacitors C21, C22, C23. Common mode (CM) and differential mode (DM) inductance of a

three phase CM choke L1 is estimated as in [2], [3], therefore measured CM inductance L_{cm}=0.2 mH and DM inductance L_{dm}=6.45uH for the horizontal alignment and L_{cm}=0.22 mH, L_{dm}=7.67uH for vertical alignment CM choke.

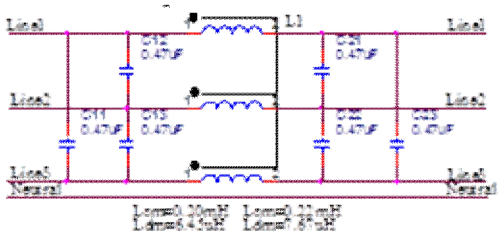

Fig. 1. Three phase filter prototype schematic

Filter prototype PCBs with vertical CM choke is shown in Fig. 2.a. and horizontal CM choke in Fig. 2.b. Capacitors and PCB layouts are the same for both filters. PCB contains two layers, where the top layer is used for component routing and bottom layer is used as ground plane.

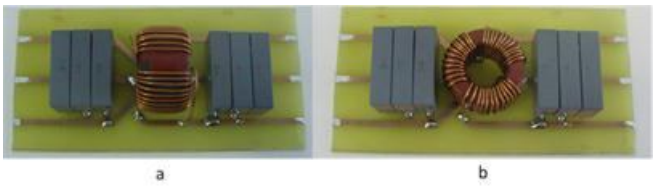

Fig. 2. (a) Filter prototype with vertical CM choke; (b) Filter prototype with horizontal CM choke.

Applicability of circuits, that used for insertion loss measurement of multiphase EMC filters according to EN55017 [19] are complicated for extraction of parasitic couplings between three phase filter components, so here are developed three phase filter DM model for the filter each phase separately as described in [2], [4], [17] and is shown in Fig. 3. Scattering parameter measurements are made modifying filter as in Fig. 4., that enables two port measurements of three phase filter.

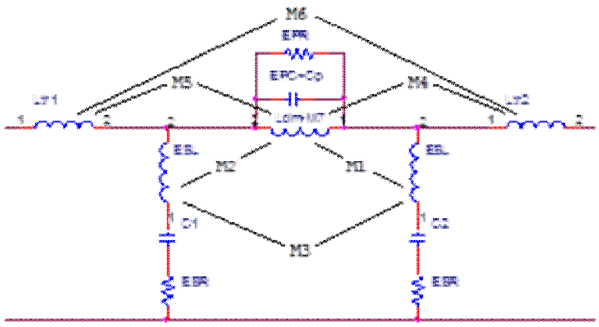

Fig. 3. One phase model of three phase filter

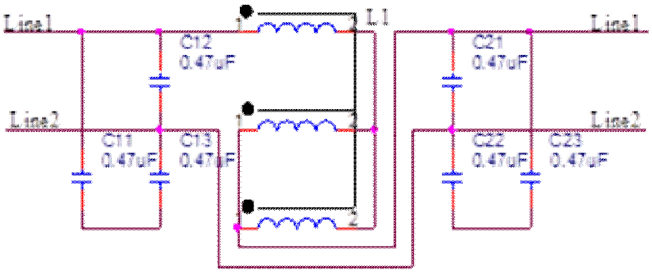

Fig. 4. Three phase filter modification to enable 2-port S-parameter measurements.

CM choke is connected using all three windings instead of two winding connection when differential mode insertion loss is measured. Connection of CM choke in this manner denies proposed model usage for insertion loss calculation for the whole filter according to [19], but it enables simple extraction of mutual couplings that can be used to further improve the filter.

II. MUTUAL COUPLING EXTRACTION PROCEDURE

Mutual couplings are extracted using two port network S-parameter measurements, made with vector network analyzer ZVRE R&S. Mutual couplings are extracted using methodology that is stated in [5] and [17]. Capacitor branch C2 impedances and angles with and without couplings are plotted in Fig. 5, Fig. 6, respectively. Using the measured data and mathematical model in [5] and [17] M1 and M4 are calculated.

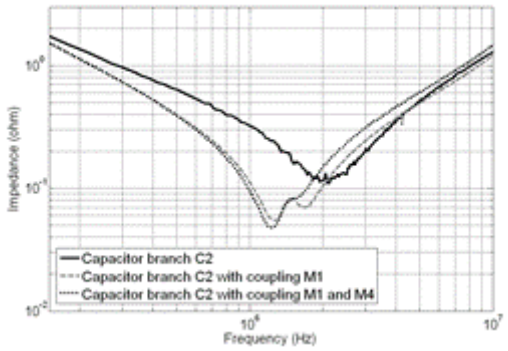

Fig. 5. Capacitor branch C2 impedance magnitude with M1 and M4 inductive couplings.

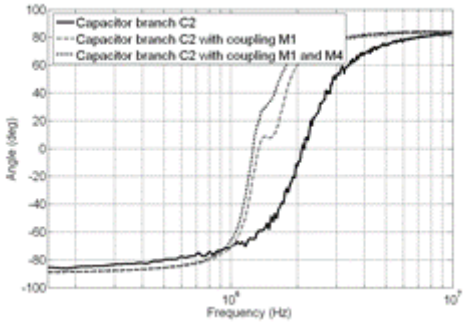

Fig. 6. Capacitor branch C2 impedance angle with M1 and M4 inductive couplings

CM choke construction and location in respect to other components and PCB, defines the coupling polarity and coupling magnitude, due to CM choke leakage inductance L_{dm}. There are no such possibilities of winding configurations for three phase common mode chokes as for one phase common mode chokes as in [9], so two types of common mode chokes-horizontal and vertical placement configurations are examined. M2 and M5 are extracted in the same manner as M1 and M4.

Mutual coupling C_p represents total coupling of parasitics in parallel with CM choke equivalent paralel capacitance EPC in Fig.3. For high frequency noise, coupling C_p and parasitic capacitance of CM choke creates a high frequency shortcut between input and output, lowering the filters performance.

REFERENCES

[1] L. Ribickis, V. Novikovs, A. Rusko G. Asmanis, "Matrix frequency converter conducted and radiated emissions," in *Electric Power Quality and Supply Reliability Conference (PQ)*, 2010, pp. 131 - 136.

[2] M.Schinkel, S.Guttowski, W.John, H.Reichl S.Weber, "Calculating Parasitic Capacitance of Three-Phase Common-Mode Chokes," in *In PCIM Conference*, Nürnberg, 20.-22. May 2005, pp. 128 - 134.
[3] M.L. Heldwein, L. D'Alessandro, and J.W. Kolar, "The Three-Phase Common-Mode Inductor: Modeling and Design Issues," *In proc. IEEE Power Electronics Transactions on Power Electronics*, vol. 58, no. 8, pp. 3264 - 3274, 28 October 2010.
[4] Lee Fred. C., Odendaal, W.G. Van Wyk, J.D. Shuo Wang, "Improvement of EMI filter performance with parasitic coupling cancellation," *In proc. IEEE Power Electronics Transactions on Power Electronics*, vol. 20, no. 5, pp. 1221-1228, September 2005.
[5] Shuo Wang, F.C. Lee, and W.G. Odendaal, "Using scattering parameters to characterize EMI filters," in *Power Electronics Specialists Conference, 2004*. 2004, pp. 297 - 303.
[6] Lee Smith, Jeff Gruszynski Dick Anderson. (1996, November) Test & Application Note 95-1 S-Parameter Techniques. Hewlett Packard.
[7] V. Tarateeraseth, Bo Hu, Kye Yak See, and F.G. Canavero, "Accurate Extraction of Noise Source Impedance of an SMPS Under Operating Conditions," *IEEE Transactions on Power Electronics*, vol. 25, no. 1, pp. 111 - 117, Jan 2010.
[8] Kye Yak See and Junhong Deng, "Measurement of noise source impedance of SMPS using a two probes approach," *IEEE Transactions on Power Electronics*, vol. 19, no. 3, pp. 862 - 868 , May 2004.
[9] F.C. Lee, D.Y. Chen and W.G. Odendaal Shuo Wang, "Effects of Parasitic Parameters on the Performance of EMI Filters," *In proc. IEEE Power Electronics Transactions on Power Electronics*, vol. 19, no. 3, pp. 869-877, 10 May 2004.
[10] D. Skinner R. Collier, *Microwave Measurements*, 3rd ed., A. D. Skinner R. J. Collier, Ed. London, United Kingdom: IET Electrical Measurement Series, 2007.
[11] S.-P., Hoene, E., Guttowski, S., John, W., Reichl, H. Weber, "On coupling with EMI capacitors," in International symposium on EMC, 9-13 August 2004, pp. 336 - 341.
[12] De Oliveira, T. Schanen, J.L. Guichon, J.M. Gerbaud, L. "Influence and benefits of stray magnetic couplings in EMC filtering," in Proceedings of the 2011-14th European Conference on Power Electronics and Applications, 30. August 2011, pp.1-10.
[13] Weber, S.-P., Hoene, E., Guttowski, S., John, J., Reichl, H. "Predicting Parasitics and Inductive Coupling in EMI-Filters" in proceedings of the Applied Power Electronics Conference and Exposition, 19-23 March 2006, pp. 4.
[14] Dongbing Zhang, Chen, D.Y., Sable, D. "A New Method to Characterize EMI Filters" in Conference Proceedings Applied Power Electronics Conference and Exposition, 15-19 February 1998, pp. 929 – 933.
[15] Heldwein M.L., Kolar J.W., "Winding Capacitance Cancellation for Three-Phase EMC Input Filters," in Transactions on Power Electronics, July 2008, Vol: 23, No:4.
[16] Heldwein M.L., Kolar J.W., "Extending Winding Capacitance Cancellation to Three-Phase EMC Input Filter Networks," in Symposium on Electromagnetic Compatibility, 9-13 July 2007, pp. 1-9.
[17] Shuo Wang, Lee, F.C., Odendaal W.G., "Characterization and Parasitic Extraction of EMI Filters Using Scattering Parameters," in IEEE Transactions on Power Electronics, March 2005, pp. 502 – 510.
[18] Gundars Asmanis, Denis Stepins, "Effects of *Parasitic Parameters on Three Phase EMI Filters*," in Conference proceedings Topical Problems in the Field of Electrical and Power Engineering, January 2012, pp. 93 – 102.
[19] Standard EN55017:2012.

A Risk Based Modeling of Interdependencies in Critical Infrastructures through UML

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This paper presents a systematic approach for computing metrics and performance indices of interdependent critical infrastructures based on their information content, expert views and risk analysis capabilities. The paper also proposes a risk-based methodology based on generic risks and assurance levels using security properties: availability, confidentiality and integrity. Unified Modelling Language (UML) is proposed in order to define a model for research of critical infrastructures interdependences.

INTRODUCTION

Most researchers represent a generic view at critical infrastructure (hereafter abbreviation CI will be used) and its services interdependencies, which support overall concept, but not rather practical for real world. Therefore an approach that awares heterogeneous nature of CI interrelating at observed territory (for example city, region) is needed.

Let us assume that each critical infrastructure is composed of services that are provided to customers. Services may be self-contained or may depend on other services, which may be provided by the same or by another service provider. Current risk analysis methods do not provide a way to share risk knowledge between providers forming CI. Usually providers have expertise on risks on their own infrastructure, but not on related infrastructures of other providers. Also, since different critical infrastructures are very divergent in nature, risk data gathered from particular infrastructure cannot be easily interpreted by non-domain experts.

This work presents an approach that allows monitoring critical infrastructures by considering the state of the services as well as the states of interdependent services. This can be achieved by abstracting data gathered from the CI to a common set of parameters that can be shared with interdependent infrastructures.

We also propose an extension to the Unified Modelling Language (UML) in order to define a model for research of CI dependences. The approach taken in defining the UML extension has been towards establishing a fair basis for multi-agent modelling and simulation of critical infrastructures. However simulation of critical infrastructures is not a task of this work.

I. METHODOLOGY

The goal of the presented approach is to address the challenge of monitoring of the state of critical infrastructures and their interdependent services. Our hypothesis is, that it is possible to reduce the complexity of a service through abstraction to a common (risk related) set of parameters. This enables to compare critical infrastructures designed to serve a very different purpose (energy, telecommunication, water supply, transport and etc.) and composed of very different infrastructure components. It enables also to monitor important system parameters like availability, confidentiality and integrity. The abstraction to a small set of common parameters will encourage service providers to share them with interdependent providers. The authors used considerably adjusted methodology described in [1] and [2] .The four modelling steps are detailed as follows (see Fig. 1):

- Service components assurance and risk assessment;
- Measurement aggregation;
- Services interdependencies linking
- CI interdependencies modelling using UML

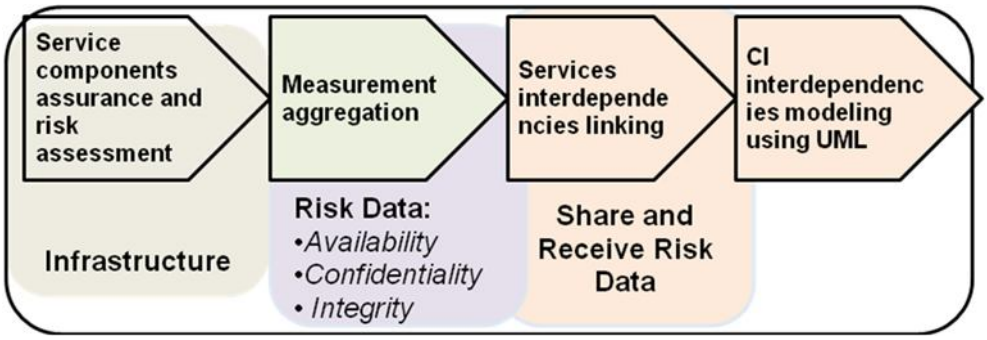

Fig. 1. Four modelling steps of CI interdependences.

II. WATER SERVICE PROVIDER CASE STUDY

In order to show the feasibility of the methodology a reference scenario is applied in this section, the UML use case diagram is created and the appropriate object interaction expressed in terms of the UML sequence diagram is summarized in the UML class diagram.

The reference scenario is composed of a high level representation of water utility (Talsi Water), which presents interdependencies with energy provider (Latvenergo CI) and a telecommunication provider (GSM Operator CI). This scenario is demonstrated as an example for validating the risk based methodology. A more complex and realistic representation is not possible due to the lack of the data and this work space constraint.

The risk analysis of Talsi Water CI has identified the critical services and interdependencies shown in Fig. 2.

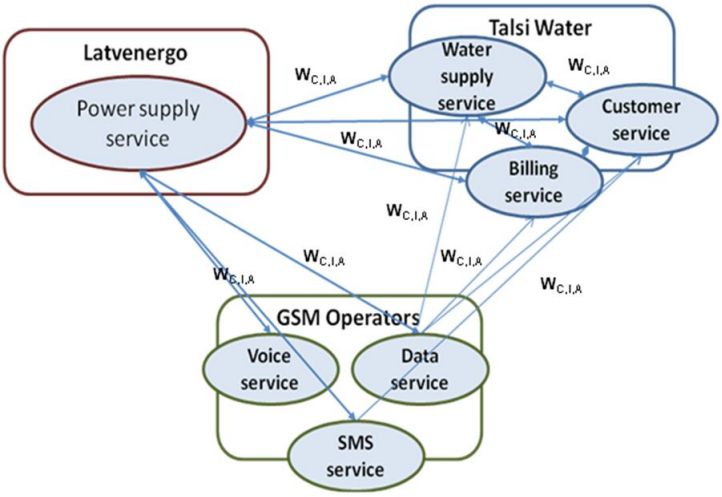

Fig. 2. Interdependencies between services and services providers.

In order to create the UML model of interdependent CI we apply StarUML, an open source UML tool, licensed under General Public License (GPL).

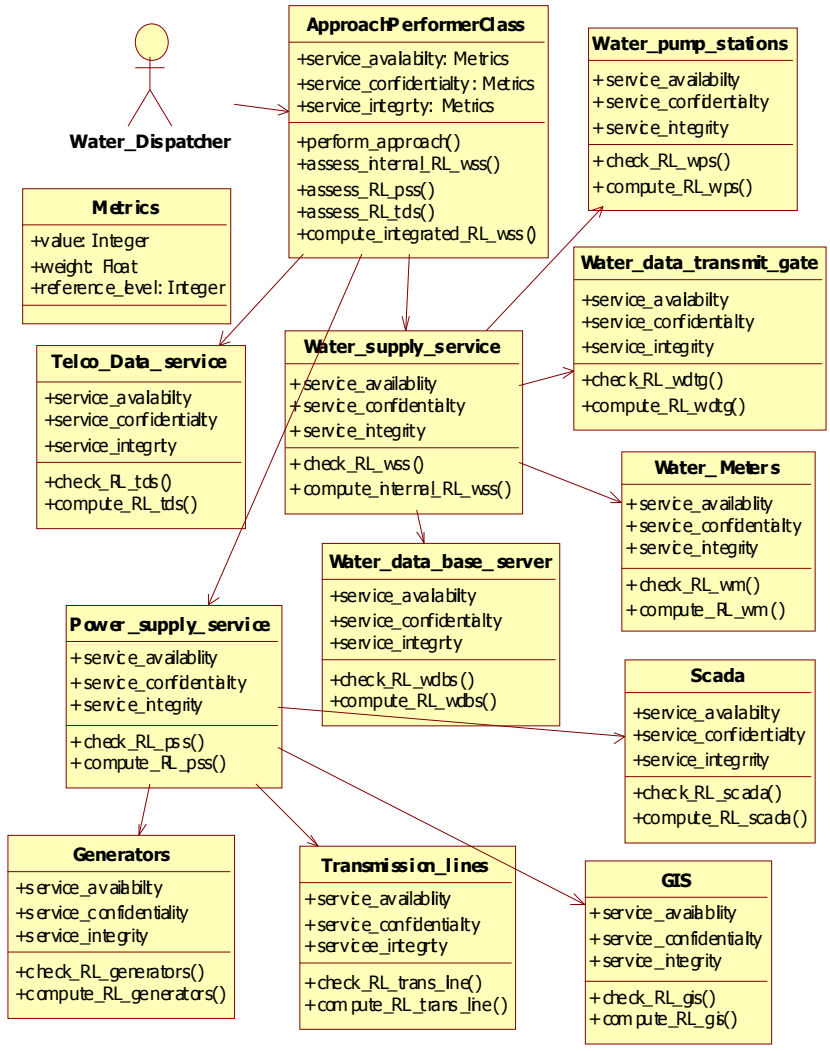

Fig. 3. Interdependencies Class Diagram.

A class diagrams in Fig. 3 shows thirteen classes, where five of them represent water supply service and its services components, five classes represent power supply, one class data transmission services and one class starts and controls services risk level assessment process.

The parameters of attributes and operations in each class have been omitted in the interest of figure clarity. One particular class, namely "Metrics", have been created in order to describe parameters of classes' attributes and classes' operations. The class has attributes "value", "weight" and "reference level" that are referred to service parameters (availability, confidentiality and integrity). Creation of particular class makes sense since unified normalized parameters are applied to divergent CI. The ontology proposed in Fig. 3 was created in order to study CI interdependencies of the particular city, but can be readily adapted to other cases, taking into account the specifics of each city.

III. DISCUSSIONS AND FUTURE WORK

The four modelling steps are described in this work, they are service components assurance and risk assessment, measurement aggregation, services interdependencies linking and CI interdependencies modelling using UML. In this work we employed an idea to abstract and to decompose services to a small set of common parameters; therefore three parameters were chosen to evaluate the state of services of different CI (confidentiality, integrity and availability), which are widely used for evaluation of systems security. The main advantage is that the model is easily extensible for including additional parameters and is ubiquitous for heterogeneous CI.

REFERENCES

[1] J. Aubert, T. Schaberreiter, C. Incoul and D. Khadraoui, "Real-Time Security Monitoring of Interdependent Services in Critical Infrastructures. Case study of a risk-based approach", ESREL 2010, Rhodes, Greece, September 5-9, 2010. pp.1-8.

[2] A. Zabasta, N. Kunicina, Approach for Monitoring and Measurement of Interdependent Services in Critical Infrastructures, Proceeding of the 11th International Symposium, Faculty of Power Engendering, Tallinn University of Technology, Pärnu, Estonia, 2012, pp.51-56

Development of the Energy Efficiency Improvement Methods for Industrial Robots

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Abstract This work summarizes various methods of the energy efficient use of medium and high payload industrial robots. As robotics in general also this is a multidisciplinary research that covers topics both in motion planning and the electrical/mechanical engineering.

Introduction

The vehicle production industry today is highly automated, where the robotic systems is one of the key components. Along the complexity that the automation degree of these factories exceeds 98%, in recent years also the energy efficiency has a growing importance. It is interesting to note that 15-28% of a vehicle's energy consumption (EC) during its overall lifecycle occurs within the production phase, whereas the electrical energy consumed by the Industrial Robots (IRs) on the assembly lines amounts to about 8% on the average [1]. Besides the European Union has set a target of saving 20% of primary energy consumption by 2020 in reference to 2007 [2]. Therefore, as previously highlighted in [3], it is self-evident that EC minimization in existing automated manufacturing systems impacts both production costs and total CO2 emissions.

