Fundamental Precision Dependencies of a CNC Laser Cutter

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***Abstract* − The paper is about a medium size and cost effective carbon dioxide (CO_2) gas discharge computer numeric control (henceforth, CNC) laser cutting and engraving machine. The main attention is given to the improvement of processing quality with plane based laser beam positioning using a linear mirror delivery system. The summary of these dependencies have been gathered and observed from a self-built CNC laser machine prototype. The laser beam is a fraction of a millimeter in diameter and the errors of the machine are transferred to the cut of the material. To improve cut quality, the frame of the construction as well as the positioning element dynamics should be analyzed. The frame of the machine must withstand the forces from the movement of the laser head; therefore it is necessary to determine the impact of these forces on the frame. A finite element method analysis was made with *Solidworks*. Insight in ways to increase the structural stability was made and with minimum costs an optimal solution was found. It was shown that the quality of the positioning depends on the belt drive and the stepper motor. Whereas the stiffness of the belt and the full revolution step count of stepper motor (or step resolution) and torque play a substantial role. The gathered information of the quality affecting factors is suitable for engineers that are involved in the building process of CNC laser cutter device or as a guide to troubleshoot errors on a working machine.**

***Keywords* − Belt drive, CNC laser, natural frequency, positioning, prototype, Solidworks, stepper motor.**

I. Introduction

Cutting by means of a concentrated laser beam proves to be very efficient and gives precise results if done properly. Such technologies allow cutting materials without any physical contact, and to process with high speed without the need to fix the stock rigidly to the cutting plane of the machine. The most common type of laser is the CO_2 laser; its simple design allowed it to grow in popularity. This also has led to a price drop of the CO_2 laser source by the last decade, enabling anyone who desires to buy his own laser source to spend just around 170 EUR for it. For cutting purposes a user must take in mind that a CO_2 laser can only be used efficiently for cutting organic materials due to the fact that the wavelength of the lasers is in the region that is absorbed only by such materials. Other materials such as metals can also be cut, but require additional equipment − a high power laser and high pressure gas assist and various safety features [1].

If for some reason one would want to build a fully functional CNC laser cutting device for personal use, for experimental purposes or for making a laser cutter for specific purposes in a manufacturing chain, it can be done, but only advised when other options are not available. A qualified engineer for this job has to have a great sense of responsibility and must foresee various possible scenarios in which the machine could malfunction, and provide safety for the operator of the machine.

This paper summarizes the main components of a CNC laser cutter and explains their impact on the accuracy and precision of the cutting process. This has been done by analyzing a prototype of a CNC laser cutter which has been fully constructed by the author. Other methods include CAD FEM simulations using *Solidworks* in which the machine has been designed. The insight helps to understand the main aspects that determine quality of a machined cut of an efficient and low cost laser cutting device. This also helps to understand what further research is needed to construct a more advanced low-cost machine.

II. Design and Structure of the CO_2 Laser Cutter

In this case the laser cutter is built so that it could process sheet materials (acrylic sheets, plywood sheets, fabric, etc.) with the work surface approximately 900 mm wide and 400 mm long. The construction is built using aluminum extrusions that can be fixed with brackets and nuts that slide along the profile in a special groove. A CAD rendering of the frame is shown in Fig. 1 along with a transparent lid and steel enclosures using fast connect connectors that don't require fasteners are used to create an enclosed box that absorbs any refracted laser beams. The fast connectors from the German manufacturer *Dirak* allow easy access to internal components in the case when calibration is needed.

Fig. 1. CAD rendering of the built CNC laser cutter.

The positioning of the beam is done using mirrors; these are aligned on one plane, and each of them refracts the beam in a

90° angle. Each individual mirror has three screws holding the mirror in place. By manipulating with these screws the mirror can be precisely calibrated by changing its angle. The current machine uses three mirrors; one is located at the back of the device, refracting the beam from the laser source. The second mirror is moving along the incoming refracted beam from the first mirror, and is the *Y* direction of the positioning system. The final mirror is refracting the beam 90° down towards a focusing lens; this mirror is movable along the refracted beam from the previous mirror, and is the *X* axis. A diagram of the laser beam is shown in Fig. 2. When moving the lens up or down, it changes the focusing point on the base of the machine; it is set according the height of the stock material.

