WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design and Fabrication of Portable Laser Engraving/Cutting Machine with Automatic Loading and Unloading Using Cylindrical Robot

[1]Ananda K N, [2]Dr. Shivashankar B S

[1]Student, 4th Seam, M. Tech in Industrial Automation and Robotics, MCE Hassan, India
[2] Assistant Prof. Dept of Mechanical Engineering, Malnad College of Engineering Hassan, India
Email-: anandkn.gpt@gmail.com

ABSTRACT

Nowadays technology is increasing rapidly, the usage and the implementation of CNC systems in industries and educational institutions are exponentially increasing but at a greater cost. Our main goal is to design and fabrication of portable Laser Engraver with automatic loading and unloading using cylindrical robot that is also a compact, cheap and low power unit that is also portable as required to elsewhere and easy to operate in order to reduce complexity, cost and manual work. The idea of open source laser GRBL Arduino based laser engraver is to use that loads the G-code coordinates of an image that is given by user and sends those coordinates to the arduino which in turn signals the hardware components i.e. stepper-motor and laser to engrave onto the surfaces for wood, Acrylic or Foam sheets. And also here we have designed that cylindrical robot and transporter which are operated by PLC programing used to feed component automatically to the engraver work bench with the help of transporter hence its avoid manual work part alignment and also here implemented automatic unloading by cylindrical robot which is eliminate the manual material handling. The engraver will be able to engrave vector graphics in two (X & Y) axes of motion.

Keywords: Mobile Laser, Automatic loading and unloading, PLC Controller, cylindrical robot, Transporter, CNC, GRBL

I. INTRODUCTION

The laser emits clear radiation, or light. This suggests that it comes from a source (referred to as a Resonator) that generates (transmits) radiation in step-by-step floods of indistinguishable recurrence, stage, and polarization, either as light or even in the undetectable range [1]. While most laser light has a narrow wavelength, some can emit a wide range of light or transmit different wavelengths of light simultaneously. The innovation of laser cutting has been widely applied to the preparation of metal and non-metal materials, greatly reducing handling time and cost while also improving the quality of the work piece. Today's laser transforms into an incredible sword that can cut through iron like mud [2]. Modern assembly and generation applications typically employ laser cutting, an invention that uses a laser medium to cut materials. The most common method of coordinating a strong laser's yield using optics is how laser cutting operates. The substance or the laser pillar is formed in coordination with the use of CNC programming and laser optics. A standard business laser for cutting materials would have a framework for movement control modelled after a CNC or G-code of the material that needs to be cut. The material either liquefies, consumes, or vaporizes away at the place where the engaged laser pillar coordinates, leaving an edge with an excellent surface wrap up [3-5]. Depending on the application, mechanical laser slicing machines are used to cut basic and channelling materials in addition to level sheet material. By utilizing the high power thickness vitality produced by the engaged laser, laser cutting is accomplished expertly. Laser releases through heartbeat and a yield of high-recurrence beat laser frames a certain recurrence and heartbeat width under PC control [6]. The beat laser shaft becomes a low-profile, high-vitality thickness flare near the surface zone that needs to be prepared. It melts or consumes the material in a minute after conduction and reflection through the optical path and cantering by cantering focal point gathering. In an instant, a fine opening can be produced by each high-vitality laser heartbeat. The laser head will move somewhat under the PC's control and be positioned along these lines by the chart to obtain the desired shape [7]. When compared to traditional cutting methods, laser cutting offers superior cutting quality, speed, flexibility, and wide range of applications.

This project uses a cylindrical robot that is programmed with PLC to autonomously feed the work piece for engraving and cutting. The part is precisely fed under the laser machine's head using a transporter that is utilized to pick it up from the tray with the assistance of a pneumatic gripper linked to the robot arm's end. Following the completion of the laser engraving process, the final component is transported by a robot outside the laser machine, where it is picked up and placed on a different tray. The conceptual drawing can be seen in the figure below.