The work consists of 4 parts each covered in one section respectively. In the first section a detailed analysis of typical characteristics of industrial robot usage in the automobile production is evaluated. The second section deals with an intelligent motion planning of robotic manipulators. Optimization of existing robot programs and partial generation of fresh trajectories in workspace using artificial intelligence are distinguished. An effective use of recuperation is analyzed in the third section. Here a novel power converter enabling DC-Bus sharing among the robot energy-team is proposed. The fourth section emphasizes all the secondary consumers in the robotic system.

1 Industrial Robot Usage in Automobile Production

According to ISO an industrial robot is an automatically controlled, reprogrammable, multi-purpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications [4]. In vehicle production body shop and assembly lines typically 200 - 360kg payload robots are used. An average IR yearly consumes around 8 MWh, if production takes 52 weeks a year in 3 shifts, 5 days a week [3].

The Figure 1 presents a detailed analysis of measured actual pause and standstill durations of 20 robots in the 3 shift automotive assembly plant and the respective EC during this time. Despite of the fact that the movement takes only 19% time most of the EC is spent for this block. However, the other 28% of the EC during standstills are not negligible.

Thus, the analysis serves as a motivation for enhanced motion planning and reuse of recuperated energy that has a direct impact on EC minimization.

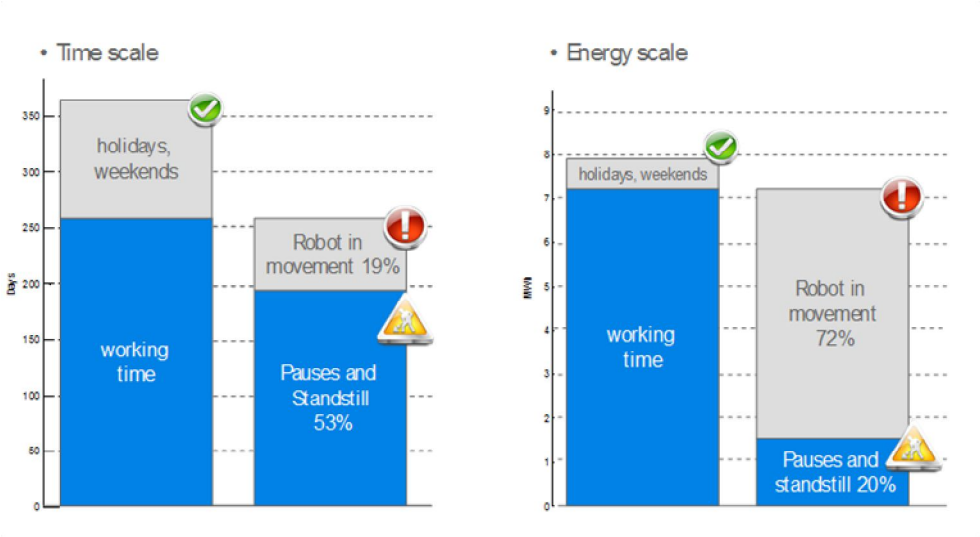

Figure 1: Evaluation of usage/EC relation

2 Intelligent Motion Planning

Robotic manufacturers in the last decade have done a significant research increasing the precision, repeatability, velocity, modeling tools [5]. According to robot manufacturers targeted programming may save up to 25% of the total consumption over the badly programmed applications using even typical programming commands [6]. A trajectory smoothing of a robotic manipulator is applicable in handling applications with many point-to-point movement commands, thus, skipping many unnecessary accelerations. Depending on path variation degree EC reduction may exceed 10% [7]. Robot movement optimization may be divided into several types:

- changing the program and subprogram structure,
- time scaling of trajectories within a robot cell,
- generation of new paths using gradient-based algorithms,
- speed and acceleration adjustment depending on application needs on given paths [8],
- enhanced use of movement commands with FLY-BY.

Not all of them are complementary and many aspects like dynamic and kinematic boundaries, collisions, reliability, minimal influence on application or factory standardization must be considered.

3 Reuse of Recuperated Energy

Industrial applications today often require rapid motion control where many fast acceleration/ deceleration phases and reversals are present. Such behaviour is typical for industrial robotics and CNC-machinery. Many drive systems today are capable to use regenerative braking of the motors. However, the recuperative energy is rarely fed back to a

network or stored locally due to AC network quality conservation issues or increased costs of the storage systems. Previous research shows impressive energy savings using an increased capacitive energy buffer on drive's DC-Bus [9]. An additional capacitor bank of about 18mF within typical DC-Bus voltage fluctuations equals to c.a. 1.6kJ storage in difference to originally 0.1kJ. Thus the brake choppers that normally limit the DC-Bus voltage and therefore dissipate the braking energy can even be replaced with energy-buffers. Tests with commercially available storage devices [10] approve that DC-Bus voltage limitation can be realized without brake-choppers.

An alternative, a common DC-link applications in means of single rectifier and multiple variable frequency drives are state of the art for many years. Multiple rectifiers and multiple drives that share the DC-links are typical in some high power variable frequency drives with nominal power ratings reaching several megawatts in order to equalize the load between IGBT switches. Modular DC-Bus sharing for functional purposes in lower power range are available from some manufacturers [11].

However, for a common DC-Bus a synchronized control of drive switches is required, so that these DC-links are equalized. But the capacitors are still relatively expensive to be used per each drive system. The research work proposes a solution for recuperative energy exchange system between DC-links that are controlled independently. The energy storage is realized in an independent DC-subgrid, to which any drive system can transfer its recuperative excess energy and again take back when needed. Thus only one energy storage device is required for multiple drive systems which reduces the costs. Many tests with industrial robot drive systems have been done showing high reliability and significant EC reduction.

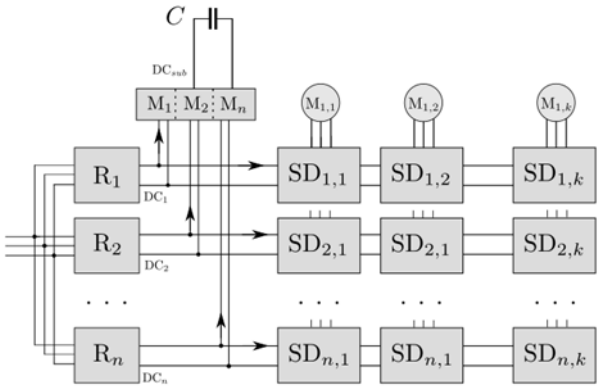

Figure 2: Block schematic of DC-subgrid for energy exchange

4 Strategic Use

Below the subtitle Effective strategic use of robotics is to be understood all the activities that are not directly connected to motion planning or robot drives, like the secondary consumers in robot system. Referring to Figure 1 here the blocks Holidays/weekends and Pauses and standstills are minimized.

As a first to mention are the normal-close mechanical brakes of the motors that are used within production standstills to keep the manipulator firmly. Because these are large

static consumers in the robotic system, methods are proposed to release the brakes dynamically depending on running robot program. Recently implemented is the robot shutdown during the production free time that involves enhanced communication to robot cell PLC to enable controlled shutdowns and startups. Thirdly, a detailed analysis reveals the fact that often for certain robotic applications not an appropriate type of the IR is being used; i.e. many robotic measuring tools weight less than 15% of the total IR's payload, which obviously is not optimal from the viewpoint of energy-efficiency.

Summary

This paper provides a summary of a PhD thesis on energy-efficient industrial robotics. It covers topics in both hardware enhancement and motion planning of robotic manipulators. Nevertheless as an important factor also the robotic hardware dimensioning for certain applications is discussed. Combining multiple optimization methods an energy-consumption reduction over 30% per annum is achievable. Many of the proposed approaches require only minimal hardware or controller software modification.

References

[1] J.Engelmann, "Methoden und werkzeuge zur planung und gestaltung energieeffizienter fabriken," Ph.D. dissertation, TU Chemnitz, 2008.

[2] "Energy efficiency plan 2011," European Comission, 2011.

[3] D. Meike and L. Ribickis, "Energy efficient use of robotics in the automobile industry," in The IEEE 15th Int. Conf. on Advanced Robotics, 2011, pp. 507–511.

[4] "International organization for standartization." [Online]. Available: http://www.iso.org

[5] "Statistics on world robotics," IFR Statistical Department, Tech. Rep., 2009.

[6] "Kuka roboter gmbh website." 2010. [Online]. Available: http://www.kuka-robotics.com/

[7] D. Meike and L. Ribickis, "Industrial robot path optimization approach with asynchronous fly-by in joint space," Proceedings of the 2011 IEEE International Symposium on Industrial Electronics (ISIE), pp. 911–915, 2011.

[8] D. Meike, "A study of time-energy optimal trajectory planning algorithms of robot manipulators," in Proceeding of the 52nd Annual International Scientific Conference of Riga Technical University, 2011.

[9] D. Meike and L. Ribickis, "Recuperated energy savings potential and approaches in industrial robotics," in The IEEE 15th Int. Conf. on Automation Science and Engineering, 2011, pp. 299–303. [10] M. Koch, "Bremsenergie managen," 2012. [Online]. Available: http://www.bremsenergie.de/

[11] Allen-Bradley, PowerFlex AC Drives in Common Bus Configurations, Rockwell Automation, 03 2011.

Implementation of the FPGA Control System for a quasi-z- source inverter

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Abstract

This study is devoted to the FPGA-based control system for a three-level neutral-point-clamped quasi-Z-source inverter. The discussed topology combines the advantages of the three-level neutral-point-clamped inverter with those of the quasi-Z-source inverter. Due to its characteristics the above inverter is especially suitable for renewable energy sources. Since it has been proposed recently, no reports are available on the implementation of the control system based on FPGA for this converter.

Introduction

A three-level neutral-point-clamped (3L-NPC) inverter has many advantages, such as lower semiconductor voltage stress, lower required blocking voltage capability, decreased dv/dt, better harmonic performance, soft switching possibilities without additional components, higher switching frequency due to lower switching losses and balanced neutral-point voltage, in comparison with the two-level voltage source inverter. As a drawback, it has two additional clamping diodes per phase-leg and more controlled semiconductor switches per phase-leg in contrast to the two-level voltage source inverter. The 3L-NPC can normally perform only the voltage buck operation. In order to ensure voltage boost operation, an additional DC/DC boost converter should be used in the input stage [1-2].

To obtain buck and boost performance the focus is turned into a quasi-Z-source inverter (qZSI). The qZSI was first introduced in [3]. The qZSI can boost the input voltage by introducing a special shoot-through switching state, which is the simultaneous conduction (cross conduction) of both switches of the same phase leg of the inverter. This switching state is forbidden for traditional voltage source inverters because it causes a short circuit of the DC-link capacitors. Thus, the qZSI has excellent immunity against the cross conduction of top and bottom-side inverter switches. The possibility of using shoot-through eliminates the need for

dead-times without having the risk of damaging the inverter circuit. The input voltage is regulated only by adjusting the shoot-through duty cycle. In addition, the qZSI has a continuous mode input current (input current never drops to zero), which makes it especially suitable for renewable energy sources (e.g. fuel cells, solar energy, wind energy) [3-6].

Recently, a new modification of the qZSI was proposed [7]: a three-level neutral point clamped quasi-Z-source inverter (3L-NPC qZSI, Fig. 1). The new converter combines the advantages of the two topologies described above.

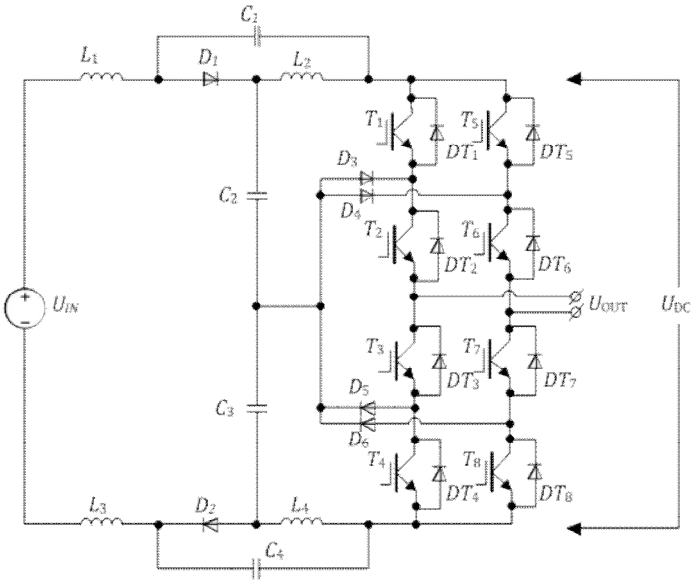

Fig. 1. Three-level neutral point clamped quasi-Z-source inverter

System Description

Fig. 1 illustrates the proposed topology of a 3L-NPC qZSI. Each leg of the 3L-NPC qZSI consists of two complementary switching pairs and four anti-parallel diodes. As an advantage, this topology has continuous input current, the possibility to use shoot-through, lower switching losses and balanced neutral-point voltage than the traditional two-level voltage source inverter.

The inverter output voltage has three different levels: 0, $B \cdot (U_{IN}/2)$ $\mathbf{B \cdot (U_{IN}/2)}$ and $B \cdot U_{IN}$ $\mathbf{B \cdot U_{IN}}$ in positive and negative directions, where B is the inverter boost factor. The shoot-through vector is generated separately. Finally, the shoot-though vector is mixed together with other control signals.

Fig. 2 illustrates the proposed structure of the system. The control system is based on FPGA (Cyclone II EP2C5T144C8 from Altera) and in addition to FPGA also contains Matching Board and Driver Board. In order to implement the control algorithm the VHDL was used. VHDL is a VHSIC (Very High Speed Integrated Circuits) Hardware Description Language.

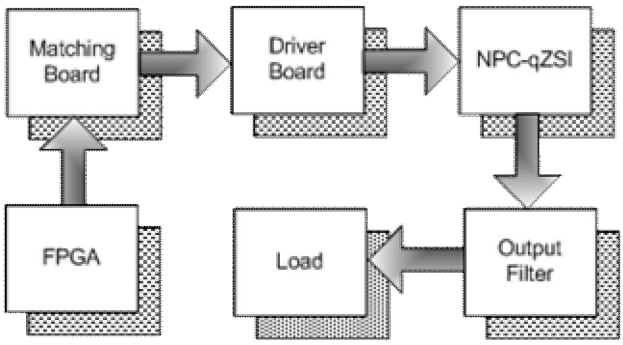

Fig. 2. The structure of the proposed system

An optical connection between the Matching and Driver Boards has been provided. In this way, the system can be managed as far as it is limited by the length of the fiber. The Driver Board contains eight channels, each of them consisting of receivers (HFBR-2528Z), driver ICs (ACPL-H312) and necessary passive components. The drivers are directly controling the MOSFETs of the NPC-qZSI. The output voltage from the NPC-qZSI is connected to the power grid through the output filter.

Experimental results

The signals applied to the gates of the power converter switches in the case without the shoot-through state are shown in Fig. 3, a). The signals applied to the gates of power converter switches when the shoot-through state was used are shown in Fig. 3, b). In both of the figures only the gate signals of the switches T1, T2, T5, T6 have been presented because the above switches have the complementary state with the others, respectively (T3, T4, T7, T8). The output voltage of the NPC qZSI controlled by FPGA is shown in Fig. 4.

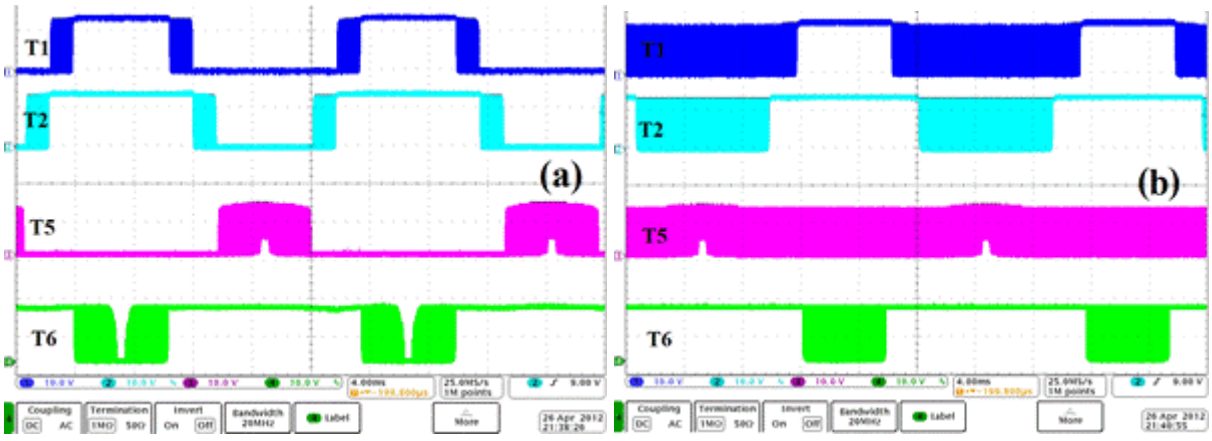

Fig. 3. The control signals applied to the gates of switches without (a) and with (b) the shoot-through state

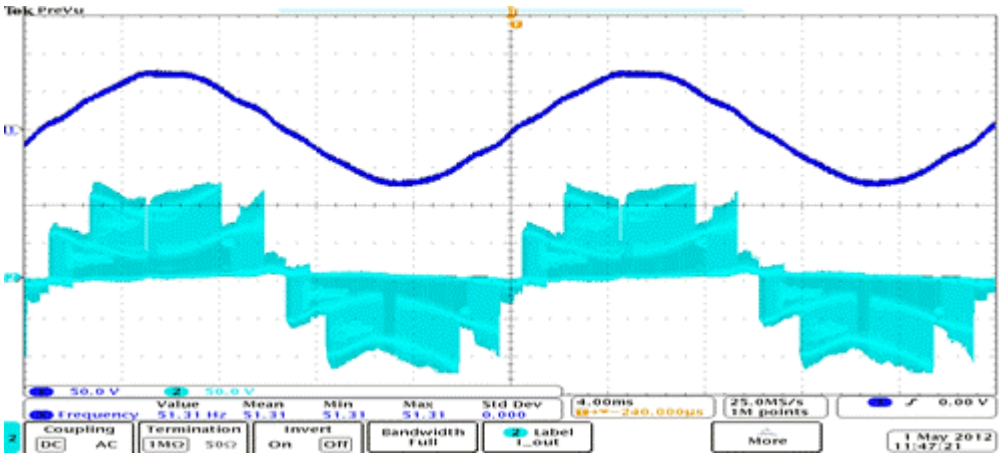

Fig. 4. The output voltage of the 3L-NPC qZSI after and before the output filter

Conclusions

The control system for a three-level neutral point clamped quasi-Z-source inverter based on the FPGA Cyclone II EP2C5T144C8 was described. This system allows different PWM signals to be obtained for different power switches and the necessary boost factor to be achieved using shoot-through signals. The results of the experimental investigations both with and without shoot-through states have proved the FPGA-based control system to be suitable for the 3L-NPC qZSI.

References

1. F. Gao, P. C. Loh, F. Blaabjerg, D. M. Vilathgamuwa, “Dual Z-source inverter with three-level reduced common-mode switching”, IEEE Transactions on industry applications, vol.43, no. 6, pp.1597-1608, 2007.
2. P. C. Loh, S. W. Lim, F. Gao, F. Blaabjerg, “Three-level Z-source inverters using a single LC impedance network”, IEEE Transactions on power electronics, vol. 22, no. 2, pp. 706-711, 2007.
3. Anderson, J.; Peng, F.Z., "Four quasi-Z-Source inverters", in Proc. of IEEE Power Electronics Specialists Conference PESC’2008, pp. 2743-2749, June 15-19, 2008.
4. F. Z. Peng, “Z-Source inverter”, IEEE Transactions of Industry Applications, vol. 39, no. 2, pp.504-510, 2003.
5. R. Strzelecki, D. Vinnikov, “Models of the qZ-converters”, Przeglad Elektrotechniczny, 86(6), 80 – 84, 2010.
6. P. C. Loh, D. M. Vilathgamuwa, Y. S. Lai, G. T. Chua, Y. W. Li, “Pulse width modulation of Z-Source inverter”, IEEE Transactions of Power Electronics, vol. 20, pp. 1346-1355, 2005.
7. S. Ott, I. Roasto, D. Vinnikov, "Neutral point clamped quasi-impedance-source inverter", Compatibility and Power Electronics (CPE), 7th International Conference-Workshop, pp.348-353, 2011.

New modulation technique for three-level quasi-z-source inverter

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There are several pulse width modulation (PWM) techniques that could be applied for the 3L-NPC qZSI [1]-[6]. All of them generate the shoot-through states when the output voltage is in the zero state (U_{AB} = 0) in order to maintain a constant value and not alter the normalized average voltage per switching period. These techniques present some problems, such as larger size of the passive elements, more input current ripple and capacitor voltage disbalance due to the low shoot-through state frequency when the desired frequency of the output voltage is 50 Hz because U_{AB} has only two zero states per period and shoot-through states can only be placed during these two intervals. Furthermore, a higher THD face to the obtained THD is produced in comparison with sinusoidal PWM techniques.

The main advantage of the proposed modified sinusoidal pulse width modulation technique is to achieve spreaded zero-states (U_{AB} = 0) and consequently spreaded shoot-through states can be obtained in the whole output voltage period. It has, as consequence, a lower total harmonic distortion (THD) of the output voltage, smaller sizes of the passive elements of the qZ stage as well those of the output filter, higher DC-link voltage stability and more possibilities of control. Fig. 1 shows a sketch of the proposed technique.