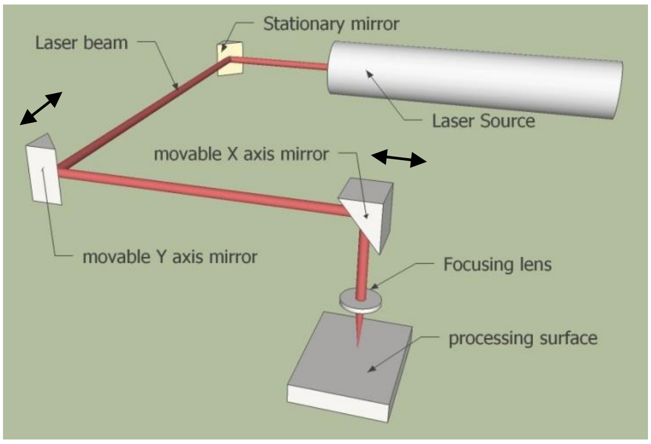

Fig. 2. Laser beam positioning system.

The mechanical drive of the gantries consists of stepper motors and a belt that drives the axis on their corresponding rails. In total there are three motors with belts, where the belt pulley is directly mounted on the stepper motor shaft.

III. Laser Beam Misalignment Caused by Deformation of the Frame

The laser beam from a CO_2 laser in ideal conditions is 10.6 μm in diameter when focused, same as its wavelength. Any slight movement or error in the frame can cause the beam to drift off the center point of the focusing lens. Therefore any error is transferred to the cut of the material, leading to a poor quality finish of the end product [1].

To understand how the movement of the frame can cause the beam to misalign, a detailed view of the positioning is show in Fig. 3.

Fig. 3. Laser beam positioning system.

The first mirror that is stationary must be fixed rigidly to the frame. If the construction of the fixture is inadequate, upon more rapid movements vibrations can occur and this can have tremendous effects on the quality of the cut, because the mirror that is the first in a chain can cause the rest of the alignment to go out of synchronism.

In Fig. 3 the longitudinal aluminum profile with a linear rail, serves as the *X* axis (Fig. 2, movable *X* axis mirror). The *X* axis is fixed on rails at each end of the long profile and controls the movement in the *Y* axis direction (Fig. 2, movable *Y* axis mirror). The second mirror (*Y* axis mirror) is in line with the third mirror (*X* axis mirror) and they move together in the *Y* direction, therefore providing one dimension of the laser movement. The *X* axis mirror moves along the long rail providing the second dimension of movement. The final mirror refracts the beam downwards onto a lens that focuses the beam. The lens is fixed in a movable tube that can be moved up or down to focus the beam on a desired height.

An aligned laser beam should hit the mirrors directly in the center in any position on the table; this ensures that the beam hits the lens in the center. Therefore great care should be made when fixing the *Y* axis profiles to the frame, so that it is parallel and on equal height. If one end of one rail is on a slightly lower or higher level than the other rail, the laser beam drifts off the center of mirror when moving along the corresponding axis.

To determine the overall stability of the aluminum profile frame, a simulation of natural frequencies of the frame was made to graphically show the deformation direction of corresponding modes, where the frame will be more likely to move. In Fig. 4 the simulation model is shown in the first natural frequency mode. To gather precise data and to save time that would otherwise be required to run a complicated simulation with large number of components, only the base frame and parts that directly fix to it are used. The load of the steel enclosures is transferred to the frame. To illustrate more clearly, the simulations of an unstiffened frame where additional profile struts on a 45° angle just under the bottom plate (as shown in Fig. 1) are removed to show the impact on the trajectory of the laser beam [2].

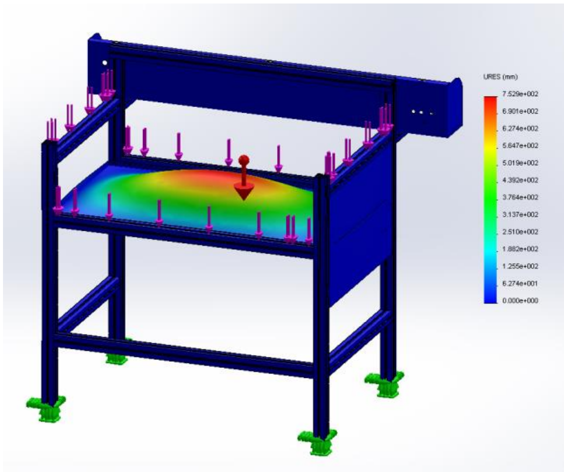

Fig. 4. First natural frequency mode.