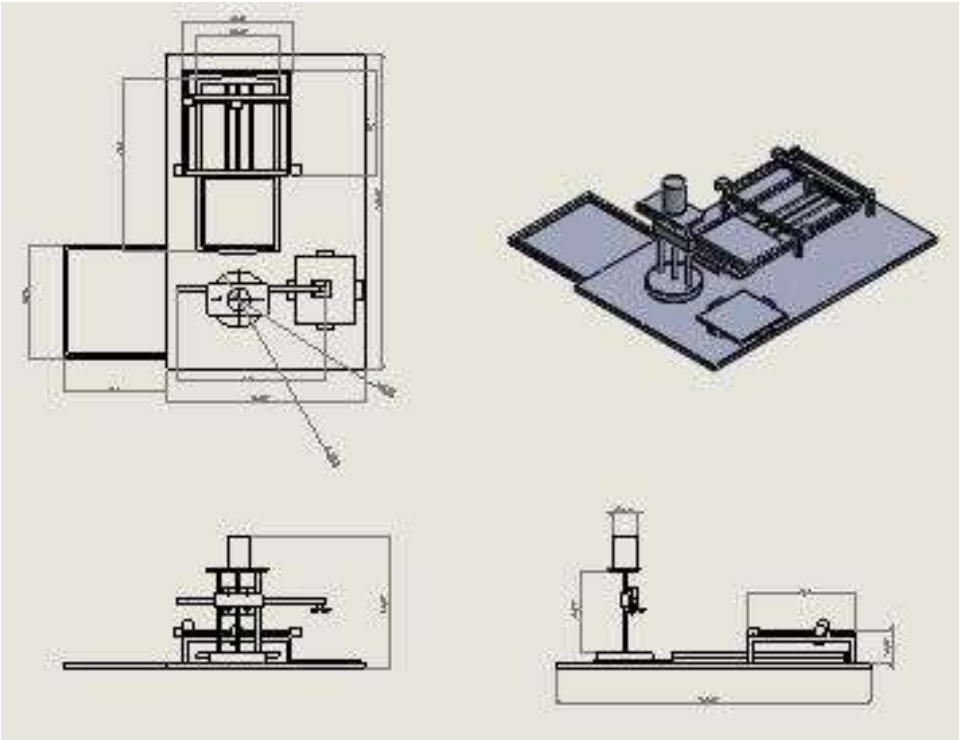

Figure 1: Conceptual drawing.

In this project basically adopting automatic component loading and unloading to the tray by the help of cylindrical robot once the engraving operation will be completed as per input given and use to supply the component with help of transporter.

The following are the parts used in this project:

- Laser Engraving machine (W: 450mm x L: 450mm x H: 1300mm)
- Transporter (W: 250mm x L: 450mm)
- Cylindrical Robot(W: 300 mm x H: 250mm)
- Laser Module capacity:5W
- Materials can be done laser engraving are :Wood ,Acrylic sheets(black),cardboard sheet, Paper, Foam sheets

II. METHODOLOGY

Required Machinery

1. Laser engraving/Cutting Machine

2. Component transporter

3. Cylindrical Robot for auto loading and unloading

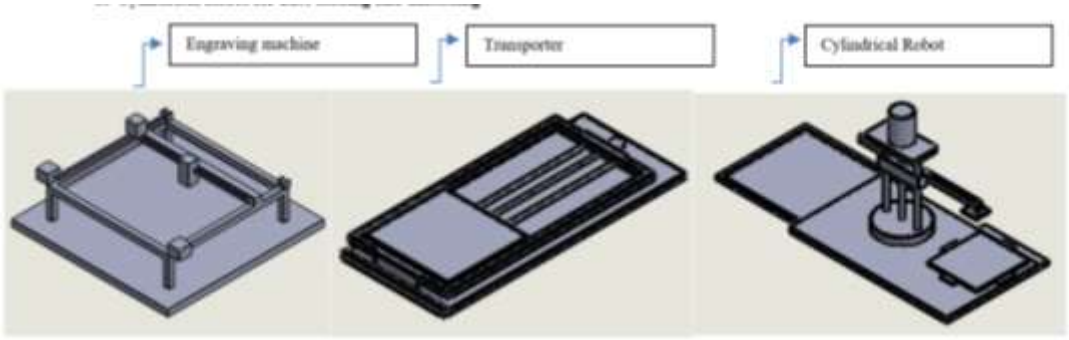

Figure 2:3D view Work outline details

DETAILED FABRICATIONS:

This project is consisting of three major parts as below

1. Laser Engraving machine
2. Work transporter
3. Cylindrical robot

1. Laser Engraving Machine:

A laser engraving machine is a piece of equipment that performs laser engraving, which is the process of engraving designs, letters or numbers on materials using a laser beam. These engraving machines use automation to achieve precise cuts and engravings on various materials, including metal, wood, glass and plastic. The essential parts of a laser engraving machine are the laser and the lenses, which create and concentrate a beam of light powerful enough to engrave the design.