Two modulating sinusoidal waves disphased 180 degrees that modulate each leg (mod_A and mod_B) are compared with two carrier waves, the first one being of a saw-tooth form ($carrier_1$) and the second one triangular ($carrier_2$). The different states of T_1, T_2, T_5 and T_6 are generated and T_3, T_4, T_7 and T_8 have the complementary state of the other, respectively.

The shoot-through state is generated during zero states (1):

$$U_{AB} = 0, \tag{1}$$

and it occurs when (2):

$$U_{A0} = U_{B0}. \tag{2}$$

Non-zero states ($U_{AB} \neq 0$) occur when the condition (3) is fulfilled:

$$s_{T1} + s_{T2} - s_{T5} - s_{T6} = 0, \tag{3}$$

and the condition is used in order to obtain the maximum value of the shoot-through state (t_s) during a period (T), applying a not-operator to the condition (3).

The shoot-through duty cycle is defined as (4):

$$D_S = \frac{t_s}{T}, \tag{4}$$

and in order to modify the D_S, the shoot-through factor (*Fs-t*) is defined. This factor scales mod_A and mod_B and these new waves are compared with the two carriers, as shown in Fig. 2.

The obtained results of these comparisons are added or subtracted respectively according to (3) and a not-operator is used again in order to obtain the real shoot-through.

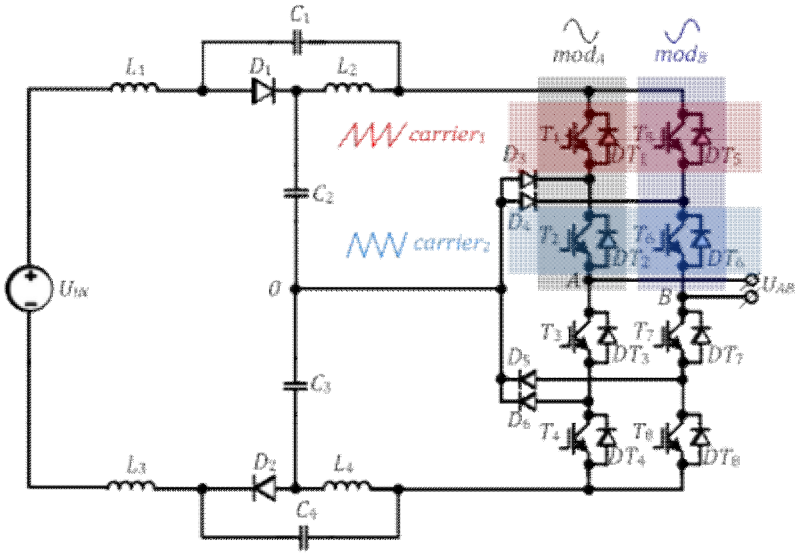

Fig. 1. Sketch of the proposed technique.

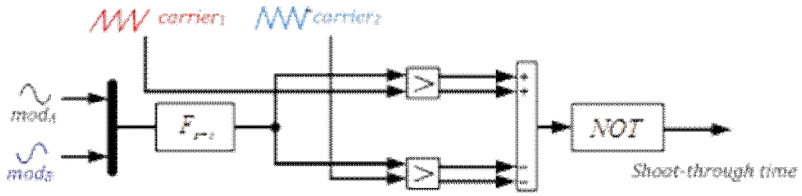

Fig. 2. Shoot-through factor and shoot-through time generation.

Operating in this way, the symmetry between the maximum value of the shoot-through and the real shoot-through time is assured (Fig. 3) and the THD of U_{AB} is reduced. Furthermore, we can see how the shoot-through states are generated during the whole output voltage period.

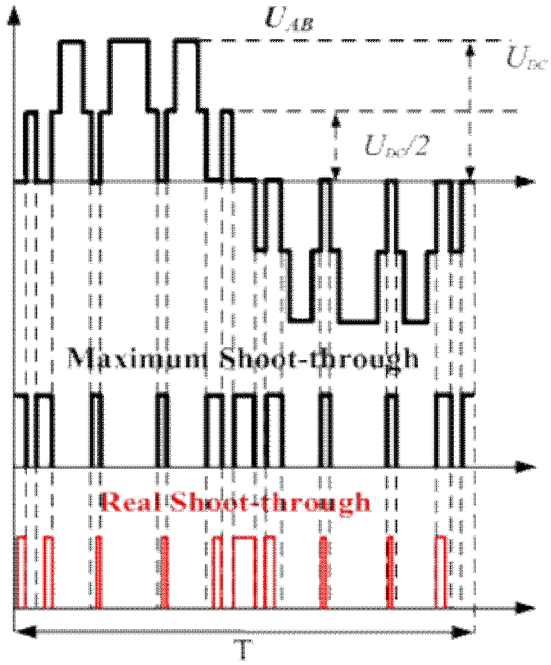

Fig. 3. Generated shoot-through states and outp

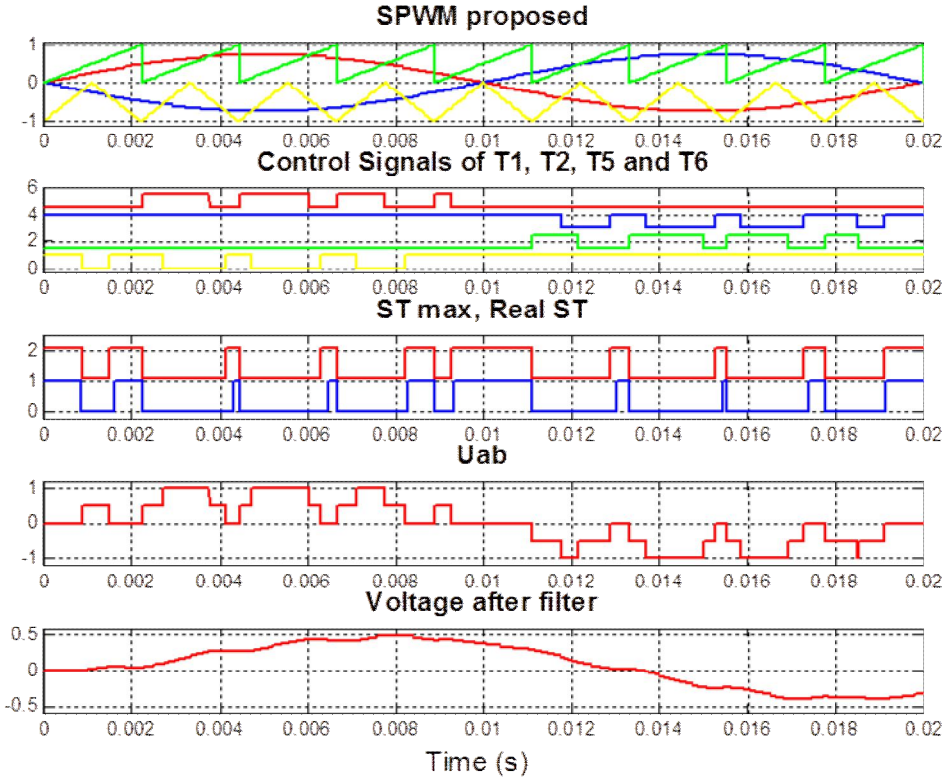

Fig. 4. Obtained simulation results.

To verify the proposed SPWM technique, a simple simulation study using Matlab/Simulink has been developed.

Fig. 4 shows the scheme from top to bottom: the SPWM signals, control signals of transistors T_1, T_2, T_5 and T_6, the maximum shoot-through and the real shoot-through states, output voltage UAB, and the voltage after filter.

We can see that spreaded shoot-through states are obtained in the whole output voltage (U_{AB}) period and the average voltage U_{AB} is compensated through the increasing of the maximum voltage ((U_{dc}) or – (U_{dc})) duty cycle D_M and meanwhile the half voltage ((U_{dc})/2 or – (U_{dc})/2) duty cycle D_H is decreased.

The disadvantage of this technique is that the shoot-through states are not uniformly distributed during the output voltage period and they have different pulse widths as well as a non-linear connection between F_{s-t} and t_s due to the modification of the modulating sinusoidal waves, resulting in a complicated control system for this topology.

References

[1] F. Z. Peng, "Z-Source inverter", *IEEE Transactions of Industry Applications*, vol. 39, no. 2, pp.504-510, 2003.

[2] F. Z. Peng, M. Shen, and Z. Qian, "Maximum boost control of the Zsource inverter," *IEEE Trans. Power Electron*., vol. 20, no. 4, pp.833–838, Jul./Aug. 2005.

[3] M.S. Shen, J. Wang, A. Joseph, F.Z. Peng, L.M. Tolbert, D.J. Adams,"Constant Boost Control of the Z-Source Inverter to Minimize Current Ripple and Voltage Stress," *IEEE Trans. Ind. Appl.*, vol. 42, no. 3, pp. 770-778, May/June 2006.

[4] Poh Chiang Loh; Vilathgamuwa, D.M.; Yue Sen Lai; Geok Tin Chua; Yunwei Li; , "Pulse-width modulation of Z-source inverters," *Industry Applications Conference, 2004. 39th IAS Annual Meeting*. Conference Record of the 2004 IEEE , vol.1, no., pp. 4 vol. 3-7 Oct. 2004.

[5] Roasto, I.; Vinnikov, D.; Jalakas, T.; Zakis, J.; Ott, S.; , "Experimental study of shoot-through control methods for qZSI-based DC/DC converters," *Power Electronics Electrical Drives Automation and Motion (SPEEDAM)*, 2010 International Symposium on , vol., no., pp.29-34, 14-16 June 2010.

[6] Ott, S.; Roasto, I.; Vinnikov, D.; "Neutral point clamped quasi-impedance-source inverter," *Compatibility and Power Electronics (CPE), 2011 7th International Conference-Workshop* , vol., no., pp.348-353, 1-3 June 2011.

Research and Development of Obstacle Avoidance Systems for Robotics

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Abstract: The goal of the project is the development of a Clear Path Sensory System for robotics in general. The system is multilayered with the first layer consisting of a 24x sensor/360^o photovoltaic array covering a spectral range of approximately λ=200nm to λ=1100nm and continuously scanning the robot environment. This array combines an incident light sensor which recurrently monitors and adjusts the weighting system of the sensors. Amplification of signal occurs in this layer. The second layer delivers the amplified readings to a fuzzification/defuzzification microprocessor for immediate response and/or transfer to the second level microcontroller for subsequent storage or mapping usage. The third layer refers to the peripherally mounted modified pyroelectric (PIR) sensors which are specifically arranged to handle obstacle avoidance (OA) utilizing near infrared spectrum detection. The PIR sensors, connected directly to analogue logic circuitry, control the main drive systems of the robot yet may be overridden by the main microprocessor when or if required. Therefore the overall system incorporates sensor selection, amplification, modulation, FL algorithm refinement, sub-system microcontroller, main system microcontroller and high speed analogue response mechanisms for mobility. The system includes generic design parameters to allow the inclusion of many sensor types and may also be expanded to utilize the photovoltaic data retrieval for environment mapping.

INTRODUCTION

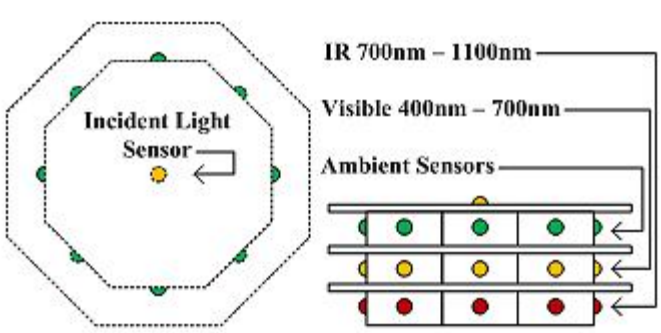
In dealing with autonomous robot mobility and addressing the inherent problems associated with dynamically changing environment analysis, this part of the research proposes a Fuzzy Logic (FL), topology for the processing of amplified photovoltaic data from an array of sensors operating in photovoltaic mode, forming a 360^o scan of a given environment. The resulting “fuzzified” data may be utilized for the purposes of obstacle avoidance, item location or safety applications such as fire detection and human detection.

The application of FL techniques has been chosen especially due to the imprecision of the multitude of signal intensities which may be collected from random ambient radiation sources. “Imprecise” or “vague” expressions are appropriate adjectives when describing fuzzy logic. As human beings we express ourselves in terms like "nearly", "about" or "far" which have little or no relationship to the absolutes of first-order logic and terms attempting to describe radiation wavelength intensities within dynamic environments cannot by their nature be absolute. A true or false mode of analysis merely emphasizes the fact that we wish to attain the highest possible precision without accounting for the inherent, imprecise nature of reality. In essence, FL is a precise logic of imprecision [1].

A further option was that of utilizing probability theory to present a closer to real-world model however this model as such still requires the collecting of information about the environment of an autonomous device with a high precision factor. FL therefore allows for vagueness in collected data and is in fact able to exploit these variances with a high level of tolerance. Ease of implementation and cost-effectiveness has resulted in FL becoming popular where differential equations offer no solution or have become cost prohibitive. The author has also looked at subsumption architecture as described by Brooks [2], however this architecture has its own inherent problems as described by [3,4,5] who developed a subsumption based system using FL based techniques to fuse certain output behaviours [6].

THE PHOTODIODE SENSOR ARRAY

The sensor array is designed with eight banks of three differing types of sensor. The lower sensors as depicted in Fig.1 are near-infrared sensors with a wavelength value, λ of approximately 700nm to 1100nm with a peak sensitivity of 900nm, which allows an accurate measurement covering 400nm of the near infrared spectrum. The second row of sensors, are covering that portion of the visible spectrum, with λ of around 400nm to 700nm and a spectral peak of 550nm inclusive of infrared rejection filters. The last row consists of light emitting diodes (LED's) which in reverse bias mode, offer the feature that an LED will be receptive to wavelengths of light, less than their own peak wavelength and covering that area of the visible spectrum of λ = 520nm to 400nm with some incursion into the ultraviolet region of the spectrum to as low as 200nm.



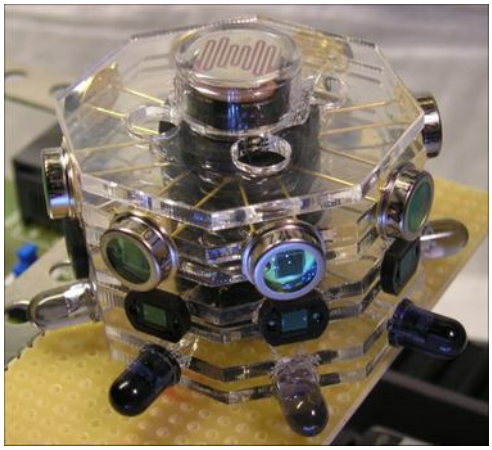


Fig.1. Sensor array configuration.

PHOTOVOLTAIC AMPLIFICATION

The project utilizes 24 transimpedance amplifiers as the method to convert the photodiode current to a voltage and keep the diode voltage at zero. The amplifiers accurately amplify the signal from the sensors and this data may be collected for fuzzification.

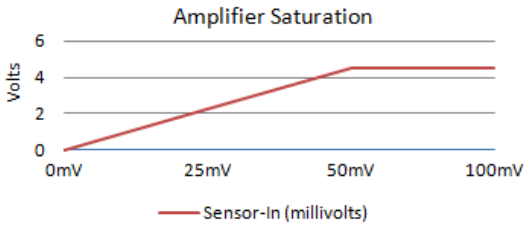


Fig. 2. Trans-resistance amplifier limits.

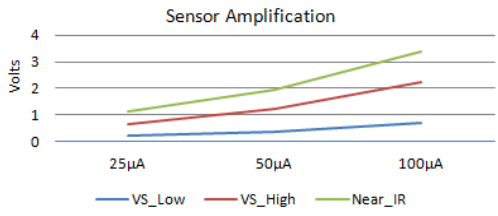


Fig. 3. Amplification adjusted for infrared, upper-visible and low-visible light.

The output voltage vs. incident light can be linear over 7-9 orders of magnitude as in (Fig.2). Electrical response depends on the response of the detector due to incident radiation across its substrate [7], and adjusted amplifications are denoted in (Fig.3). The sensor system

outlined in this paper has three basic elements. These are the sensors and the amplifiers with the addition of a governing FL controller.

MEMBERSHIP FUNCTIONS

As the primary purpose of fuzzification is to more accurately assess the variance of the many voltages produced across the array sensors, the control scheme has been left open ended, leaving the overall output to be adjustable in line with the subsequent usage, be that mapping, obstacle avoidance or any number of other applications.

Three sets of functions were created to express degrees of membership for each set of three sensors, all having a membership from 0 to 1. The crisp values, represented in millivolts, mV, specify a range of 0mV to 4500mV, presenting the broadest range available before saturation occurs in the transimpedance amplifiers. A one third membership input graph is denoted in (Fig. 4-a), representing the limit of the lower visible spectrum photodiodes as 0 to 1000mV, in (Fig. 4-b), the limit of the visible spectrum photodiodes as 0 to 2500mV and in (Fig. 4-c), the limit of the infrared photodiodes as 0 to 4500mV, representing the real time capabilities of the selected sensors.

The scheme requires three membership functions for each bank, totaling eight sets in all, giving a total of 24 input membership functions with eight output membership functions. Simulation has been accomplished using linear, triangular functions in line with the requirement for simplicity of modification and high speed computation and computational times in simulation resulted in data analysis every 0.05 seconds, (50 milliseconds). The resultant membership functions allow the photovoltaic data to be fuzzified then de-fuzzified for an output value based on various weighting of the system. In the paper the output function was related to PWM motor drivers and as such would be synonymous with the autonomous device navigating using photovoltaics however it must be noted that with the ease of adjustment in any of the membership functions many varying behaviours may be attained, dependent only on the requirements of the user.

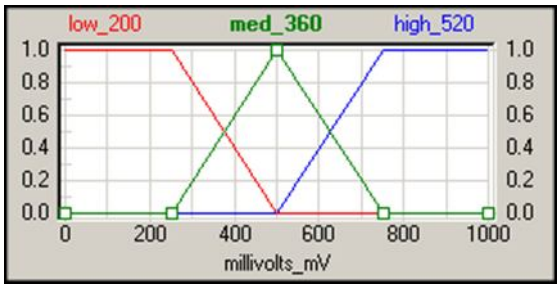


Fig. 4-a. Membership function of visible spectrum low.

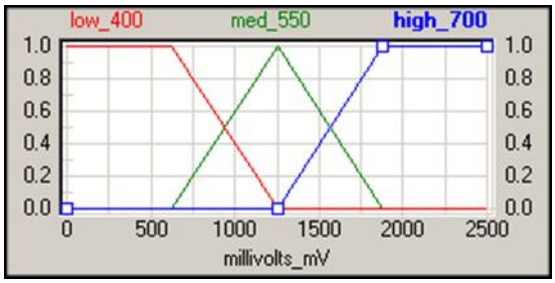


Fig. 4-b. Membership function of visible spectrum high.

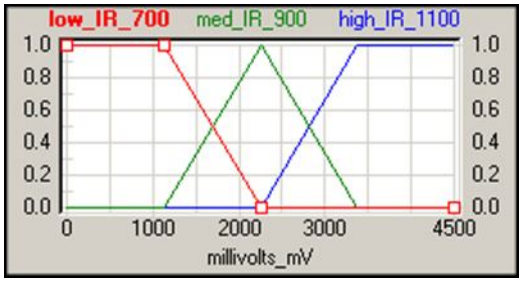


Fig. 4-c. Membership function of near infrared.

Upper level sensors:

These sensors have two tasks, being to determine the ambient light level in conjunction with the incident light meter located at the apex of the array. The "incident light meter" is not specifically referred to within this paper however provides an active light monitoring and control to all array sensors. The upper level sensors measure that light in the level of the spectrum from midway (green) to the lower range (blue) infringing marginally into the ultra violet region. So for testing and evaluation the preliminary assumption is that for the upper level sensors, the brightest illumination in the environment will be the priority.

Middle level sensors:

These sensors measure light over the whole visible spectrum. The mid sensors, having the whole of the visible spectrum as their source would set of course the brightest zone as priority as unlike the other sensors, have a greater ability to detect shaded areas. Shaded areas of course represent a voltaic decrease or variance in each particular sector and logically either indicate an object of low reflectivity or the entrance to a darker environment within that sector. Shaded areas indoors (photovoltaic decrease), generally would point to an obstacle in close proximity, therefore initial priority would be high.

Lower level sensors:

Measuring the near-infrared spectrum, the IR sensors will always detect infrared radiation as it is everywhere in the environment however we may assume that a higher level of infrared could be damaging to our mobile robot so from this perspective the lowest IR emission should be more preferable and set initially as the priority low. This statement of course reflects the particular goal programming of the mobile robot and may be opposite when searching for hot spots or fire danger.

Modification of all membership functions may be applied within the rule blocks of the fuzzy system which will adapt the output outcome (Fig. 5), in line with user requirement.

Fig. 5. Module output function.