The simulation in *Solidworks* was performed using a mixed mesh, and it is curvature based with element sizes between 13.2 mm and 66.07 mm.

The first mode shown in Fig. 4 affects the base plate of the machine at 20 Hz, the large unstiffened plate moves vertically, this does not impact the positioning of the laser severely. Although, if the system is kept at this frequency, it can cause vibrations to move to the other parts of the frame and to the belt drive, causing noise in the cut pattern.

In Fig. 5 the second mode just at a slightly bigger frequency – 21.4 Hz affects the frame axially along the longer *X* axis and, if viewed from above, warps the construction clockwise by its central axis.

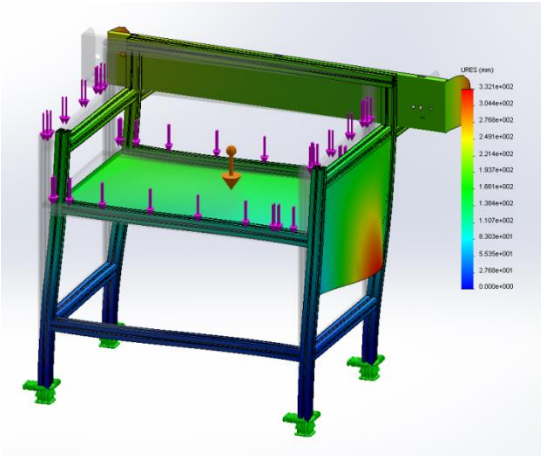

Fig. 5. Second natural frequency mode at 21.4 Hz.

The laser beam from the source hits the center of the first mirror, because it is fixed on the same platform as the laser source and, if movement occurs, they move together. The second mirror, however, is no longer in the line of the beam coming from the first mirror, so the unparalleled frame movement causes the beam to drift off its predefined trajectory. This can have a tremendous effect on the quality of the cut.

The third mode, shown in Fig. 6 at 26.7 Hz moves the left part of the construction, and makes the longer *X* axis at this point to move causing the trajectory of the laser beam to go out of synchronism.

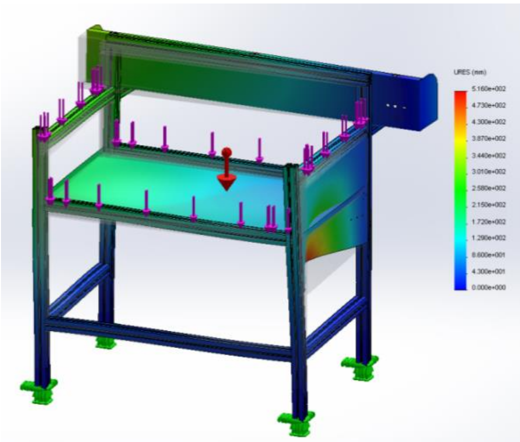

Fig. 6. Third natural frequency mode at 26.7 Hz.

Similarly to Fig. 5, the plate that is located on the right side of the vertical frame (which is where the electrical installation parts are mounted) in both cases moves considerably. This vibration can also be transferred to the belt or frame and interfere.

These simulations just show the freedom of movement of the construction, where the frame is more likely to deform and give an insight where it should be stiffened to achieve overall rigidity. Under loading the diagram would be different, but, if an oscillating excitation takes place, these frequencies should be avoided [3].

After some tests on the machine excessive movement of the frame was observed. Additional structural beams were added after analyzing the modes of the natural frequencies in the front and the rear of the frame, and on the sides, fixing the separate profiles diagonally to secure the frame so increasing its stiffness. Running of a new test showed positive results shifting the second and third mode to 28.3 Hz and 36 Hz. After these modifications on the frame the cutting and engraving process was more stable and the frame showed slight movement only at higher oscillating speeds. Therefore, a more thorough analysis of the system that considers the dynamics of the oscillating movement should be made. To better the stability the machine can be made without the lower frame structure, thus creating a small compact frame that is placed on a table or on a separate under-frame. This would reduce the leverage acting on the vertical frame beams and keep the position assembly rigid, and the axis perpendicular to each other.