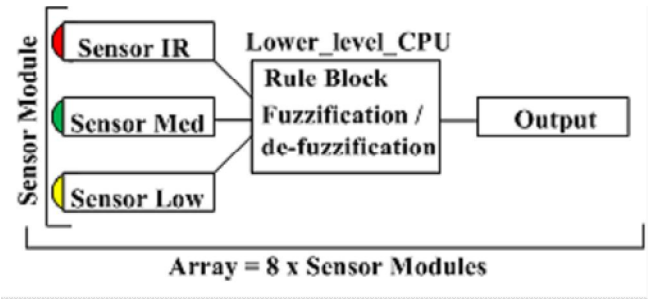


Fig. 6. Function block for single sensor module.

RULE BLOCKS

De-fuzzification rule blocks consist primarily of if/and/and/then statements followed by a "degree of support", DoS function where either random values or a constant user defined value is assigned to a rule set. For the existing system 135 individual "rules" are developed for each three sensor module of the array (Fig. 6).

The membership function module as described within this paper is replicated eight times to complete the array in (Fig.1). Three possible scenarios are denoted in (Fig.7) as a

simplified example of the associated" if/and/and/then" statements from the rule block. In the first example, infrared radiation is high, mid spectrum light is medium and low spectrum light is high therefore according to the chosen priorities of the system this equates to a danger zone and should be avoided, producing a "then" status of negative 50 PWM which in essence is a reversal at high speed of the motors. Similarly in example two, all sensors indicating "high" likely would denote that the mobile robot has come into contact with direct sunlight and according to its DoS it must stop to recharge its solar batteries, therefore PWM = 0 (stop). The third example simply indicates that all sensors are medium and so we should proceed cautiously, half speed. These are verbal examples only to provide a generalized idea.

if	and	and	op	then
IR_High	Mid_S_Med	Low_S_High	=>	PWM = -50
IR_High	Mid_S_High	Low_S_High	=>	PWM = 0
IR_Low	Mid_S_Med	Low_S_Med	=>	PWM = +25

Fig. 7. Function block for single sensor module.

The resultant 8 output blocks becomes individual responses which may be directed to a logic array for direct response to drive systems or to an MCU embedded algorithm for further analysis. Further, the generated eight outputs may also become input membership function blocks for additional fuzzification/defuzzification providing perhaps only 2 outputs for "H-Bridge" motor control.

References

1. **L.A. Zadeh,** A theory of approximate reasoning, in: J. Hayes, D. Michie, L.I. Mikulich (Eds.), Machine Intelligence 9, Halstead Press, New York, 1979, pp. 149–194.
2. **Brooks, R. A.,** "A Robust Layered Control System for a Mobile Robot." IEEE Journal of Robotics and Automation, Vol. RA-2, No. 1, 1986, pp. 14-23.
3. **Toal, D., Flanagan, C., Jones, C., Strunz, B.,** "Subsumption Architecture for the Control of Robots." IMC-13, Limerick, 1996.
4. **Flanagan, C., Toal, D., Strunz, B.,** "Subsumption Control of a Mobile Robot." Polymodel 16, Sunderland, 1995.
5. **D.J.F. Toal., C. Flanagan.,** 'Pull to position', a different approach to the control of robot arms for mobile robots. Journal of Materials Processing Technology, Volume 123, Issue 3, 10 May 2002, Pages 393-398.
6. **Payton, D., Rosenblatt, J., Keirsey, D.,** "Plan Guided Reaction." IEEE Transactions on Systems, Man and Cybernetics, Vol. 20, No. 6, pp. 1370-1382, Nov. 1990
7. **R. Ciupa, A. Rogalski,** Performance Limitations of Photon and Thermal Infrared Detectors, Opto-Electrics. Rev.,5, no. 4, (1997)

The Frequency – code shunting automatic locomotive signal system problems

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On the main railways the status ahead of laying sites to the driver of the locomotive is transferred with the automatic locomotive signal system. It is the code automatic locomotive signal system of continuous type more often [1], [8]. Under indications of this system the driver of the locomotive is guided for a choice of speed of movement of a train, and at an entrance to station defines as also a direction of movement on station. At large stations there is a shunting automatic locomotive signal system which informs the driver of the locomotive on a status of a shunting traffic light in front of the locomotive [1], [6].

If railway station to equip with system of automatic control of the shunting locomotive, opportunities of such locomotive signal system are limited, because the quantity of their statuses is not enough. For coordination of the managing computer complex by centralization of railway station and the managing computer complex of the shunting locomotive it is necessary to develop program and the hardware of such signal system which can liquidate these lacks. Such signal system can be the frequency-code shunting locomotive signal system. By its development requires the solution of the following problems [4], [5], [6]:

1. Connection between managing computer complexes of railway station and the locomotive should be bilateral. It will allow locomotive devices not only to receive the information, but to exchange with the results of calculations and those of the equation of the data.

2. For connection between devices of the central post and the locomotive the rail-wire line which provides this bilateral connection should be used. In this line it is maximum necessary to use already existing communications, for example cables, rails, etc. Such line can be rail-wire line of inductive connection which will consist of the cable communication line and a rail way [3], [4].

Generally in such line without taking into account influence of other lines wave processes describe system of the differential equations:

- $dU_1/dx = x_1I_1 + x_{12}I_2 + x_{13}I_3$
- $dU_2/dx = x_2I_2 + x_{21}I_1 + x_{23}I_3$
- $dU_3/dx = x_3I_3 + x_{31}I_1 + x_{32}I_2$
- $dI_1/dx = y_1U_1 - y_{12}U_2 – y_{13}U_3$
- $dI_2/dx = y_2U_2 - y_{12}U_1 – y_{23}U_3$
- $dI_3/dx = y_3U_3 - y_{13}U_1 – y_{23}U_2$

Where

x_1, x_2, y_1, y_2 – specific resistance and specific conductivity of rail circuits.

x_3, y_3 - specific resistance and specific conductivity of a vein of a cable.

I_1,I_2, I_3, U_1,U_2, U_3 - currents and voltage in rail strings and a vein of a cable.

x_{12}, y_{12} - mutual resistance and mutual conductivity of rail strings.

x_{13}, x_{23} , y_{13}, y_{23} - mutual resistance and mutual conductivity between a corresponding rail string and a vein of a cable.

3. The type of the signal system should provide an opportunity of transfer of a plenty of the information for short time of a presence of the shunting locomotive for a concrete rail site. Such signal system of the code shunting signal system can be frequency. The structure of codes of this signal system will consist of a set of pulses of active and passive frequencies. They are formed with the equipment connected to the station computer complex (signals of management) or the locomotive computer complex (signals of the control). The equipment of decoding of codes transfers the information to control the locomotive. In the case of reception with the locomotive computer complex of the information resolving movement, the shunting locomotive will begin movement in the set direction, with the set speed, on the certain distance.

Thus, with the frequency - code shunting locomotive signal system's help it is possible to solve the problem of automation of shunting movement on railway station without intervention of the locomotive's driver.

REFERENCES

1. *Latvijas Republikas dzelzceļu Tehniskās ekspluatācijas Noteikumi, N-724, 2010.,* Rīga www.ldz.lv
2. Arkatovs V., Kotļarenko N. un citi. Maģistrālo dzelzceļu sliežu ķēdes.// Rokasgrāmata M.: «Transports», 1995.
3. Cibuļa N., Bariševs J. Manevru pārvietojumu automatizācija rūpnieciskajā transportā. M.: «Transports», 1986.
4. Cibuļa N. un citi. Sliežu sakaru kanāli priekš MALS. «Automātika un telemehānika» №12, 1986.
5. Cibuļa N. un citi. KAMO sistēmas elementi.// «Automātika un telemehānika» №9, 1988.
6. Gončarovs N., Kazancevs V. Manevru darbs dzelzceļa transportā.// M.: «Transports», 1988.
7. Jagudins R. Dzelzceļa automātikas un telemehānikas ierīču drošība.// M.: «Transports», 1989.
8. Kokurins I., Kondratenko L. Dzelzceļa automātikas un telemehānikas ierīču ekspluatācijas pamati.// M.: «Transports», 1990.
9. Pernikis B., Jagudins R. Dzelzceļa automātikas un telemehānikas ierīču profilakse un bojājumu novēršana.// R.:LDz, 1997.
10. *1993 Emergency Response Guidebook.* (U.S. Department of Transportation. Research and Special Programs Administration)
11. *„Noteikumi par drošības konsultantu (padomnieku) norīkošanu, profesionālo kvalifikāciju un darbību bīstamo kravu pārvadājumu jomā" Nr.546* (MK, 2002.gada 15.novembrī) www.ldz.lv
12. *Vilcienu kustības drošības pārskats 2005 - 2010.,* www.ldz.lv
13. *Statistika par kravu pārvadājumiem* www.csb.lv/Satr/rad/J1.cfm?kurss=J1
14. *"Pārmiju un luksoforu releju procesoru centralizācija "Dialogs-C".* Ekspluatācijas rokasgrāmata. DT467920.501 ER//M.:2003.

Analyzing location data with an embedded device in a railway electric transport safety control system

Andrejs Mors - Jaroslavcevs

Objective of this paper is to design an embedded device for an intelligent rolling stock safety system which would provide a possibility for railway transport to avoid dangerous situations based on its location data. The authors examine data analysis algorithms used in artificial immune systems and ways how they can be used together and provide data for each one via communication protocols.

The authors review data analysis methods used to detect, predict and control undesirable rolling stock travel conditions.

During journey the rolling stock driver may experience many undesirable situations and have to make decisions on how solve them. The situations may include such examples as:

- the last car from the flow is still on the level crossing 25 seconds before the train arrival, while the safety regulations require the crossing to be cleared at least 35 seconds before train arrival;
- a daredevil is running across the tracks somewhere in the urban zone;
- there is a wide but harmless rod lying between the tracks, etc.

Each of these situations requires different actions or no action at all. The driver may have to apply brakes, speed up, continue the steady movement and in any case communicate the information to the control center and other drivers.

The desired result conforms to at least two requirements:

- the train is on schedule;
- there are no casualties.

A common situation is illustrated in Fig. 1, where L is a locomotive and I is an invading object on tracks.

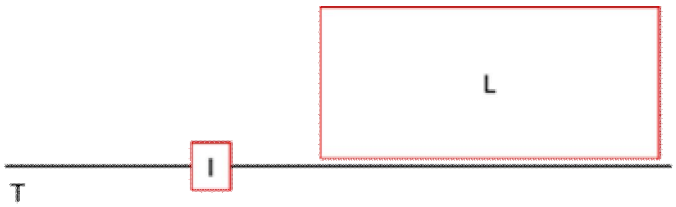

Fig. 1. A common undesirable situation on the railway tracks.

The authors offer the intelligent rolling stock safety system functional design which is presented in Fig. 2.

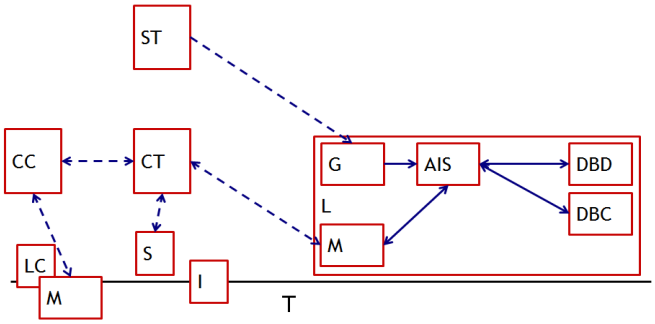

Fig. 2. The intelligent rolling stock safety system functional design.

The invading object I is picked up by sensors S and the data is transmitted to the nearest cell tower CT, which relays it to the control center CC and nearest locomotives wireless modems M. Through the same modem the locomotive L receives data about closest neighbors' rolling stock position and status, railway segment profile and maximum allowed speed.

L also hosts: a positioning receiver G which receives data from a positioning satellite ST; data analysis module AIS which communicates to the immune detector database DBD and control cell database DBC. Depending on the results of control cell maturation the module makes a decision and executes it by sending a control signal or displaying an alert to the driver.

The information is also communicated to the device on a level crossing LC through a similar modem M.

The principles behind AIS, DBD and DBC are discussed further in the article.

Variables:

- Let $U \in \boldsymbol{R}$ be problem space containing all the possible sets of parameter values ("situations"),
- $P \in U$ — set of known "good" situations,
- $S(t) \in U$ — current situation which changes with time t,
- $D = \{D_1, D_2, \ldots, D_n\} \notin P$ — set of detectors produced by the initial training procedure,
- $C = \{C_{D1(1)}, C_{D1(2)}, \ldots, C_{D1(p)}, C_{D2(1)}, \ldots, C_{Dn(p)}\}$ — set of control cells affiliated to detectors,
- $E = \{E_1, E_2, \ldots, E_m\}$ — set of encountered situations,
- $W = \{W_{E1D1}, W_{E1D2}, \ldots, W_{E1Dn}, W_{E2D1}, \ldots, W_{EmDn}\}$ — set of detector weights in different situations.

The intelligent rolling stock safety system for an embedded device general algorithm:

1. Fill in the initial values D for *DBD* by running the negative selection training routine.
2. Run in real time the detection routine using the negative selection algorithm.
3. Determine the possible situation identifiers (detectors which matched above a given threshold).
4. Assign weights to the detectors based on their "distance" to the situation.
5. Retrieve a population of control cells C from *DBC* which are related to the activated detectors.
6. Run the control cell maturation routine using the clonal selection algorithm.

7. Execute the found optimal solution.
8. Communicate the information to the control center *CC*.
9. Continue from step 2.

The incoming data from the sensors is the set of antigens. The data includes but is not limited to speed, acceleration, voltage, rotation and operational temperature.

Research of single phase compensated rectifiers

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Many electric technologies have a necessity to use single-phase AC voltage uncontrolled rectifiers, and the rectified voltage quality must be high enough – with small voltage pulse and a small rectifier effect on the AC network - secure network with high current THD indicator and power factor close to unity. In addition, single-phase rectifiers often must be with high power, such as in the single-phase AC electric train and locomotives. AC electric locomotive rectifiers have capacity of up to 2-3MW and with output voltage up to 2.5kV.

Such uncontrollable rectifiers of electric trains and locomotives are used, either directly through the DC motor pulse regulator control, or are used as the DC link for frequency converter systems, where AC motors are used for traction. In both cases, system quality is dependent on the quality of uncontrolled rectifier

The large capacity electric power is divided into two groups: AC motor drives with inverters and DC motor drive with rectifier. Currently, electric rolling stock, locomotives have a large proportion of the DC motor drive type, as it is a Latvian and other European countries. It is expected that the DC motor drive locomotives will be operated for a long period. Sometimes the locomotive rectifiers no longer meets the current requirements and needs improvement or replacement. Locomotive with asynchronous or synchronous motor drive as well as DC motor drive in case if used network is taken as alternating current and most often it is rectified, then inverted AC motor needs a way rectifier process quality, this way it is a topical issue in cases with an AC motor drive.

There have been several proposals for the technical quality of single-phase AC voltage rectifier creation. For example, it is proposed to install output LC filter to a high power rectifier. The main disadvantages of such a system are large filter element dimensions and weight, as well as the high cost of active material. This system should be used in conjunction with the rectifier input filter, as well as reactive power compensation units to significantly reduce system efficiency.

In recent times there is gained wide popularity of active rectifiers, which are also relevant to the uncontrolled rectifier class, in such rectifiers, diodes, contrary to the added transistors in parallel, and the output capacitor and the input AC choke circuit, from the network consumed current is almost sinusoidal and regulation of reactive transferable power quantity is possible, including the full operation of active power mode. In most cases, when the train or locomotive traction transformer is installed, there is no need to use the input inductance filter.

Such active rectifiers can be created as a multi-level, which reduces the high voltage drop across diodes and transistors load operating voltage can be reduced. With the use of multilevel active rectifier it can also simplify the creation of the traction transformer, creating

a multi-level transformer. It should be noted that the active rectifier application allows for bi-directional power flow, enabling the effective implementation of the traction motor regenerative braking.

However, the active rectifier creation requires high-power transistor implementation in the system and the creation of a sophisticated control algorithm, which greatly increases cost and complicates the establishment of the rectifier, as well as reduces the system reliability.

It should be noted that it is possible to create so-called rectifiers for power correction principle, such systems can be both symmetric elements and asymmetric, and may be several phases of the bridge rectifier output. It is possible to create a system with so-called high-frequency electronic transformer; the rectifier DCV is inverted, transformed and re-rectified. But all of these systems are rather complex and requires use of sophisticated control algorithms.

Having regard to the above, the work offers a new type of unguided dual rectifier system, the first channel operating at partial capacity uncontrolled conventional bridge rectifier mode, the second channel by lowered voltage pulse regulator with partial power fill the rectified voltage drops of the first channel. Such a system allows getting high quality rectified voltage by two reduced capacity channels, and provides a reasonably good result in a total network current. The aim is to study such systems and to evaluate the use for electric traction systems.

Refrences

[1] David C. Hamill, Philip T. Krein, „A ‘Zero’ Ripple Technique Applicable To Any DC Converter”, 1999 IEEE.

[2] M. Darwish, T. Thomson, P. Mehta, “A novel technique for smoothing DC ripple in rectifier circuits”, Power Electronics and Variable-Speed Drives, 1991., Fourth International Conference, Issue Date: 17-19 Jul 1990, pp. 280 – 285.

[3] T. Siebert, A. Troedson, S. Ebner, “AC to DC Power Conversion Now and in the Future”, ABB, PCIC-2001-14, 2001.

[4] M. Ogasa, „Harmonic Compensator for 50/60-Hz Fed Railway Vehicles”, QR of RTRI, Vol. 41, No. 1, mar.2000, pp. 37-42.

[5] B. Singh, G. Bhuvaneswari, V. Garg, „Improved Power Quality AC-DC Converter for Electric Multiple Units in Electric Traction”, 2006, IEEE.

[6] J. Bauer, „Single-Phase Pulse Width Modulated Rectifier”, Acta Polytechnica Vol. 48 No. 3/2008, pp. 84-87.

[7] I. Rodionova, “Maiņstrāvas Elektrovilcienu Līdzstrāvas Elektrovilcienu Efektivitātes Izpēte”, Rīga, 2005.

[8] K. L. Lian, P. W. Lehn, “Harmonic Analysis of Single-Phase Full Bridge Rectifiers Based on Fast Time Domain Method, IEEE ISIE 2006, July 9-12, 2006, Montreal, Quebec, Canada, pp. 2608-2613.

[9] G. Sandoval, J. Houdek, „A Review of Harmonic Mitigation Techniques", 2005.

[10] A.G. Vishal Anand, N. Gupta, V. Rammarayanan, „Unity Power Factor Rectifier using Scalar Control Technique", 2004 International Conference on Power System Technology, POWERCON 2004, Slngapore, 21-24 November 2004, pp. 862-867.

[11] M. J. Schutten, R. L. Steigerwald, M. H. Kheraluwala, "Characteristics of Load Resonant Converters Operated in a High Power Factor Mode", GE Co., IEEE, 1991, pp. 5-16.

[12] B. Singh, B. N. Singh, K. Al-Haddad, A. Pandey, D. P. Kothari, "A Review of Single-Phase Improved Power Quality AC-DC Converters", IEEE Transactions on Industrial Electronics, Vol. 50, No. 5, October 2003, pp. 962-981.

[13] R. Balamurugan, G. Gurusamy, „Harmonic Optimization by Single Phase Improved Power Quality AC-DC Power Factor Corrected Converters", 2010 International Journal of Computer Applications (0975 – 8887), Volume 1 – No. 5, pp. 33-40.

[14] M. T. Madigan, R. W. Erickson, E. Hamid Ismail, "Integrated High-Quality Rectifier–Regulators", IEEE Transactions on Industrial Electronics, Vol. 46, No. 4, AUGUST 1999. pp. 749-758.

[15] M. T. Zhang, Y Jiang, F. C. Lee, M. M. Jovanovic, "Single-Phase Three-Level Boost Power Factor Correction Converter", 1995, IEEE, pp. 434-439.

[16] L. Parvulescu, D. Floricau, M. Covrig, "Comparision Between Three Level Rectifiers", U.P.B. Sci. Bull., Series C, Vol. 73, Iss. 2, 2011.

[17] F. Jafari, A. Dastfan, "Optimization of Single-phase PWM Rectifier Performance by Using the Genetic Algorithm", International Conference on Renewable Energies and Power Quality (ICREPQ'10) Granada (Spain), 23rd to 25th March, 2010.

Ionizing radiation dosimeter with a Geiger-Mueller counters – measuring techniques, schemes and algorithms research, optimization, development and implementation

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Abstract

The paper studies the physical foundations of ionizing radiation, the measurement methods, schemes and algorithms. Based on these studies, improvements were made; a prototype dosimeter was designed and produced, using the company Microchip PIC18F4220 microcontroller. Prototype was tested and improved algorithms for the microcontroller. Based on the Salaspils radiation laboratory measurements, microcontroller calculation formulas used constants were specified.

Introduction

Traditionally, the ionizing radiation dosimeters with a Geiger-Mueller tubes use two methods – counting electric discharges through the Geiger-Muller tube in the time unit (frequency method) and measurement of electric current through a Geiger-Mueller tube (current method). In this work we use these two methods simultaneously, according to the measurement results (or, depending on the intensity of ionizing radiation) the microcontroller automatically selects the best method to perform calculations. Another novelty of the work is that the same microcontroller, performing the calculations, is used for DC-DC type voltage converter, which feeds the Geiger-Mueller tube voltage, control. Also, all other functions that are traditionally carried out discrete elements were integrated into the microcontroller program. This allowed reducing of the number of components and dosimeter's costs, as well as significant improvement of the device modification, by using only the microcontroller program modification.

1. Geiger-Mueller tube power supply

Geiger-Mueller tube power supply, see schematic in figure 1, is the DC-DC type voltage converter, which is formed by elements R6, Q1, Q2, T1, D1 and C2. Same Step-DC converter circuit is conventional [1]. This voltage converter provide a voltage on the capacitor C2, so that it is within the limits laid down by the Geiger-Mueller tube type [2], [3] (this should be a voltage on the meter response of the *Plateau*).

Converter output voltage is adjusted by changing the pulse width and freqency supplied from microcontroller (port RA1). Since the converter is a low power, the output voltage is highly dependent on the load current. Current through the Geiger-Muller counter is measured with the same microcontroller, which deliver pulses to the converter. This allows the delivered

pulse parameters change automatically, depending on the load current, thus stabilizing the voltage on C2.

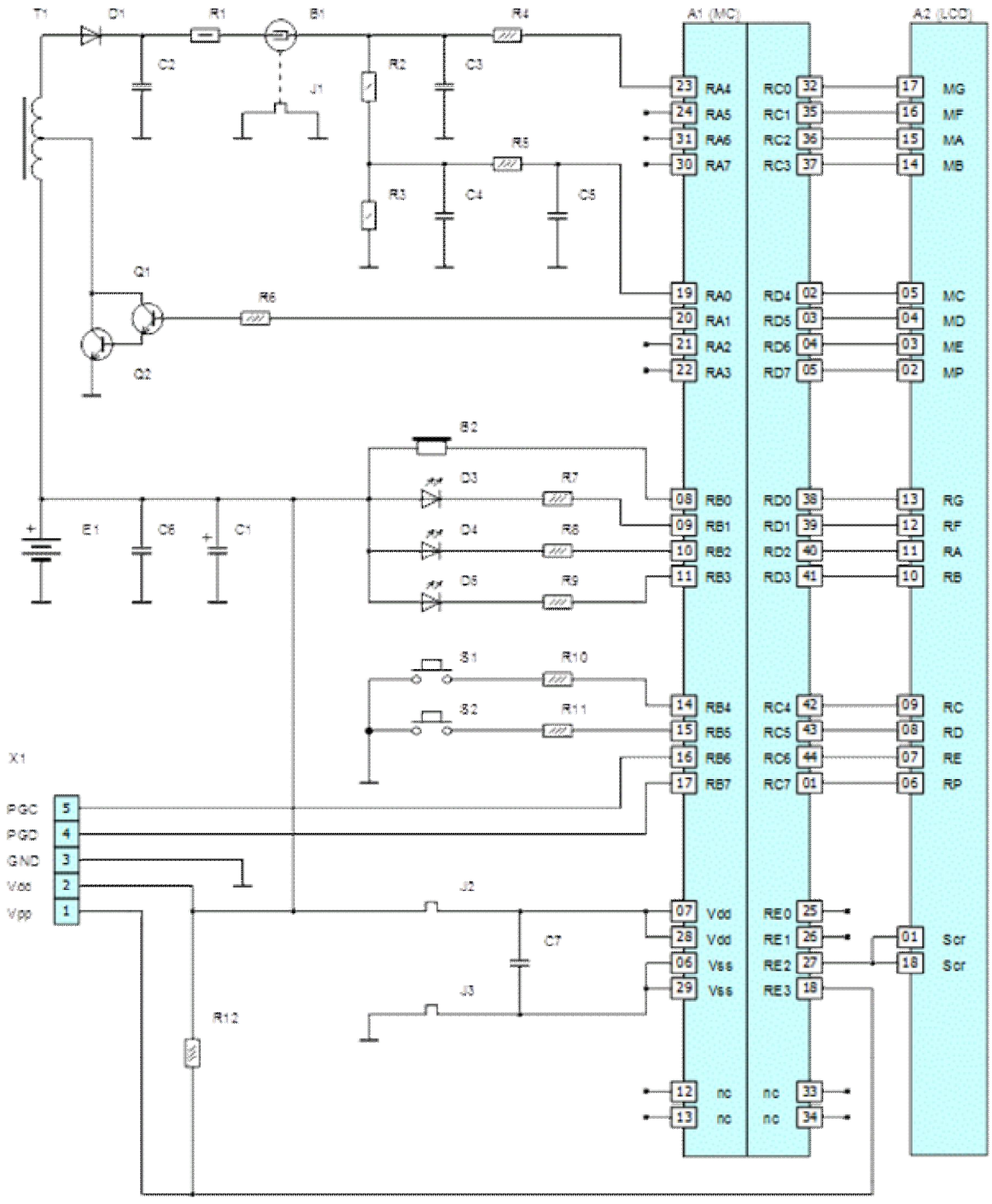


Figure 1. *The electrical schematic of dosimeter*

2. Radiation dose rate and dose measuring

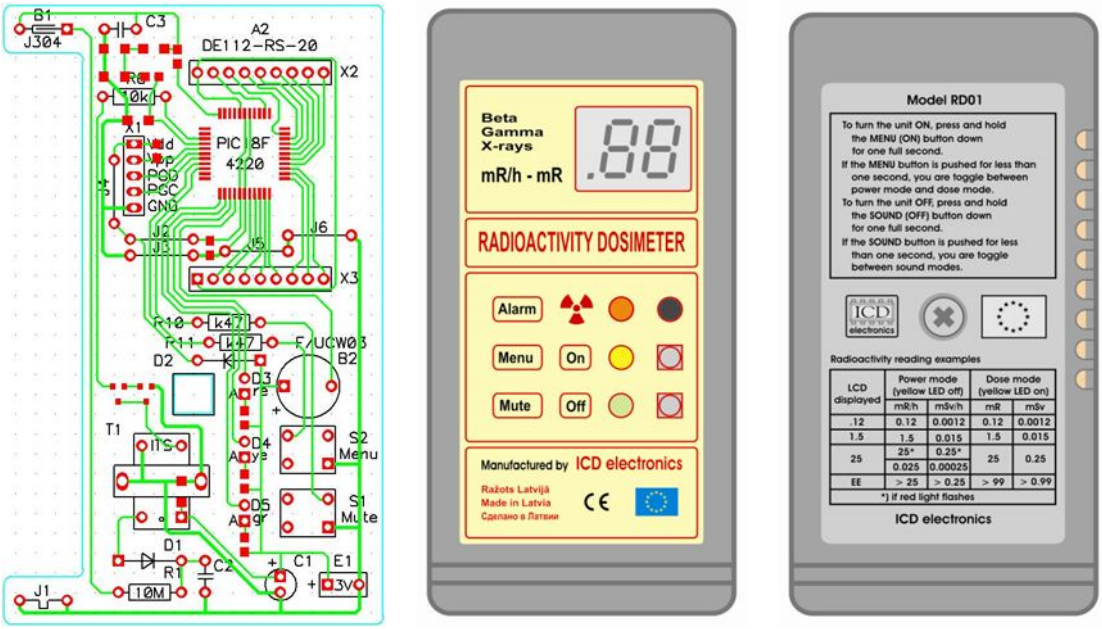
The radiation dose rate is continuously measured by the two (frequency and current) methods. Electrical discharge through B1 is smoothed by C3 (the value of which depends on the particular tube type technical regulations) and pulses through R4 to the microcontroller input RA4. Input RA4 is configured as asynchronous pulse counter and counter value is used in dose rate and total dose calculations.

The electrical discharges through B1 cause an electrical current through the resistors R1, R2 and R3. Voltage drop across R3 through an integrating filter C4, R5, C5 is fed to the microcontroller port RA0. RA0 port is configured as an analog to digital converter (ADC) input. For batteries E1 resources saving, ADC is automatically turned on when the radiation reaches a certain level.

The total dose, received by the dosimeter since dosimeter is powered on, is obtained by integrating the dose rate measurement. Both dose rate and cumulative dose measurement is continuous, as long as the dosimeter is switched on. The method of measurement and calculation formulas is automatically selected by the microcontroller, eliminating the need for operator intervention. User can only choose what the displays show or audible signals.

3. Implementation

Based on the results of the studies were made dosimeter samples. The samples were tested in different laboratories; design and circuitry have been repeatedly modified and improved. Most of the elements are placed on printed circuit board (PCB), mainly using surface-mounting. Plate of cells and dry cell batteries are inserted into the pocket-sized plastic case, see Figure 2.



2.attēls. *The construction of the dosimeter*

4. Results

Proposed methods of dosa rate and dosa measurement, circuits with microcontrollers, and the algorithms for microcontroller were tested in laboratory for electromagnetic compatibility and several radiation measurement laboratories. Calibration measurements of example are given in Table 1. The dosimeters are tested in sertificied radiation measuring laboratories in Salaspils, Latvia and by Steven Snay in U.S.A. showed that high accuracy of radiation dose rate measurements in a wide range of dosa rate is achieved. Figure 3 shows the dependence of the electrical discharges of radiation dose rate. We can see that dose rate measurement using only one - linear counting method when radiation is with high intensity is not accurate; therefore the author's proposed method is fully valid.

Table 1. *The example of Calibration measurements*

Distance to etalon [cm]	Etalon [μGy/h]	Distance [cm]	Source [M]	Power tolerance [±%]	Air Kerms power [mR/h]	Xav [mR/h]	Calibration factor	2s	2s/Xav [%]
50	2.4	59.4	7.4	4.5	0.2	0.16	1.25	0.022	14.0
80	9.1	83.2	74	2.4	1,0	0.65	1.54	0.037	5.7
50	23.2	58.8	74	2.4	2,0	1.20	1.67	0.044	3.6
40	36.3	48.0	74	2.4	3,0	1.75	1.71	0.067	3.8
100	61.0	120.6	740	2.1	5,0	2.80	1.79	0.070	2.5
90	74.6	101.4	740	2.1	7,0	3.69	1.90	0.084	2.3
80	94.4	84.9	740	2.1	10	4.78	2.09	0.071	1.5
70	122.4	77.2	740	2.1	12	5.46	2.20	0.123	2.3
60	166.9	69.1	740	2.1	15	6.17	2.43	0.082	1.3
50	240.2	59.0	740	2.1	20	6.93	2.89	0.079	1.1
50	240.2	53.5	740	2.1	25	7.31	3.42	0.060	0.8
50	240.2	48.8	740	2.1	30	7.38	4.07	0.049	0.7

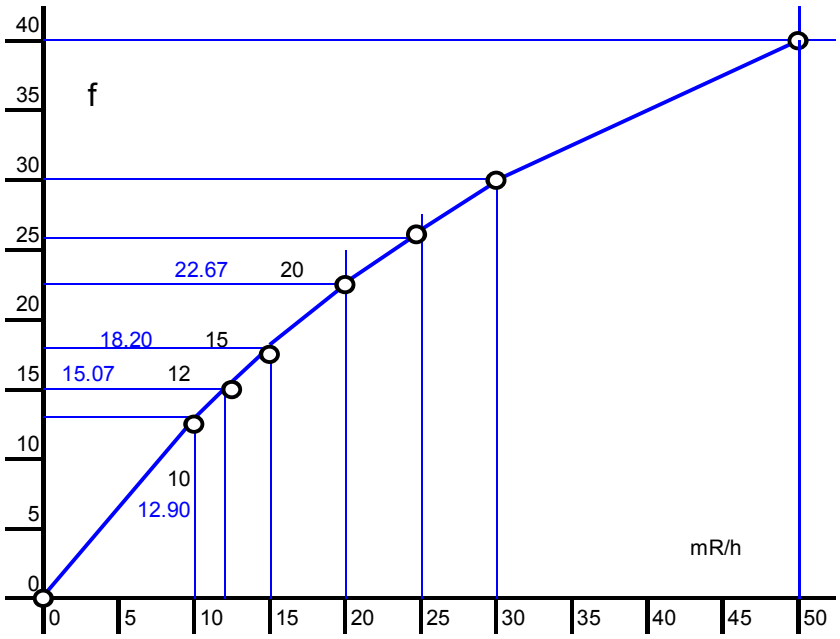


Figure 3. *Frequency discharges (relative units) dependence on the radiation dose rate*

Dosimeter has technology and manufacturing in company "ICD electronics" with the name of RD01 and it has been awarded with the certificate CE (Figure 4.). Technology and permit the production of the developed dosimeter, called DX3 or DX4, was sold to U.S.A. firm "Industrial Test Systems".

Paziņotās iestādes numurs: / Notified body number: 1693

LNMC

Atbilstības Sertifikāts Nr.SeD1074S11

CERTIFICATE OF CONFORMITY

Produkts: / Product	Radiācijas dozimetrs / Radiation dosimeter
Pieteicējs: / Applicant	Biedrība „Biznesa inkubators Cēsis" / Society „Business Incubator Cesis"
Pieteicēja adrese: / Address of applicant	Pļavas iela 5, Cēsis, LV-4101 / Plavas street 5, Cesis, LV-4101
Ražotājs: / Manufacturer	SIA „ICD electronics" / ICD Electronics ltd
Ražotāja adrese: / Address of manufacturer	Viestura iela 14-20, Cēsis, LV-4101 / Viestura street 14-20, Cesis, LV-4101
Modelis/tips: / Model/ type:	RD01
Produkta paraugs(-i) testēts(-i) un tam konstatēta atbilstība prasībām: / A sample(s) of the product was tested and found to be in conformity with:	DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC Harmonised standards: LVS EN 61000-6-2:2005+AC:2006; LVS EN 55011:2010+A1:2010
Apliecinājuma dokumenti: / Documents of Conformity	LEITC Test report Nr. LEITC-TR-10-06(3)

Apstiprināja: / Approved by:

CE

LATVIJAS NACIONĀLAIS METROLOĢIJAS CENTRS SIA

Figure 4. *Certificate of conformity*

5. Conclusion

The proposed methodology for measuring, circuit and microcontroller operation algorithm allows the increase of the accuracy of measurement of ionizing radiation dosa rate and dosa. Microcontroller with flash memory makes it possible to improve the quality of measurement, making changes only in microcontroller and allows calibrate each individual dosimeter copy, further increasing accuracy. The author continues to work on the dosimeter design.

References

[1] Raņķis I., Buņina I. *Energoelektronika*, Rīga, RTU, 2007.,221 lpp.

[2] Knite M. *Atomu kodolu fizikas elementi.* Lekciju konspekts fizikā RTU studentiem, Rīga, RTU, 2003., 15 lpp.

[3] James F. Burkhart *Radiation Fundamentals for Radon Professionals*, Western Regional Radon Training Center University of Colorado-Colorado Springs, 80918.

Optimisation of wireless and Internet network applications for computer controlled electro - technologies

Peteris Apse Apsītis

I. PRACTICALLY ORIENTED E-LEARNING WORKSHOP

Practically oriented e-Learning workshop (Fig.1.) in electrical engineering studies, are developed and implemented in study courses like control of electrical drives, power electronics, lighting control as well as in automatic control. Network based e-Learning semi-vocational workshops are considered as a way to:

- give possibility for students to have semi-vocational practice on basic parameter relationships, control methods and algorithms,
- provide better understanding and improvement in quality and creation speed of knowledge,
- give opportunity for professionals to practice in areas not well known for them or for life-long learning,
- extend possibilities of evaluating student's overall knowledge and understanding of the course material with the help of workshop's log file.

The gained knowledge can later be tested by carrying out one of "must know and understand" vocational tasks on site under supervision of educational staff.

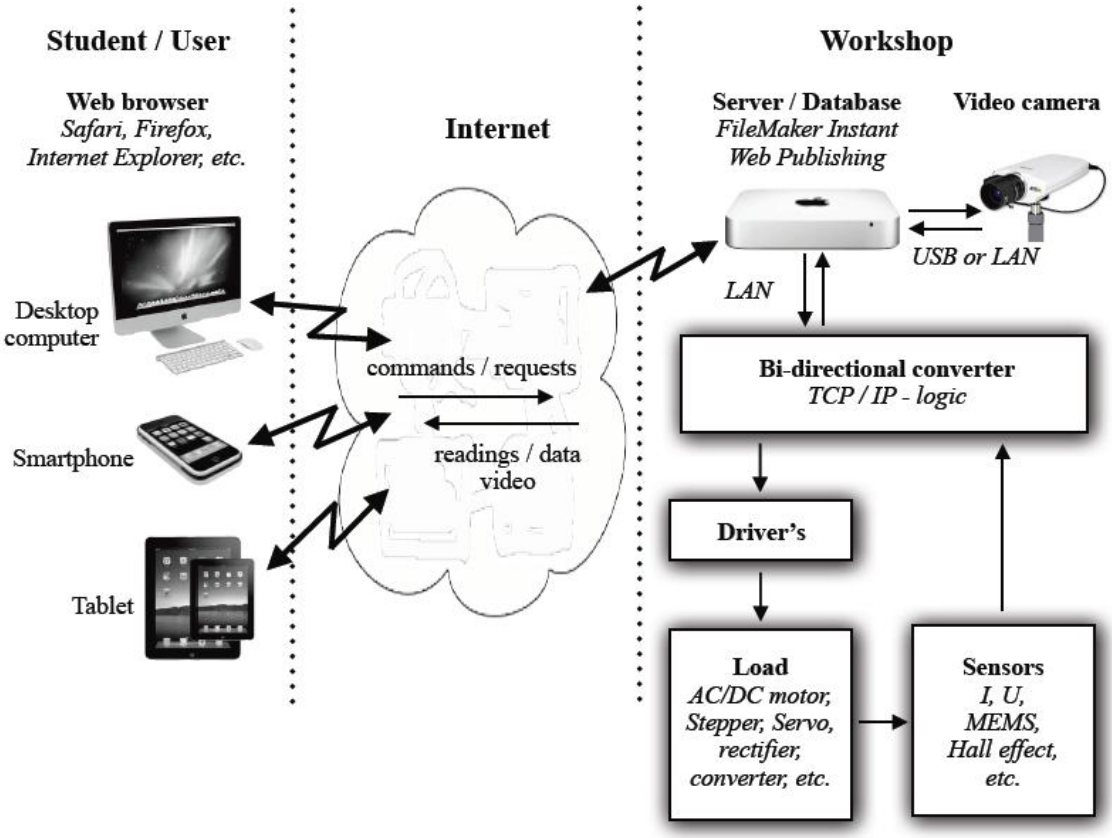


Fig.1. e-Learning workshop structure.

All controls and value readings are provided locally on site or remotely via Internet. Equipment observation and readings also can be done via Internet.

The main (but not the only) elements of e-Workshop are:

- web-server (the well known Apache web-server);
- FileMakerPro database with enabled Instant Web Publishing engine. Database stores user information, enables access to workshop via Username and Password, activates commands to drives, displays readings and activities and logs them;
- bi-directional TCP/IP - logic converter for each load. Converters are based on Arduino board and Arduino compatible modules. One converter can serve several loads in some cases;
- separate hardware driver for each load, for example driver to experiment with stepper motor control;
- sensors: current, voltage, tilt, acceleration, torque etc., installed on each load (if necessary);
- sensors driving digital oscilloscope;
- video camera for load and instruments observation;
- necessary safety switches and protection devices;
- GSM module for SMS information to workshop administrator in case of fault.

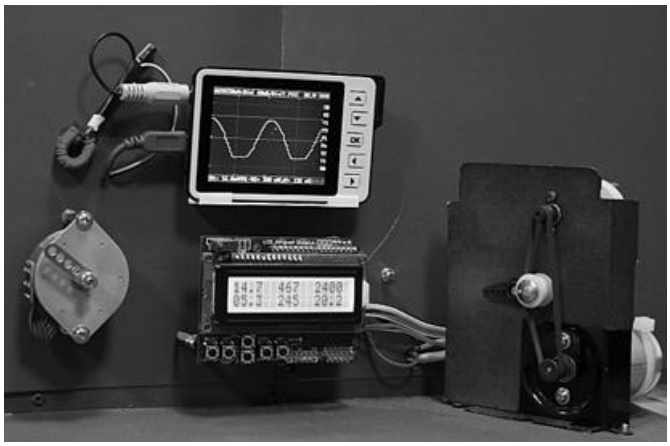
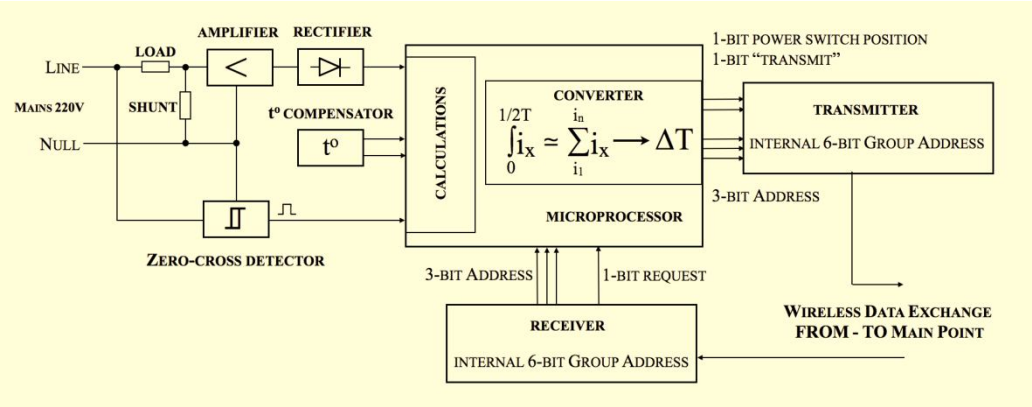


Fig.2. partially show e-Workshop DC drive-generator and step motor practicing equipment for illustration purposes.