IV. BELT DRIVE

For a system with no external loads and small distance movements a belt drive is advised. Another method, like rack and pinion, is also possible, but it is more expensive, and should be considered for an even larger table size where belt elastic deformation would be a bigger issue.

In Fig. 7a view of the positioning system is visible and also the two movable *Y* and *X* mirrors.

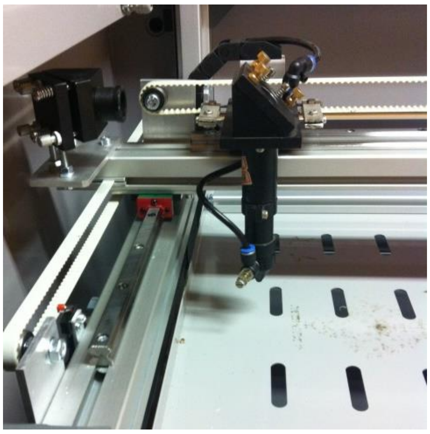

Fig. 7. Close view of the *X* and *Y* gantry with T5 belt drive.

For the built, a T5 belt was chosen using catalog descriptions. Other belt types are available, but the current type is less costly and is widely available, although not the best choice for positioning systems because of backlash from the teeth mesh in the pulleys and belts [4].The pulley size and step resolution can be calculated using a simple expression:

$$u = \frac{z \cdot p}{st}, \tag{1}$$

where u is the step resolution in degrees, z is the number of teeth on the pulley, p is the distance between the teeth and st is the total steps of one rotation of the stepper motor.

The *Y* axis moving along the *X* axis construction is driven by two separate stepper motors and belts, the signals from the processor controlling the *Y* axis movement are outputted from one port and split into two separate amplifiers and steppers. This design proves to be more compact and allows smaller motors to be used. But after some tests it was shown that at startups, when the motor windings are energized, each stepper takes its closest step to hold, and in most cases in opposite directions, twisting the longer *X* axis beam. As a result the axis and the laser trajectory are no longer parallel to the front plane of the table or perpendicular to the *Y* axis. After startup each side of the gantry needs to be calibrated in order for it to be perpendicular to the *Y* axis.

Another issue that arises is that the belts on each side are not in mesh with the pulleys equally, as shown in Fig. 5. After changing directions or accelerating as observed in [5], this can lead to minor ripples in the laser cut pattern. This type of drive can be used on wide tables, but the electronics should have a possibility to set up individual mechanical end stops to zero each side of the gantry at a system startup, so that it is perpendicular to the other axis. Alternatively, a shaft should be used to connect both sides of the belt system; this would ensure a parallel drive with a single motor, but care should be taken in loading the pulleys equally (Fig. 8).

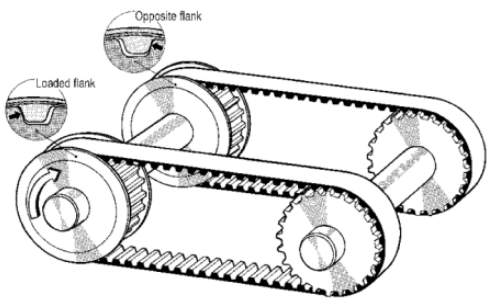

Fig. 8. Parallel belt drive loading.

A small amount of force does not stress the belts, but the elastic deformations can significantly impact accuracy and precision. Therefore, the following equation is used to calculate the elongation caused by the acceleration forces:

$$\Delta l = \frac{F_{\max}}{C}, \tag{2}$$

where Δl is the elongation of the belt, $F_{\max}$ is the maximum force applied to the system and C is the rigidity of the belt in a specific position. Consequently to calculate C:

$$C = \frac{L}{l_1 \cdot l_2} \cdot C_{spec}, \tag{3}$$

where L is the total length of the belt, l_1 is the distance of the tensioned part of the belt, l_2 is the slack part of the belt. C_{spec} is the specific stiffness of the belt.

For the current prototype the tangential forces on the *X* axis are 10.23 N and for the separate *Y* axis belts – 10.7 N. The forces were calculated using the following equation:

$$F_{\mathrm{t}} = F_{\mathrm{a}} + F_{\mathrm{f}} + F_{\mathrm{ab}} + F_{\mathrm{ai}}, \tag{4}$$

where F_{t} is the force acting upon the circumference of the pulley, F_{a} − acceleration force, F_{f} − resistance caused by friction and viscous friction, F_{ab} – belts inertial force and F_{ai} − the inertia of both pulleys.