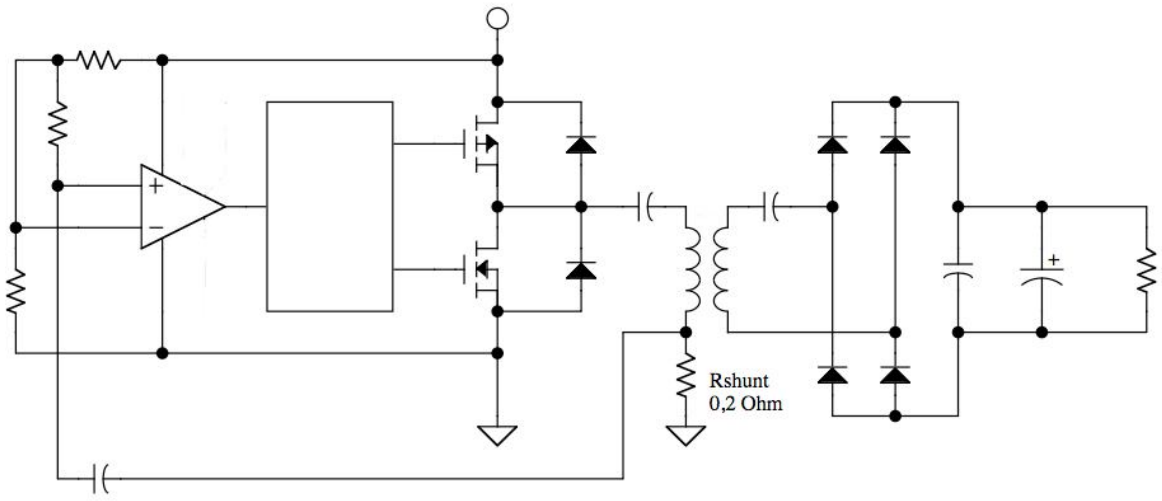
II. Low-Cost Energy Monitoring System

The uprising SmartGrid technology with alternative energy sources is demanding for a "smarter" consumer with ability to monitor and manage his loads. The new concept of household energy consumption monitoring system is developed - energy consumption apportionment between consumers instead of precise energy consumption metering for each consumer type. Data readings wirelessly are transferred from monitoring points to monitoring base station and can be observed via Internet. Structure of the monitoring system is shown in Fig.3.



III. SELF-TUNING CORE-LESS SERIAL RESONANT DC/DC CONVERTER

Sensors or another electro motor can be fixed on more than 360^0 turning or rotating servo, stepper or DC motor shaft, pan/tilt system or robotic systems, for example. To feed sensors and motors (fixed un rotary part) and receive sensor data, widely used wire loops cannot be applied in this case. Wireless energy transfer from stationary part to rotating (moving) part solves the problem. Self tuning resonant converter is applied. Control signals and data readings are provided over mentioned wireless link. Simplified converter circuit is shown in Fig.4.



IV. LED LAMP ILLUMINATION DIMMING DRIVER

Implementation of LED light sources are rapidly growing in-spite of higher LED price. Also LED drivers currently are expensive, especially with light dimming capability. Simple and inexpensive new type of LED driver are developed. Driver can power up to 100W led lamps, have wireless dimming capability as well as consumed power monitoring and fault detection over local ZigBee network and Internet. Two variants are shown below (Fig.5).

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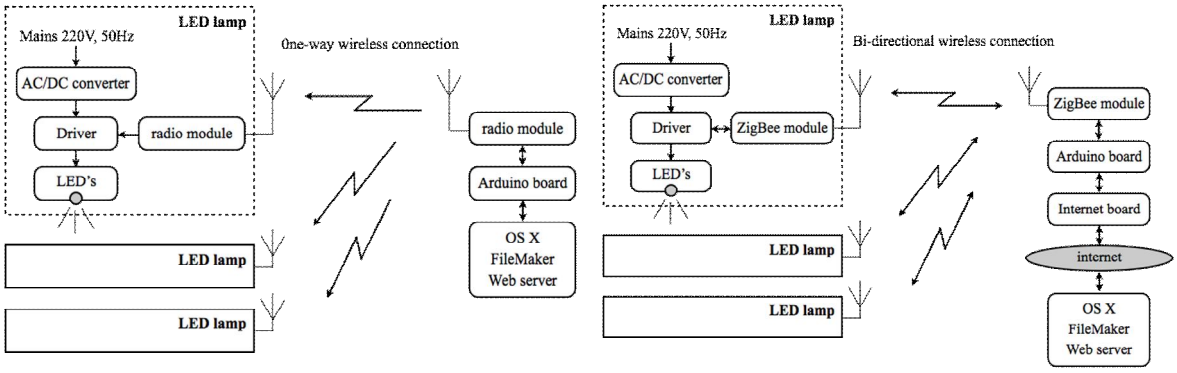

V. ICT TODAY

Mainly ICT are divided in to consumer ICT (PC's, cell phones, home electronics etc.), industrial ICT (PCL's, automatisation electronics, embedded microprocessors etc.), networking and networking equipment (wired or wireless), global positioning and navigation systems and satellite communications. In many cases there are practically the same equipment for consumer and industrial applications.

ICT consist from hardware and software. For the same hardware are possible several different software operating systems. And the came operating system can run on different hardware (not so many practical examples and mainly achieved via virtual machines).

For the same task and the same operating system is possible to find several application programs.

Production and manufacturing authorities and other involved specialists mainly share the point of view that only proprietary software applications, developed by big brand names, must be used in serious applications. This not clearly true because we can count that open source or freeware software designed by individual or groups of programmers dominate against brand name developed proprietary software.

Big and expensive example of proprietary software are Microsoft products[1].

Examples of popular open source products include[2] UNIX OS, Linux OS, FreeBSD OS, OpenBSD OS, Android OS, Emacs, GNU toolset, Apache, HTML, PHP programming languages and others. The development of Perl is an example of the open source process.

Open source project SourceForge: "*2.7 million developers create powerful software in over 260,000 projects. Our popular directory connects more than 46 million consumers with these open source projects and serves more than 2,000,000 downloads a day.*"[3]

Apple OS X and iOS4 partially are open source and partially proprietary. Based on UNIX, Cocoa and Ruby on Rails OS X include developed by Apple Inc. software groups (for example - drivers) and applications still are low cost proprietary software.

"*Mac OS X is far from perfect. But Windows is far from adequate. Mac OS X remains the single safest GUI operating system on the planet. Only OpenBSD and FreeBSD have better security reputations. Sorry Linux.*"[4] Authors 20-years long ICT experience prove that too.

OS X is UNIX certified computer operating system[5].

Regardless of software proprietary, practical "field tests" - millions of users every minute, hour and day- and achieved "test" results are one of the main points (or general point) to choose - can or cannot software be used for safety applications.

Are consumer targeted iOS4 based applications enough reliable for safety applications? Yes.

iOS4 equipped consumer equipment sales are rising every month and now (iPhone and iPad sales, first quarter 2011) they count 7,78 million per month[6]. Sales cannot and don't rise if product isn't reliable.

Mission-critical applications use OS X and Apple hardware platform - US Army has video surveillance based on the Mac OS X platform[7] as well as more than 1500 OS X Servers installed from 2004. OS X version OS X 10.7 "Lion" are designed that only one software will be use for both - desktop and server - applications. Such possibility significantly decrease overall system servicing downtime, increase service stuff availability as well as make more easy to keep spare computers it to the stock.

OS X "sister" iOS4 are specially adopted OS X for iPhone, iPod Touch and iPad mobile devices. These devices have installed GPS receiver, accelerometer, magnetic compass, WiFi data exchange and Safari internet browser as well as many (more 200 000) applications are available to install. We can find several navigation or position on the map applications. Or it is possible to design special application via iOS4 SDK (Software Development Kit).

All the mentioned above cannot be taken as advertisement - we are talking about safety and are interested to choose the best solution available - equipment and software.

References for par V - ICT today.

[1] www.microsoft.com
[2] www.mitre.org/work/tech_papers/tech_papers_01/kenwood_software/kenwood_software.pdf
[3] http://sourceforge.net/about
[4] http://mac-security.blogspot.com/2011/03/bbc-us-cyber-war-defences-very-thin.html
[5] http://www.opengroup.org/openbrand/certificates/1194p.pdf
[6] www.apple.com/pr/library/2011/04/20results.html
[7] www.securitysystemsnews.com/article/government-going-apple

Use of Non-intrusive Load Monitoring System in Autonomous Energy Systems

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INTRODUCTION

The problem of minimization of electrical energy consumption is very topical these days, due to rapidly rising cost of the electricity and in some cases also insufficiency of installed electrical power, which may cause the electrical energy crisis. The same relates to autonomous energy systems, which by definition should have minimized power consumption, for example, so called "island mode" of microgrid concept, when some community users are disconnected from utility grid and load is supplied from the local energy sources.

This could be solved by managing the load of the end user by means of modern communication equipment, which allows sending commands and controlling the load over the same power lines. For this reason each load should be equipped with data transferring module, and some microcontroller to realize the communication protocol with some master controller of the local grid. However, this implementation could be costly for the end user.

Another strategy to minimize the energy consumption is to analyze acquired consumption data during some period of time and make corrections in usage of load or replace them with more efficient ones. This solution could be realized in different ways. First, is to use various monitoring devices, each for one load. This is the most precise, but the bulkiest solution, because it requires stand alone monitoring device for each load and getting the information from each monitoring device (by means of some communication equipment or by removing storing device and manually downloading data) could be inadmissible because of additional costs or time investments. Another variant is to analyze the load pattern in non-intrusive way, by putting load monitoring device in central point of electricity distribution, which is more preferable due to minimal number of installed devices and easy data acquisition. This approach is called non-intrusive load monitoring (NILM). The process of energy consumption analysis becomes simple, if additional functions of load analyzer are realized, such as drawing diagrams of energy consumption, or generation of report showing total energy consumption of each appliance by the end of some period.

Currently proposed solutions [1-10] are aimed to load disaggregation in simple (analyzing step changes) or more difficult (analyzing also changes in frequency domain, multi-state loads and time periods of different loads) manner. However no one of them propose solution for households with connected local energy sources, such as small wind turbine, PV (photovoltaic) panels, local energy storage equipment etc, which also change the total consumption by decreasing it. In this article the case study on defined problem will be discussed.

I. UNDERSTANDING THE PROBLEM

The NILM technique allows disaggregating energy consumption by different appliances. However, this technique is faced with some problems in identification of some type of loads, like: constantly on load, variable in time load, multi-state load. Different approaches try to solve this problem by using special algorithms or analysis techniques.

Considering modern trends, many households are getting equipped with local electrical energy generators, mainly from renewable energy sources – wind and Solar energy. The inconstancy and unpredictability of such type of generators faces with the problem of it disaggregation, as it has influence on the total energy use. For this reason additional equipment or special analysis are proposed as a solution.

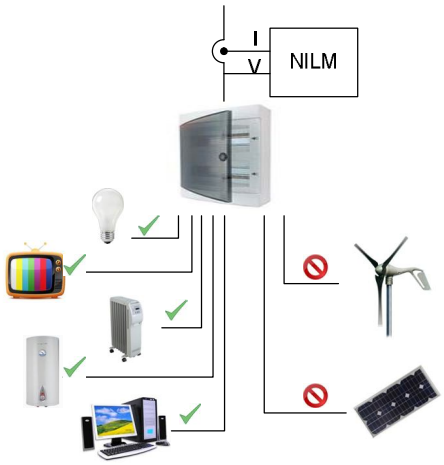

Fig. 1. Scheme of currently recognized household electrical appliances.

II. PROPOSED SOLUTIONS

This chapter describes the proposed solutions for defined problem in previous section.

A. Using additional meteorological sensors

First solution may be realized by installing additional sensors to monitor solar irradiation and wind speed. In this case NILM controller will be possible to correlate electrical energy consumption changes with provided data from sensor and disaggregate generated energy form variable in time loads. In this case special firmware improvements of NILM device should be done realizing this approach, as well as additional inputs are required.

This solution may not be the best one, due to imprecision of irradiance sensor or anemometer data comparing it with generated energy by the corresponding generator, because of some delays or nonlinearity of sensor's and generator's curves.

B. Installing additional current sensors

Another approach is based on assumption, that some electricity distribution boxes are localized, where all appliances are divided in groups and connected to different circuit breakers, as well as different generators may be connected through separate circuit breaker also.

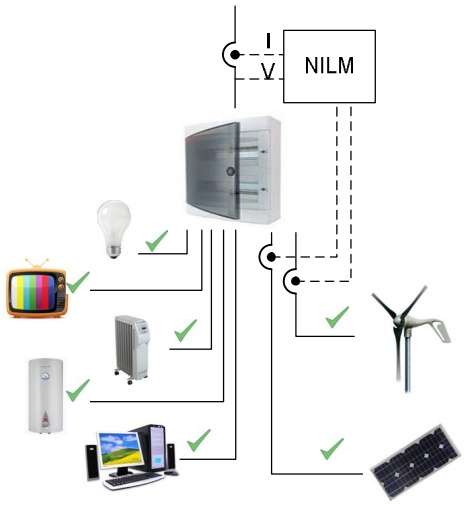

Fig. 3. Proposed solution with additional current sensors

In this case additional current sensors (see Fig.3.) may be useful for precise measurements of generated electrical energy that allows identifying variable loads more precisely.

From the technical point of view, this approach can be realized with additional smart energy meters connected to NILM device or with additional inputs for current sensors in case, if NILM device calculates energy consumption by itself.

Proposed solution has also advantage of disaggregation of identical loads connected to different circuit breakers. For example two bedrooms are electrically supplied from one switch board, but from different circuit breakers, and both has identical load appliances. In this case NILM device, which is located closely to switch board and has various inputs for current sensor, may properly identify the certain load in certain bedroom.

C. Analysis of spectral pattern change

This solution is based on the assumption, that power converter is always used, when connecting RES to the grid. Each switching converter has specific "spectral envelope" – special content of information about active and reactive power, as well as harmonic content of an appliance. By using this method, NILM device could identify the amount of generated energy by the RES, by analyzing total consumption and harmonic pattern change in time. If the harmonic pattern of power converter is known, then the amount of generated energy could be disaggregated from the variable in time load.

This solution requires significant computational resources, as it requires not only energy calculation and analysis, but also spectral analysis of the electrical energy consumption, thus making it most complicated

III. CONCLUSIONS

Despite a big number of publications about non-intrusive load monitoring, which describe different approaches of load identification, no one describes the problem of connected local generators, such as wind turbine or solar panels, and its power consumption disaggregation and identification approaches, as they may be mismatched with variable in time loads.

Present article describes three approaches of electrical energy consumption disaggregation from energy, generated from local renewable energy sources.

Proposed solutions have different advantages and disadvantages that are summarized in the table below (see Table I).

TABLE I
COMPARISON OF PROPOSED SOLUTIONS

Solution	Accuracya	Computational load	Additional hardware
Meteorological sensors	Low	Low	Yes
Current sensors	High	Low	Yes
Spectral analysis	Moderate	High	No

As it can be concluded, the second approach (with additional current sensors) may have been most attractive, due to most precise load disaggregation method. Nevertheless, last approach (with spectral analysis) requires no additional hardware for installation, however requires high computational potential, which may cause to change NILM device.

REFERENCES

G. W. Hart, "Nonintrusive appliance load monitoring", *Proc. IEEE Conf.*, 1992, pp. 1870–1891.

Z. Remscrim, J. Paris, S.B. Leeb, S.R.Shaw, S. Neuman, C. Schantz, S. Muller, S. Page, "FPGA-Based Spectral Envelope Preprocessor for Power Monitoring and Control", *Proc. Applied Power Electronics Conf. APEC*, Palm Springs, CA, USA, 2010, pp.2194-2201.

H.H.Chang, C.L. Lin, "A New Method for Load Identification of Nonintrusive Energy Management System in Smart Home", *Proc. of 7th International e-Business Engineering Conf. ICEBE*, 2010, pp.351-357.

D.Srinivasan, W.S.Ng, A.C.Liew, "Neural-network-based signature recognition for harmonic source identification", *IEEE Trans. Power Delivery*, Vol. 21, No. 1, 2006, pp. 398-405.

J.Liang, S.K.K. Ng, G. Kendall, J.W.M.Cheng, "Load Signature Study—Part I: Basic Concept, Structure, and Methodology" IEEETrans. Power Delivery, vol.25, Issue 2, 2010, pp. 551-560.

K. Yoshimoto, Y. Nakano, Y. Amano, B. Kermanshahi, "Non-Intrusive Appliances Load Monitoring System Using Neural Networks" *ACEEE Summer Study Proceedings Paper,* 2000, pp.7.183-7.194.

H.S.Matthews, L.Soibelman, M.Berges, E.Goldman, "Automatically Disaggregating the Total Electrical Load in Residential Buildings: a Profile of the Required Solution" Proc. Intelligent Computing in Engineering Conf. ICE08. Plymouth, UK, 2008, pp. 381-389.

A.Marchiori, D.Hakkarinen, Q. Han,L.Earle "Circuit-Level Load Monitoring for Household Energy Management", *IEEE Pervasive Computing*, vol. 10, no. 1, 2011, pp.40-48.

F.Kupzog. T.Zia, A.A. Zaidi, "Automatic electric load identification in self-configuring microgrids", Proc. AFRICON, 2009, pp.1-5.

D.C. Bergman, J.Dong, J.P. Juen, N. Tanaka, C.A. Gunter, A.K. Wright, " Distributed non-intrusive load monitoring" *Proc. Innovative Smart Grid Technologies Conf. ISGT*, 2011, pp.1-8.

Resonant DC/DC Converter for Fuel Cell Application

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Abstract- Detailed simulation study of the most appropriate resonant converter has been carried out to be used for 5kW proton exchange membrane (PEM) fuel cell. The proposed 5kW LLC resonant converter is designed for boosting from the low input voltage (25Vdc-48Vdc) to high output voltage (400Vdc), the predicted maximum efficiency is η>95%.

Introduction

The research of renewable energy resources, as well as the hydrogen energy has gained a growing interest in the recent years. The hydrogen fuel cells are fully ecological, taking into account that heat and water are the only by-products, which are excreted into the environment. In order to utilize the electrical energy which is produced by the fuel cells, characterized by slow dynamic response, low output voltage and large voltage variations, static power converters are researched widely throughout the world. [1]

The fuel cells used in domestic application, either as main power supply or backup source, need to be connected to the grid. Thereby, their low DC voltage has to be converted by means of a power converter into AC voltage in accordance with the grid voltage parameters. Such power converter systems usually consist of a DC-DC converter and a DC-AC converter. To reach a suitable DC voltage supply for the inverter, it is necessary to use a transformer or a boost DC/DC converter. When the required voltage amplification is large, the boost topology is not appropriate due to the lack of galvanic insulation between the input and output. In such cases DC/DC converters with high frequency transformer are preferred. In order to minimize the switching losses in high frequency DC/DC converters, different topologies of resonant converters have been investigated [2], [3] using the soft-switching power conversion techniques.

For the purpose to increase the overall efficiency of the system it was decided to use several converters in parallel. First advantage is to reduce the power handling of transformers versus the case of single converter. This will result in smaller size of the transformer. Secondly the conduction losses for the switches are drastically reduced, due to smaller current that flows through them.

Resonant DC/DC converter

For many years, it has been a world-wide trend to reduce the volume of the switching power supplies by increasing the switching frequency. However, the high frequency causes low efficiency because of high switching losses. Since the resonant converter has ZVS or ZCS function for reducing the switching losses, the resonant converter has been widely used in the power industry. Resonant DC/DC converters are constituted by an inverter followed by a rectifier and an output filter. Many structures may be employed to realize a resonant DC/DC converter; the two basic structures are characterized by a different position of the capacitor of the resonant circuit that can be placed in series (Series Load Resonant, SLR), or in parallel

(Parallel Load Resonant, PLR) to the load. Other structures, denoted as series parallel resonant converters, employ two capacitors (LCC) or two inductances (LLC). [2]

LLC converter displays many advantages over other resonant converter topologies; it can regulate the output over wide line and load variations with a relatively small variation of switching frequency, it can achieve zero voltage switching (ZVS) over the entire operating range, and all essential parasitic elements, including junction capacitances of all semi-conductor devices and the leakage inductance of the transformer, are utilized to achieve soft-switching [2].