As a result, calculating the forces at an acceleration speed of 10 mm·s^2 and using the specified belt stiffness, a 10 mm wide belt would elongate to a maximum of 0.132 mm on the longest *X* axis belt, considering that the tension of the belt is above the specified minimum tension:

$$F_{\mathrm{v}} \geq 1 \cdot F_{\mathrm{t}}, \tag{5}$$

where F_{v} is the tensioning force of the belt.

$$F_{\max} \geq F_{\mathrm{v}} + F_{\mathrm{t}}. \tag{6}$$

After calculating the data from equation (4) and entering it in equation (5) and (6) the maximum force with the minimum tension in the *X* axis belt is 20.5 N. On each side of the *Y* axis the force is 21.4 N. Upon reviewing the calculation it is clear, that a wider, more rigid belt should be used to decrease the elastic deformation of the belt.

A test was carried out measuring the amount of free play when applying ~15 N of force on the laser head in the *X* axis direction when the motor is energized. The dial gauge showed that the average movement is around +/− 0.15 mm, where some play was observed on the stepper motor rotor and pulley [6], [5].

V. Stepper Motor

Stepper motors are well known for their simple design, low cost and the ease of use. A stepper motor is an open loop device. It works as its name suggests − by rotating the rotor by a defined angle (a step). For most motors the value of the step is 1.8 degrees; this makes one full revolution 200 steps. To drive a stepper motor, a signal amplifier is necessary, which amplifies low voltage digital signals outputted by the processor to higher voltage signals [7], [8].

A disassembled stepper motor is shown in Fig. 9.

Fig. 9. Rotor and stator from a stepper motor.

An additional aspect that makes the stepper motor so robust is that the bearings holding the rotor in place are the only parts that are exposed to wear. If sealed properly, the motor can run for a long period of time, because no contactors are used and no dust or other particles are accumulated inside the stator. A typical lifespan is 10000 operating hours. Similar characteristics and a long lifetime can only be achieved with a brushless servo motor, which is considerably more expensive [9].

The rotor core is a permanent magnet, usually with two sections of teeth that are offset from each other. The stator has separately wired pairs of coils that are energized in sequence, forcing the rotor to move in a desired direction [8]. The coils, being energized, create a magnetic field with a specific polarity. In Fig. 10, the permanent rotor magnet is forced to change position aligning the rotor teeth according to the opposite polarity. Input of a specified algorithm in which the polarity changes, gives the user a controllable motor with variable speed and a specific step.

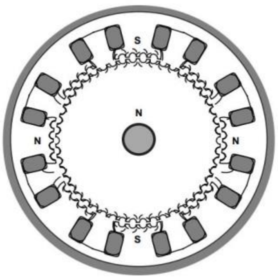

Fig. 10. Cross-section diagram of a stepper motor.

To control the movement of a system in which some kind of mechanism is used, the processor must know how many steps should be sent to the motor to create a desired linear or rotational movement. This is done by calculating the relation of the motor rotation to the linear or rotational movement of the system. This can be done using equation (1) for a belt system where the pulley is mounted directly on the shaft of the motor.

To determine the size of a motor for a specific purpose, the forces that the motor will withstand need to be calculated and then these values can be used to find a suitable motor using a torque–speed curve (Fig. 11). The pull-out torque notes the maximum force the motor can achieve until the step synchronism is lost. The two dips in the speed curve show the mechanical resonance, which should be avoided. A stepper motor delivers its highest torque when the coils are energized and the rotor is not moving or moving at a slow rate, therefore making the stepper motor ideal for heavy loads and medium speed positioning. However, a stepper motor can achieve higher speeds as long as the torque of the system is below the given motor torque-speed curve. If a stepper motor is overloaded, either by applying too much force on the shaft or its speed is too high, it will lose steps or stall. This cannot do any damage to the motor, but the system will be out of synchronism. For a more reliable movement an encoder can be mounted on the shaft of the motor providing feedback to the controller to monitor its movement – this, however, increases the cost of the system dramatically.