LLC Resonant converter

The circuit diagram of a half-bridge LLC Resonant Converter is shown in Fig. 2. The behavior of the LLC conversion system is quite similar to that of the SLR as concern the three operation modes, but this circuit presents two different resonance frequencies. When diodes D3 or D4 are turned on, resonant circuit becomes composed by Lr and Cr , so resonance frequency is equal to f0:

$$f_0 = \frac{1}{2\pi\sqrt{L_r C_r}}. \qquad (1)$$

On the contrary, when both diodes are open, inductance Lm is in series to Lr ; therefore the resonance frequency becomes equal to f1 :

$$f_1 = \frac{1}{2\pi\sqrt{(L_r + L_m)C_r}}. \qquad (2)$$

Fig. 3 shows the DC gain characteristic g of the LLC resonant converter assuming a value of L_m equal to that of L_r . The DC gain characteristic g is defined as:

$$g = \frac{V_o}{V_{in}/2}. \qquad (3)$$

The characteristic factor Q is the ratio between the characteristic impedance and the load. (Fig. 2) - shows, for different values of characteristic factor, Q defined as:

$$Q = \frac{2\pi f_0 L_r}{R_o} \qquad (4)$$

A ratio k between the switching frequency and the resonance frequency is:

$$k = \frac{f_s}{f_0}. \qquad (5)$$

Comparing with SRC, the converter can achieve both Buck mode and Boost mode. When the switching frequency is higher than resonant frequency, voltage gain of LLC converter is always less than one, and it operates as an SRC converter and zero voltage switching (ZVS) can be achieved. When the switching frequency is lower than resonant frequency, for different load conditions, both ZVS and zero current switching (ZCS) could be achieved. At the boundary of ZVS and ZCS regions, converter voltage gain reaches its maximum value.

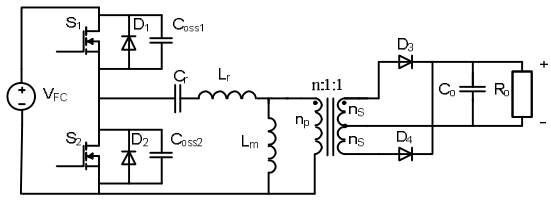

Fig. 1. LLC Resonant ConverterFig.

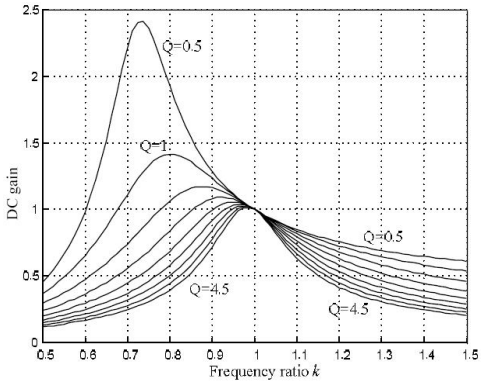

Fig. 2. DC gain characterictеristics of a LLC Resonant converter

As shown in Fig. 1, the primary switches S_1 and S_2 conduct alternately to generate a symmetrical square waveform with the magnitude of $V_{in}/2$. D_1 (D_2) and C_{OSS1} (C_{OSS2}) are the anti-paralleled diode and the equivalent output capacitor of S_1 (S_2). The resonant tank is formed by the resonant capacitor C_r, and the leakage inductor L_r and magnetizing inductor L_m of transformer. The center-tapped rectifier is constructed by connecting diodes D_3 and D_4 to the secondary windings of transformer.

Simulations

To describe the operation of the LLC resonant converter for fuel cell application, simulation results were obtained using PLECS simulation software (Fig. 3) shows a model of a 5 kW converter with 100 kHz switching frequency. Scopes are connected to measure resonant output voltage, driving pulses and load voltage. Waveforms are presented in the following order: gating signals; output of the inverter; resonant tank circuit output voltage; output of the rectifier and load voltage.

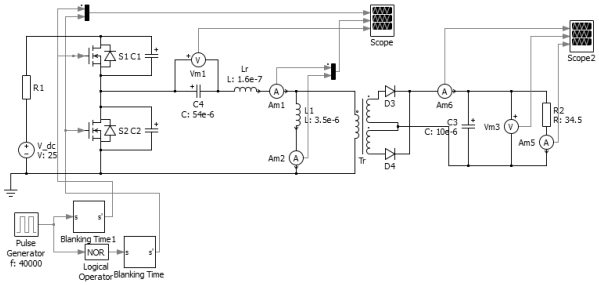

Fig. 3. LLC Converter schematics in PLECS environment

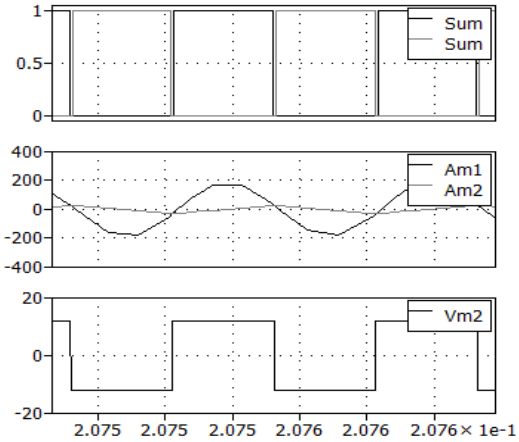

Fig. 4. Simulated waveforms of the LLC converter at full-load and 25Vdc input, from the top – S1, S2 control voltage, current through Lr and Lm, voltage of the transformer primely side resonant capacitor Cr

As it can be seen from the simulation, the converter operates as desired, providing 100 V output voltage at rated input and load conditions.

Experimental tests

Experimental testing of one LLC converter was carried out as well. The testing was performed using two 12V 50Ah car batteries in series as the input voltage source and connecting the LLC resonant converter to a resistive load. To calculate the efficiency of the converter, measurements of the input current, transformer's input voltage and load voltage and current were done.

The results of experimental testing are summarized in Table I. The step-up HF transformer used has a turn's ratio of 1:7.6. The transformer was built using two E-cores and has the leakage and magnetizing inductances given in the design example. The converter was tested at constant frequency at variation of the load. The operating waveforms of power transistors with fixed input voltage for various load conditions (from full load to about 5.1% load) are represented by Fig. 5. The maximum output power obtained from the converter was approximately 400 W (Fig. 10). Since the component values used were not exactly the same as the design values, the output voltage and the output power is smaller than the designed values.

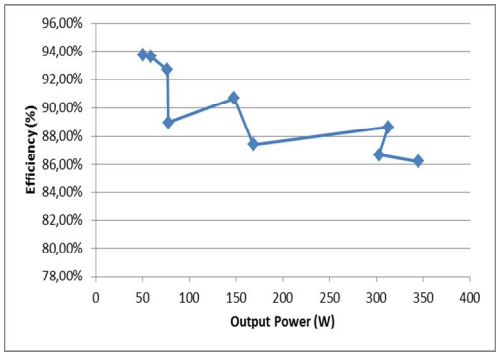

Fig. 5. Efficiency curve for the proposed converter at minimal input voltage

Table 1. The measured quantities

V_{out}	I_{out}	V_{in}	I_{in}	R_l
88,2	0,574	22,01	2,454	164
87,9	0,671	21,99	2,865	138
87,1	0,8802	21,94	3,77	102,5
86,7	1,705	21,97	7,42	49,5
72,5	2,323	18,26	10,55	29
71,4	4,38	20,5	17,21	17
59,5	5,09	17	20,55	12
35	9,854	15	26,06	6

Conclusions

In this paper, the design considerations for LLC resonant converter for fuel cell application are explored. The analyzed converter gives many advantages over other resonant converter topologies; it can control the output over wide line and load variations with a relatively small variation of switching frequency, it can achieve zero voltage switching over the entire operating range and all essential parasitic elements, including junction capacitances of all semi-conductor devices and the leakage inductance of the transformer, are utilized to achieve soft-switching.

The voltage gain characteristics were analyzed based on the theoretical analysis and computer simulation, which has confirmed the conducted analysis. Every switching component is operated in the soft switching condition of ZVS state for primary MOSFET switches and ZCS state for secondary diodes.

References

8. Lazar J. F., Martinelli R., Steady-State Analysis of the LLC Series Resonant Converter // IEEE APEC'01. – 2001. - vol. 2. - P. 728-735.
9. Hsieh G. Design Considerations for LLC Series-Resonant converter in two-resonant regions // PESC. – 2007. - P. 731-736.
10. Lu B., Liu W., Liang Y., Fred C., Jacobus D., Wyk V. Optimal design methology for LLC Resonant Converter // APEC 2006. - P. 533-538.
11. Bellini A., Bifaretti S., Iacovone V. Resonant DC-DC converters for photovoltaic energy generation systems // SPEEDAM 2008. - P. 815-820.
12. Jovanovic M. Princeple of Resonant Power Conversion // house seminar. - Toulouse 2004.
13. Steigerwald R., Roshen W., Saj C., A High-Density 1 kW Resonant Power Converter with Transient Boost Function // IEEE Trans. On Power Electronics. - Vol. 8. No. 4. – October 1993. - P. 431-438.

Optimization of control systems of AC drives with frequency convereters

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Abstract

Analysing the well-known investigations in the field of vector control of induction motors it can be concluded that practically all types of the control methods existed as a result of improvement or optimization of previous methods. Therefore it seems possible to create a joint optimization system of these control methods that could allow selection of an optimal approach for each separate application as well as give an opportunity for further optimization of each approach. The classification of the field-oriented control methods is studied, main parameters according to which the optimization could be realised are considered, analysed and classified. On this basis an idea of criteria system is proposed with the aim to analyse it in details according to each control method, compare them and systematize the information.

One of the significant advantages of vector control in the area of the system optimization, is a possibility to construct a cascade control system for the induction motor regulation.

Introduction

Due to wide application of induction motors (IM) in different technological processes and installations the problems of control and regulation of IM are of high importance and in details investigated from the theoretical as well as practical point of view. The devices requiring the most accurate and fast response operation widely and successfully are equipped with so-called field-oriented control that provides IM control similar to that of DC motor significantly simplifying the essence of IM control as well as provides the most accurate control of transient processes as in comparison with scalar approaches (U/f=const) the field-oriented control operates with the instant values of current, voltage, etc. [11].

With the widening of field-oriented control application increases also a necessity in more theoretical investigations of these processes that in its turn caused a full set of changes and approaches for improvement and optimization of parameters as well as an investigation and solving of mathematical description of the control method for its better realizing. It resulted in the division of IM control method into several methodologies similar in basic principles but different in its realization approaches and therefore in the result and effect. [7,8]

Evaluating the level of complexity of the field-oriented control system and its mathematical apparatus one can conclude that the system of optimization criteria and parameters is branched and complicated enough. It seems rational to consider a general optimization criteria components of vector control approach providing an opportunity to take into account simultaneously all the mentioned above technical economic indices as well as the level of complexity of control realization (i.e. method) and purpose of control (i.e. field of application).

1. GENERAL OVERVIEW OF THE METHODS.

Scientists [11] propose full available at the moment classification of field-oriented control. It is demonstrated in fig.1.

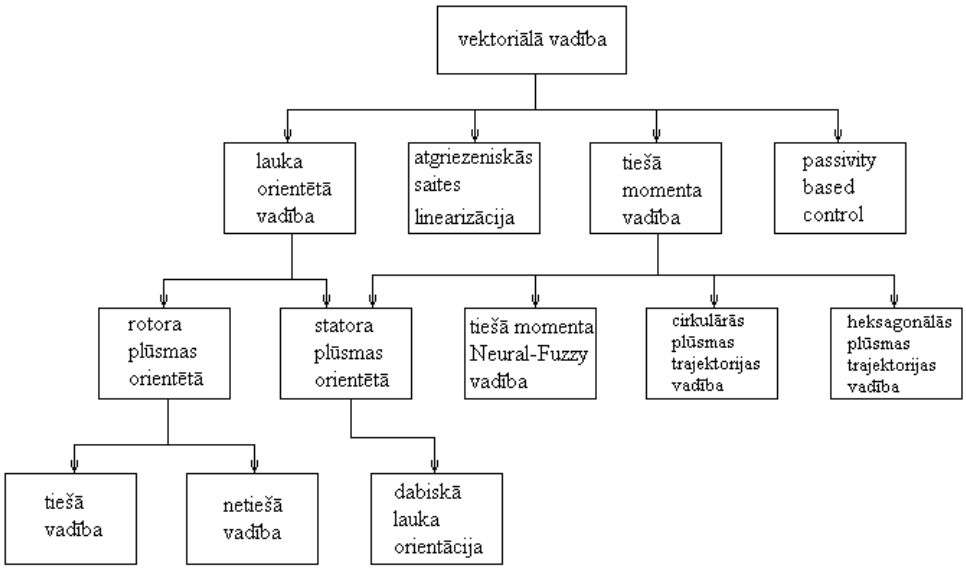

Fig.1. Classification of vector control methods

2. PARAMETERS OF THE METHOD EVALUATION

One of the instruments by means of which the control systems can be evaluated and investigated is the block scheme and equations system describing the system. In addition the defining of such criteria can be mentioned like speed, torque, current and flux regulators parameters and tuning of the system according to the classical optimization criteria.

A user should have an opportunity to estimate such parameter like the expenses of the system to make the most suitable decision. The technical-economic indicators can not be considered separately from the really produced industrial converters applying the field-oriented control [12].

The upper limit of the frequency regulation range is an important factor applying the motors with high rated frequency 200 ... 1000 Hz Usually these are the instruments with a very high speed - mills, centrifuges, etc. It should be assured that the converter can provide an appropriate frequency. The number of the control inputs can be also considered as a evaluative criterion. The discrete inputs are necessary for different commands (start, stop, fix speed, reverse, emergency braking, change place of operation - usually can be programmed), Analogue - inputs for the pre-set tasks. The digital inputs are necessary for supplying the high frequency signals from the decoders (digital sensor of speed and placing. The large amount of inputs is necessary if it is planned to realise a complex control system with several control signals.

The number of output signals is used by the digital outputs in the complex system realization (e.g. pump stations) and output signals - for realization of different regimes and analogue - for displaying supply equipment and production of control system.

The type of control with which the motor is controlled in the operation regime. It can be controlled through an embedded output or remote or computer control (form the personal data processor or computer). A combined or switched over control is often available. As it is seen these parameters mostly refer particular converters.

The frequency converters with pulse-width modulation most of all applied in field-oriented control contain also a DC-link.

The structure of methods parameters evaluation is given in fig.2.

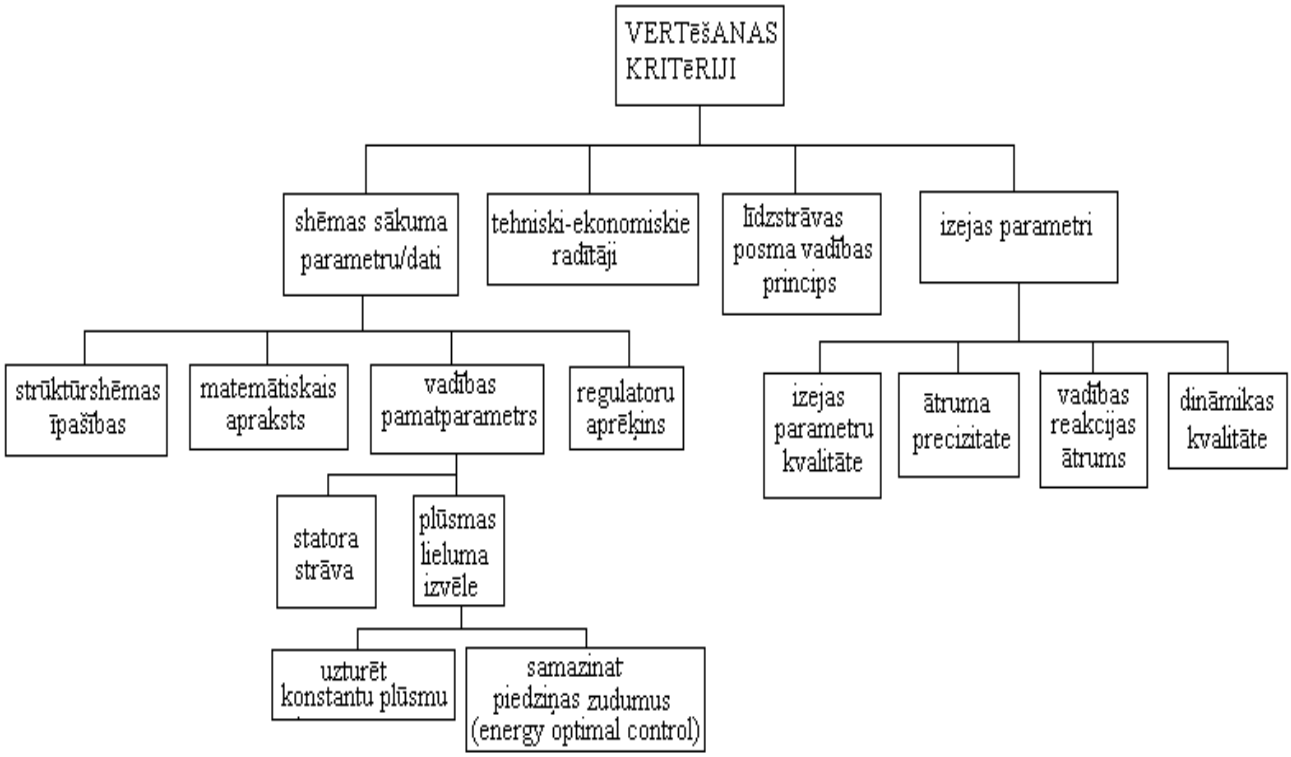

Fig.2. The structure of methods parameters evaluation

3. Cascade control of IM realised possible applying field-oriented control

The investigations of cascade control in the scheme of field-oriented control have been started to investigate. A program calculating the parameters of IM substitution scheme according to the rated parameters of the motor and therefore the parameters of cascade scheme regulators according to the selected optimization criterion is being created as well as all the steps are tested by means of MatLab/Simulink software environment (fig.30. [14, 15]

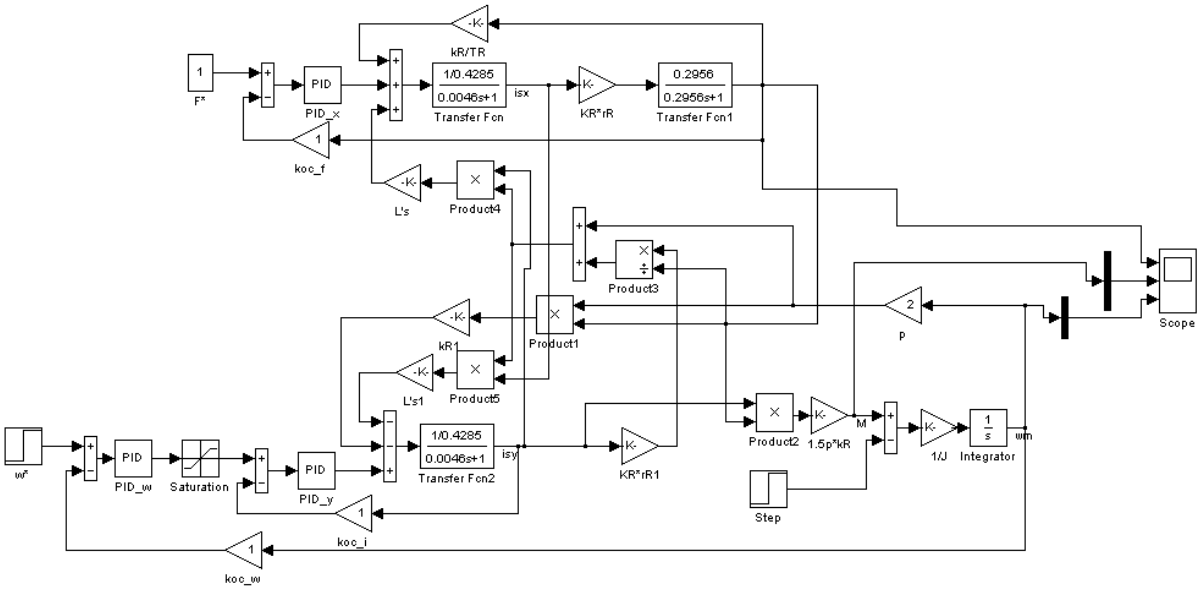

Fig.3. Block scheme of cascade control of IM realised possible applying field-oriented control

REFERENCES

[1] Bose B.K., Modern Power Electronics and AC Drives, Prentice Hall, 2002

[2] D. W. Novotny and T. A. Lipo. Vector Control and Dynamics of AC D rives, Oxford University Press,1997.

[3] M. B. B. Sharifian, E Babaei and A.Eslami, Comparison of two tarque control methods for induction motors, Faculty of Electrical and Computer Engineering, Tabriz University, Tabriz.

[4] A.D. Karlis, K. Kiriakopoulos, D.P. Papadopoulos and E.L. Bibeau, Comparison of the Field Oriented and Direct Torque Control Methods for Induction Motors used in Electric Vehicles, Laboratory of Electrical Machines, Department of Electrical and Computer Engineering, Democritus University of Thrace.

[5] W. Leonhard, Control of Electrical Drivers. Springer, Berlin, Heidelberg, NewYork, 2001.

[6] Peter Vas, "Sensorless Vector and Direct Torque
Control," Oxford University Press, 1998.

[7] Takahashi I., Noguchi T. A New Quick Response and High Efficiency Control Strategy of an Induction Motor. IEEE-Trans. Ind.Appl. 1986, p.820.

[8] Depenbrock M. Direct Self Control (DSC) of Inverter-Fed Induction Machine. IEEE Trans. Power Electr. 1988, p.420.

[9] D.Casadei, F.Profumo, G.Serra, A.Tani. FOC and DTC: Two Viable Schemes for Induction Motors Torque Control. IEEE Trans. Power Electr. 2002, p.779.