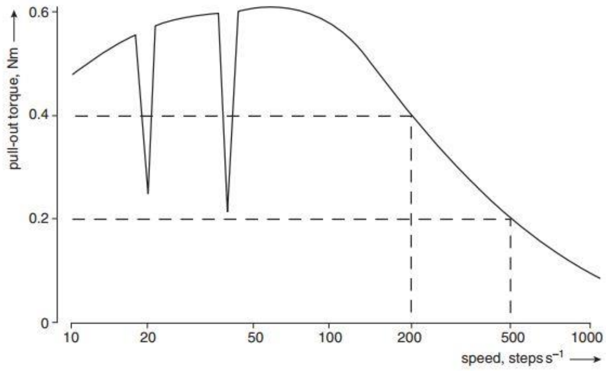

Fig. 11. Torque-speed curve of a stepper motor.

The movement created by sequent steps has also some drawbacks; every step creates an excitation in which the rotor slightly overshoots its position and then, after a small amount of time, settles. A close view of the anatomy of a single step movement is shown in Fig. 12.

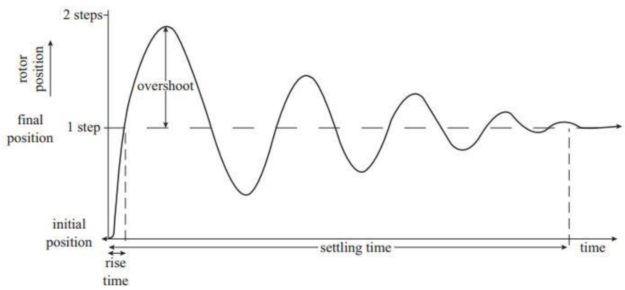

Fig. 12. Step overshoot.

The frequency of oscillation can be determined by knowing the stiffness of the torque and position characteristics, and the inertia of an unloaded motor, and, if a load is connected to the steppers shaft, the combined inertia has to be calculated [8].

$$f_n = \frac{1}{2\pi}\sqrt{\frac{T'}{J}}\,, \tag{7}$$

where f_n is the resonant frequency, T' is torque and position characteristics or spring constant, and J is the inertia of an unloaded motor.

A stepper motor (that is, a brushless motor) has little inherent friction and, therefore, dampens slowly, taking time to settle. If the motor is run on this specific frequency or steps shown in Fig. 11, it will lose torque and eventually could go out of synchronism and even stall. An option is to quickly pass the critical frequency, use mechanical gearing or change the properties of the motor. In equation (7) the spring constant T' is given by the torque of the motor over step size in radians. Therefore, if the step size is decreased, the critical frequency can be shifted to a higher position. This can be achieved with "microstepping" the motor; depending on the stepper amplifier it is possible to increase the resolution of the motor step. This is done by controlling the input of signals of the motor. A visual representation of how the decreased step size impacts the overall movement is shown in Fig. 13 [9].

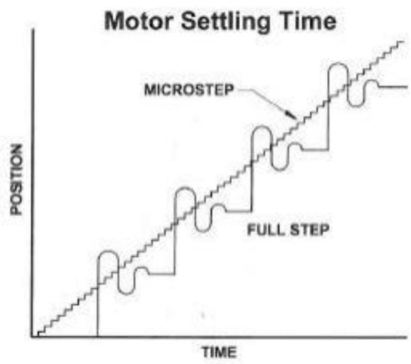

Fig. 13. Stepper motor full step comparison with microstepping.

This method significantly decreases noise and vibrations and increases the movement resolution, thus creating a smoother motion. This method is cost effective, but the increase of steps also decreases the dynamic torque of the stepper. The smaller step shortens the time the rotor is energized when passing by the windings. At a larger micro step, for example, a micro step of 256 gives one full rotation in 51200 steps. The torque on the other hand is only 0.62 % of the given torque. Therefore, a balance is needed between resolution and torque. A nearby location of steps can lead to a slightly inaccurate position fixing, decreasing accuracy and precision of the motor [10].

To increase controllability and stability of the laser positioning system, the vibrations caused by the motor should be ruled out. The main goal would be to avoid the resonant frequency of the stepper or to bypass it before any oscillation could happen. Microstepping can be used to lower vibrations and noise, and to shift the resonant frequency without changing the mechanical system. Using elastomeric motor mounts, shaft couplers or implementing any other viscous damping effect, or even ball bearings and linear shafts with lubrication can be sufficient to avoid the accumulation of energy into resonance. Careful calculation of the speed and loading the motor according to the data specified by the manufacturer should be carried out, because an unloaded or underloaded motor is similar to an overloaded motor [11].

VI. Dynamic Force

To analyze the dynamic forces acting upon the frame, the 3D CAD model is tested in *Solidworks*. To gather necessary data from the model, sensor point is added to the fixture points of axis, respectively, on the *Y* axis carriages where the *X* axis assembly is attached. The carriages are moved 3/4 of the distance towards the front of the machine where, according to the natural frequency analysis the frame is less rigid.

The maximum forces will be taken from the belt calculation and harmonic loading will be carried out by changing the amplitude of the load and direction in a short amount of time, imitating swift direction changes and acceleration. The *X* axis is the main target; when engraving work is done, the laser head moves rapidly back and forth. If it is working on a resonant frequency, it can have a negative effect on the stability of the frame. The model has been simplified to include only the frame elements. Parts that are several times longer than in cross-section were meshed using a special beam mesh, sheet metal parts were meshed using shells, and the rest as solid objects. This approach shortens the calculation time. For the simulation a dampening coefficient of 0.04 was taken in account, according to the value for aluminum constructions recommended by *Solidworks* .

After a number of tests, the resonant frequencies were slightly different than in the natural frequency analysis; this is possible because different model meshes were used and the added force from the metal covers provided some dampening. Therefore, the results give a better view of the parameter impact on the simulation.

To interpret the data, the speed parameters of the system should be set. For the current objective, the *X* axis is the main subject; this axis runs at high speeds back and forth repeatedly to control the laser beam and engrave on the work piece. The top speed that the stepper motor can handle is around 1.2 $\mathrm{m \cdot s^{-1}}$s and the acceleration – 10 $\mathrm{m \cdot s^{-1}}$. To calculate the excited frequency of the machine the following expression is used:

$$t = \frac{v}{a} \cdot 2 + \frac{s}{v}, \quad (8)$$

where *t* is the total time for the *X* axis laser head to accelerate while run at a constant speed and decelerate, *v* is the constant set speed, *a* is the set maximum acceleration of the machine and *s* is the width of the object that is to be engraved [5].

To compare the results, a small engraving with width of 1 mm is chosen, and from the equation (8) the time of a half cycle in which the laser head accelerates, runs the 1 mm width at a constant speed of 1.2 $\mathrm{m \cdot s^{-1}}$ and decelerates is calculated. As a result, the frequency at which the machine operates at the given occasion is 17.8 Hz. This speed shows the maximum operation frequency that the motors are capable of achieving. However, this speed is several times larger than the speed the machine will operate on because of power limitations of the laser source, and at which cutting or engraving is inefficient.

Fig. 14 shows the results of the simulation in the *X* axis direction at 17 Hz, loading is 0.02 mm on the carriage and 0.086 mm on the plate for mounting of electrical components . However, the plate will have an increased stiffness because of the components mounted on the plate.

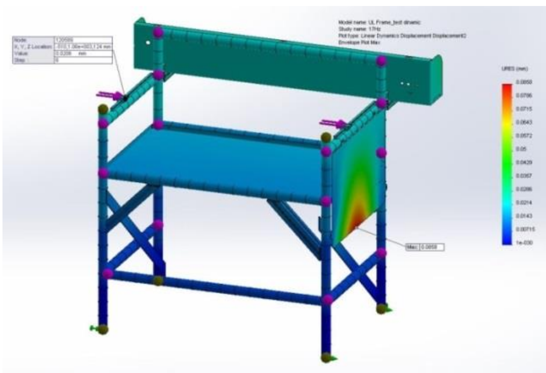

Fig. 14. *X* axis deformation on harmonic loading at 17 Hz.

The second resonant frequency at 20.5 Hz, results in 0.035 mm movement on the carriage and 0.23 mm on the electrical mounting plate. The third frequency is at 25.4 Hz at which the highest results were again on the electrical mounting plate – 0.29 mm and 0.078 mm on the linear axis. All simulation runs had similar result views, but with different magnitude.

The *Y* axis direction runs at a much lower speed, therefore the analysis of it was made at the first resonant frequency 20.9 Hz. The areas that are more affected are shown in Fig. 15. The maximum deformation is located on the electrical installation plate and the bottom cover plate.

The results show that the system is stable except for the larger unsupported metal plates. If under exploitation vibrations on these plates increase and are visible, then additional support should be added, to protect the sensitive electronics and prevent further vibration accumulation.