[10] Naceri Farid, Belkacem Sebti, Kercha Mebarka, Benmokrane Tayeb
Performance Analysis of Field-Oriented Control and Direct Torque Control for Sensorless Induction Motor Drives. Pr. 15th Mediterranean Conference on Control & Automation, Athens – Greece, July 27-29, 2007.

[11] Marian P.Kazmierkovski, R.Krishnan, Frede Blaabjerg. Control in power Electronics, selected problems. – Academis Press, 2002. 518pp.

[12]http://www.directindustry.com/industrial-manufacturer/frequency-converter-62118.html

[13] N.Hur, J.Jung, K.Nam. A Fast Dynamic DC-Link Power-Balancing Scheme for a PWM Converter-Inverter System. IEEE Trans. Power Electr. 2001, p.794.

[14] Герман-Галкин С. Г. - Matlab & Simulink Проектирование мехатронных систем на ПК.-2008 г

[15] С. Г. Герман-Галкин, Г. А. Кардонов – Электрические машины. – Санкт Петербург.-2003 г.

Keeping public transport system in sustainable and safe position

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Abstract- Public transport system control as a large system control for system sustainability is offered. Public transport system sustainable development was defined and formalized. Passenger traffic monitoring system solution is developed and offered during the research for public transport system sustainability. The possibility to use Lidar technologies in transport systems is discussed; it is offered to use them for braking control for safety system development to reduce human factor effect in transport system. There are some experiments made; and results are offered and discussed. Developing three-level public transport control tool for public transport system control, the authors suggest, that this system solution can improve all the public transport system performance in Riga city, taking in account ecological problems, priorities of passengers and also economical effect. Integrated tools discovered, such as communication system solution for public transport network, alarming system solution and safety system solution will work together, as good as technologies and algorithms offered will be used for making public transport system safer and better. Public transport system sustainability monitoring tool is developed and offered by author and computer-based model is developed. Offered system solution is open for further researches in the whole and in each component in particular.

According to automatic control, transport system functional scheme can be shown as in figure 1.

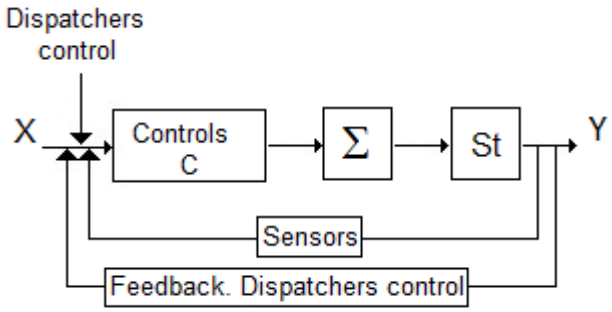

Fig.1. Transport system functional scheme

Public transport system sustainable development is formalized as:

$$PTSSD(\Delta T) = <E1, Qs, E2, G>(\Delta T) \quad (1)$$

Where:

PTSSD(ΔT) - public transport system sustainable development in time period *(ΔT)*;

E1 – Environmental sustainability;

Qs – Quality of service for passengers, including safety, security and comfort level.

E2 – Economical sustainability aspects of transportation;

G – Influence of Governance;

(ΔT) – Time period.

In world practice, there is no general analytical solution of nonlinear systems found, so it is possible to use the method of intervals, as the unit of measurement for each parameter using a subjective evaluation - the levels.

For example, evaluation scale can be defined as 5 levels scale. For each criteria of the system let's describe such levels system:

1-the best condition;

2-good condition;

3-normal condition;

4-bad, but still suitable condition, situation would be improved;

5-extremely bad condition; situation would be improved immediately.

For each condition it is possible to attach the color for better visual system monitoring, for example, in this sequence: (1=white; 2=blue; 3=green; 4=yellow; 5=red).

Using this scaling it is possible to monitor the system also visually:

E1				PO_{10}	CO_2			.....	.....
Qs				Time			Schedule	.....	.....
E2			Price					.....	.....
G						Restrictions		.....	.....

Fig. 2. PTSSD visual monitoring concept

Use of modern technologies of monitoring and the transport control integrated in intelligent transport system have received wide popularity all over the world. Such systems are the means of considerable reduction of non-productive expenses for transport and increases of an overall performance of transport system as a whole. The first step in Riga city is bus control system ASOS [1]. Systems of satellite monitoring of motor transport now are widely used in the transport, however the strategic development in city and implementation in tree levels of control is not just engineering issue, it is also an issue for decision makers. In the article the usage of such system for passenger's transportation is discussed.

The necessity of developing of the centralized system of wireless dispatching management of city passenger transport in Riga is obvious. The centralized management of city passenger transport presumes to use more effectively transport resources and to provide higher level of service for passengers. It will be promoted also by integration of railway transportation into system of passenger transport of the city of Riga, with including into the general control system.

Analyzing world experience in designing and use of control systems of city passenger transport, it is possible to assume that introduction of similar system in the city of Riga will

have a positive effect [5]. Considering experience of other countries, it is possible also to assume approximately-necessary functionality of system.

It is offered to create Riga city passenger transport three-level centralised control system solution.

At first level – vehicle equipment and processes control.

At the second level the control of each type of transport separately (something similar now well only for the Riga buses) will be carried out (ASOS system).

The third level will allow supervision system as a whole. It will allow to plan more competently work of transport system using corresponding methods of the theory of management, more effectively to transport passengers.

Thereby the system of passenger transport will work more in coordination, in the best way carrying out the main function - timely delivery of passengers in the place of a city necessary to them.

According to the control theory and system theory fundamentals, it is offered scheme to global control of public transport system.

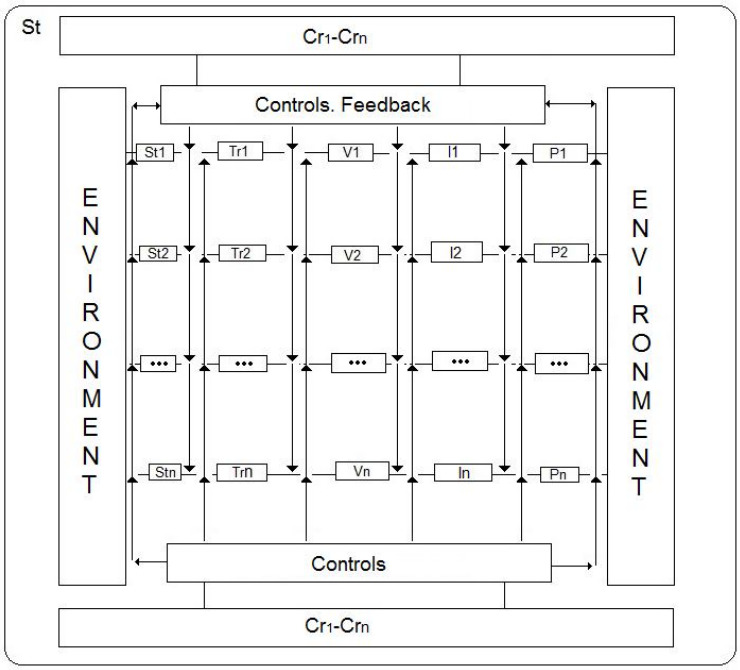

Fig. 3. Transport control system solution structure. Third (global) control level

Where:

St – transport system; $\{St_1\text{-}St_n\} \in St$ – subsystems in whole transport system; $\{Tr_1\text{-}Tr_n\}$ – kinds of public transport; $\{V_1\text{-}V_n\}$ – vehicles of public transport; $\{I_1\text{-}I_n\}$ – infrastructure objects in public transport system; $\{P_1\text{-}P_n\}$ – passengers; $\{Cr_1\text{-}Cr_n\}$ – public transport system sustainable development criteria list: (environmental sustainability; passenger safety and comfort level (quality of service); economical/technical aspects; influence of governance).

The authors also have developed a computer-based model for public transport system sustainability monitoring.

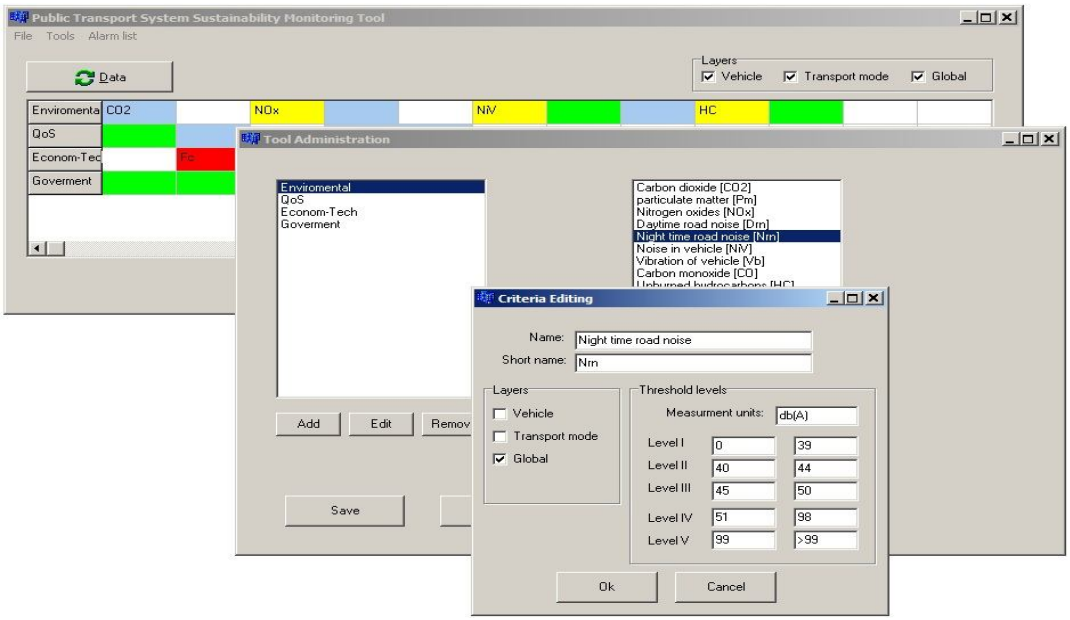

Fig.4. Administration tool for public transport system systainability monitoring – criteria editing

The main idea of this model is, that pressing the button "Data" – all the criteria values are generated and uploaded into the system. Values for each criterion are generated randomly. After that, input values are evaluated, using 5 level scale (described in first part of thesis) for each criteria. So it is possible to receive visual results and visually monitor the system sustainability. It is possible to use checkboxes for viewing criteria only for vehicle level, only for transport mode level, only for global level, or in combination for different levels. If the criteria value is on alarm border or can damage system sustainability, then this criterion is shown in yellow or red colors and short name of this criterion is also shown. In this case it is possible to "click" the criteria short name and see full name of criteria, current value and possible comment, as good as all the system levels where this criteria is shown. This tool gives the possibility to edit groups of criteria, as good as add and edit criteria for each group. It is also possible to edit values which could be used for criteria evaluation (see figure 4).

RESULTS

The main result of current researsh is a three-level system solution and monitoring tool development that provides public transport system sustainable development. This is reached by formalizing the concept of public transport system sustainable development taking into account ecological problems, priorities of passengers and also economical effect, therefore, developed monitoring tool give the possibility to monitor all the sustainability criteria level to keep the system in sustainable and safe position. Developed by author monitoring tool show also all the criteria which are in critical level and can threat the system sustainability, so it is possible to react maximally fast to keep the system in sustainable position by normalizing the level of critical criteria. Other hand, increase the level of security is achieved through the use of video-cameras in vehicles, as well as outside the vehicles, emergency alerts are also sent to the system's monitoring tool, providing a response to the alarm causes and consequences. The possibility to use LIDAR [2], [3], [4] technology in vehicles to provide higher level of safety in cases of emergency braking has been tested and proven experimentally. The results are

positive and allow to conclude that these technologies allows to avoid the crashes, which are dependent on the "human factor", in emergency braking cases, thereby also increasing the level of public transport system safety.

REFERENCES

1. A.Patlins, N.Kunicina. “Integrated Control Tools Development for Sustainable City Transport System”. 10th International Conference October 20-23, 2010, Katowice-Ustroń, Poland.
2. Patlins A., Kuņicina N., Žiravecka A., Šukajeva S. “LIDAR Sensing Technology Using in Transport Systems for Tram Motion Control”. // ELEKTRONIKA IR ELEKTROTECHNIKA. - No. 5(101). Technologija, Kaunas 2010, Lithuania pp 13.-16. ISSN 1392-1215.
3. Kyron Abraham Jr. , Steven Comer. Artificial Vision: Detection Technology of the Autonomous Car. University of Pittsburgh, Swanson School of Engineering, Eleventh Annual Freshman Conference.
4. Kovalev, V. (2004). Elastic Lidar: Theory, Practices, and Analysis Methods. Hoboken, New Jersey: John Wiley & Sons inc.
5. Patlins A., Kunicina N., Ribickis L. Worlds Innovative Concepts in the Field of Public Transportation Usage for Riga City Public Transport System Sustainability // Mechanics, Transport, Communications. - Iss.3, Part 2. (2011) V-58.-V-64. pages.

The electromagnetic compatibility of the railway automatic devices with back - draft network on the electrified sections of the railway

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The track circuits are the main elements in the system of interval regulation of the trains` traffic. The information about free sections of the railway lines and about the integrity of the railway`s track wires provides the interval regulation of trains` traffic. By track wires of track circuits, which at the same time is the floor channel of the automatic locomotive alarm, the information about traffic lights forward, is given to the locomotive.

The east - west transit corridor is actively used for the cargo transport. This section is equipped by the system of tonal track circuits of the third generation. In order to reduce costs for the cargo transport it is planned to electrify the section by the alternating current.

The main feature of the railway automatic devices system is the use of railway lines, where the back - draft currents flow, as the lines for transmission the automatic locomotive alarm in the code combinations to the locomotive, as well as for the control of free railway line.

The electromagnetic compatibility of these devices is provided, using the frequencies, which differ from the harmonics of the traction current. However, modern electric locomotives are a powerful source of the interference in a wide range of frequencies. The applied high-voltage filters not always may provide the reduction of the interference level.

The increased traction current of the asymmetry in the elements of track circuits and the automatic locomotive alarm leads to the generation of direct currents, which could worsen the quality of the functioning of these elements, causing the disruptions in their operation and the overlapping of automatic lock signals in front of moving train. As a result the safety of train's traffic is worse; the costs increased due to additional stoppages and delays of the train[1].

The complexity to solve the problem of interfering effects of currents is determined by the variety and the difficulty of identifying the causes of malfunctions and failures in the operation of track circuits and the automatic locomotive alarm devices. These difficulties are related to the complexity of the physical processes of traction currents` distribution along the metal parts of electric locomotive, as well as on back-draft of the railway network.

The main source of the interferences on the electrified sections of the AC current is the traction power frequency and its harmonics. For the operation of track circuit the receiver and the radio transmitter are used.

Depending on the type of track circuit, the different code combinations and forms of the electrical signal are used. For example, in tone track circuits of the third generation the amplitude-modulated signal is used, as well as the alternation of the different carrier frequencies (420,480,580,720,780 Hz) and the frequency modulations (8,12 Hz).

The intervals of code combinations may be filled by pulse or harmonic interferences. The impulse interferences usually are the result of abrupt changes in the traction current in the rails and the locomotive, as well as the result of the magnetization of the rails. The main source of the impulse interferences is the electric draft of the locomotive equipment.

The power lines also impact on the track circuits, creating the additional inductance. The impulse interferences appeared at random moments and may to misrepresent the duration of the intervals. As a result, in the cabin of the machinist, on the locomotive traffic light, the signal, which prohibits the traffic, appeared.

One of the reasons of inferences` appearing in the apparatus of the railway automatic devices is the asymmetry of the traction current. The level of the mentioned inferences is

proportional to the value of the traction currents difference in the railway whips. In accordance with the current standards, the relative value of the traction currents difference has to be not more than 4%, when the value of the inverse AC traction current is equal to 300 A.

The absolute value of the traction currents difference has not to exceed 15 A [2,3,4]. The difference between the traction currents in the track wires is directly proportional to the value of the longitudinal asymmetry and transversal asymmetry of the electric resistance of the railway line and the value of the traction current [5].

The longitudinal asymmetry appeared, if the resistances of track wires are not equal, when the sum of the resistances of joint connections within the track circuits, which are limited by isolating joints, are not the same.

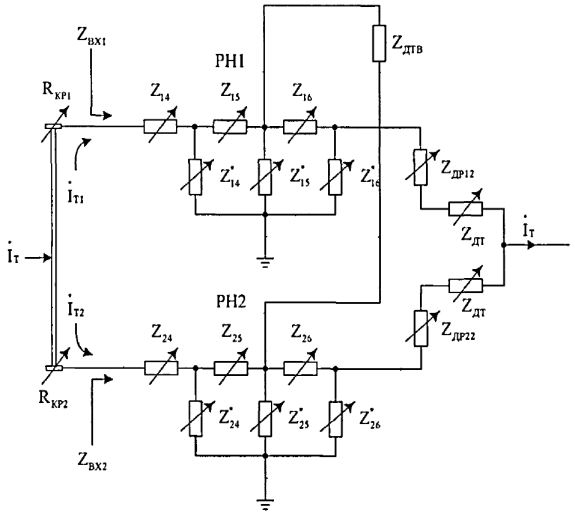
The transversal asymmetry appeared, if railway wires have the different resistance to the ground. The transversal asymmetry always presents in places, where the railway wires are connected to the grounding circuits of the contact network [6].

The analysis of the literature and new publications shows that there are many unsolved problems related to the railway sections, which are electrified with the alternating current, including the effect of reversal traction current to the nonlinear elements of track circuits equipment and the automatic locomotive alarm equipment, as well as the influence of current harmonics on the stability of the locomotive receivers in automatic locomotive alarm.

The purpose of the modeling is to research the changes of the asymmetry coefficient of AC traction current under the coils of the automatic locomotive alarm, when the train moves on various railway track circuits. To implement such tests experimentally during operation is quite difficult; therefore, we propose to use software simulation in Matlab environment, as well as to check the values in the Electronics Workbench.

The input resistances of railway wires are the main parameters of the distribution of the traction current under the coils of the automatic locomotive alarm. During this simulation the scheme of the back-draft railway network replacing was used within the non-regular lines [4], which were supplemented by the leveling choke-transformers. This model is characterized by the following sections:

- for the stages of non-joint track circuits, when grounding of the traction substation is connected to the midpoint of the Drossel - Transformer, which is established on the border of stage to the station;
- for the stages of track circuits of automatic lock code and for track circuits of the station, when grounding of the traction substation is connected to the midpoint of the Drossel - Transformer, which is established on the output - point of the track circuit.



In such sections the reversal traction currents in the rails have a maximal values [7]. The intensity of automatic locomotive alarm failures and track circuits malfunctions in such sections are the highest.

For example, the input resistance of the track wires PH1 can be calculated by the formula [1,2]:

$$Z_{BX1} = Z'_{14} + \frac{1}{\frac{1}{Z^{\bullet}_{14}} + \frac{1}{Z'_{15} + \frac{1}{\frac{1}{Z^{\bullet}_{15}} + \frac{1}{Z'_{16} + \frac{1}{Z^{\bullet}_{16}} + \frac{1}{Z_{ДР12} + Z_{ДТ}}}}}}\ [1];$$

$$Z_{BX2} = Z'_{24} + \frac{1}{\frac{1}{Z^{\bullet}_{24}} + \frac{1}{Z'_{25} + \frac{1}{\frac{1}{Z^{\bullet}_{25}} + \frac{1}{Z'_{26} + \frac{1}{Z^{\bullet}_{26}} + \frac{1}{Z_{ДР22} + Z_{ДТ}}}}}}\ [2];$$

To know the values of the input resistance of the track wires of various lengths, we can calculate the distribution of back-draft traction current under the coils of the automatic locomotive alarm by the formulas[3,4]:

$$I_{T1} = I_T \times \frac{Z_{BX2}}{Z_{BX1} + Z_{BX2}}\ [3];$$

$$I_{T2} = I_T \times \frac{Z_{BX1}}{Z_{BX1} + Z_{BX2}}\ [4];$$

References

1. Штолл К., Бечка Й., Надворник Б. Влияние тягового подвижного состава на устройства СЦБ и связи. - М.: Транспорт,1989.-199 с.
2. Леонов А.А. Техническое обслуживание автоматической локомотивной сигнализации. - М.: Транспорт, 1982. - 255 с.
3. Сороко В.И., Милюков В.А. Аппаратура железнодорожной автоматики и телемеханики. Справочник:. - М.: НПФ “ПЛАНЕТА”, 2000. - 960 с.
4. Шаманов В.И. Помехи и помехоустойчивость автоматической локомотивной сигнализации. - Иркутск: ИрГУПС, 2005. - 236 с.
5. Котельников А.В., Наумов А.В. Особенности работы дроссельтрансформаторов в условиях обращения тяжеловесных поездов. Автоматика,телемеханика и связь. 2008.N 11. - С. 8-12.
6. Котельников А.В., Наумов А.В., Слободянюк А.П. Рельсовые цепи в условиях влияния заземляющих устройств. - М.: Транспорт, 1990. - 215 с.
7. Брылеев А.М., Поупе О., Дмитриев В.С. и др..Автоматическая локомотивная сигнализация и авторегулировка - М.: Транспорт, 1981. - 320 с.