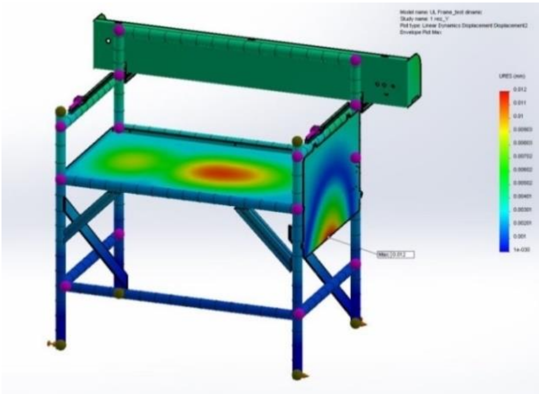

Fig. 15. *Y* axis deformation on harmonic loading at 20.9 Hz.

V. Conclusion

A CNC laser cutter and engraver is very prone to errors. If the system or a part of it is running inefficiently, then the cuts of the material will be of poor quality. That is why the fundamental structure of a CNC laser device should be examined to identify possible causes of error.

The viewed aspects are critical parts of the system and create the core of the machine. Frequency analysis tests allowed to cost effectively increase the overall rigidity of the frame by stiffening the construction in accordance to vibration modes. The adoption of calculated loads on the belts and tension forces made it possible to significantly improve quality of technological process and to reduce fluctuation on corners of cuts. However, some cut errors existed because of insufficient belt stiffness.

A substantial part of the position is the stepper motor. When used correctly, it can deliver torque and precise movement at a low price.

This write-up does not only help engineers to understand the construction, but also may serve as a guide where error identification should be carried out on a commercial machine. If further accuracy and precision is desired, more detailed analysis of separate components should be carried out.

Acknowledgment

The authors want to express gratitude to J. Janusevskis who supervised the study of the master thesis "Design of CNC Laser Engraving Machine" on which this paper was based. Also thanks to V. Dobelis for financing and allowing the creation of a CNC laser prototype and giving full freedom of the design and construction.

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Dobelis Jānis, Beresņevičs Vitālijs. CNC lāzergriešanas iekārtas precizitāti ietekmējošie faktori
Raksts veltīts vidēja izmēra apstrādes laukuma un zemu izmaksu oglekļa dioksīda (CO_2) gāzizlādes datora ciparu vadības (turpmāk – CNC; angliski – *Computer Numeric Control*) lāzergriešanas un gravēšanas iekārtas precizitāti noteicošo kritēriju analīzei. Apskatītas iekārtas ar plaknē pozicionējošiem un lineāri pārvietojamiem spoguļiem. Konkrētie pētījumi un apkopojumi ir izpildīti ar iekārtas prototipu, ko autori projektēja un konstruēja. Ņemot vērā, ka ideāli fokusēts lāzera stars no CO_2 lāzera avota veido diametru, kas ir aptuveni simtdaļa no milimetra, jebkura kļūda vai nepilnība, kura pastāv sistēmā, atspoguļosies apstrādājamā materiāla griezuma līnijā. Lai mazinātu nepilnības un nodrošinātu optimālu apstrādes kvalitāti, jāaplūko iekārtas rāmja un piedziņas dinamika. Konstrukcijas rāmim ir jāiztur spēki un svārstības, kas radušies apstrādē, tādēļ svarīgi noteikt to ietekmi uz lāzera pozicionēšanu. Šim nolūkam tika veikta konstrukcijas rāmja datorizēta analīze, izmantojot programmu *SolidWorks*. Aplūkoti veidi, kā palielināt konstrukcijas stabilitāti, – to pielietošana ļautu ievērojami uzlabot rāmja stabilitāti ar samērā zemām izmaksām. Parādīts, ka būtiska nozīme ir piedziņas kustības kvalitātei, kas ir tieši atkarīga no siksnas piedziņas un soļu motoru precizitātes. Turklāt siksnai svarīga un noteicoša īpašība ir tās stingums, bet soļu motoram – tā pilnas rotācijas soļu skaits (jeb soļu izšķirtspēja) un griezes moments. Pētījumu rezultāti ir noderīgi speciālistiem, kas nodarbojas ar CNC lāzergriešanas iekārtu projektēšanu un praktisku izmantošanu, jo palīdz izprast un ievērot šāda tipa iekārtu kvalitāti ietekmējošos faktorus.