There are many uses of a laser engraving machine. Laser engraving provides durable, long-lasting marks like:

- 2D data matrix codes
- Barcodes
- QR codes

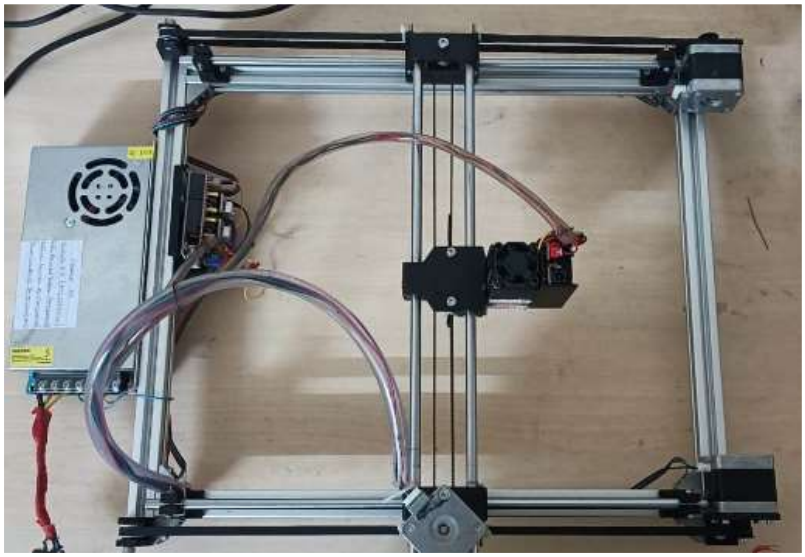

Figure 3: Laser Engraver Machine

2. Work transporter:

This part is used to supply the work to the laser engraving machine. The work part is placed inside the tray. Cylindrical robot arm is used to place the work part on the transporter exactly on the surface of the work positioning place .once the component placed on transporter start moving towards laser engraving machine along with the component. Once the engraving operation is completed the finished component return back with the help of transporter.

Benefits:

- Avoid table calibration every time of operation
- Eliminate manual placing of work and safe from laser beams

Specification:

- Length and width: 500x250mm
- Dimension of work table: 110x110mm

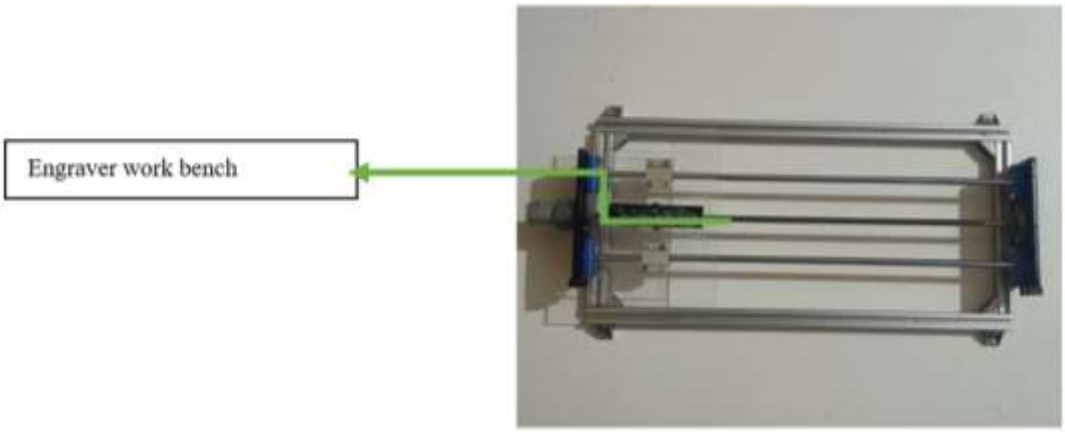

Figure 4: Work part Transporter

3. Cylindrical Robot:

This part is plays an important role that is pick up the work part from the raw material tray as per the instruction to be given by the PLC programing .Initially the robot arm is at 90˚ to its vertical axis. Once the signal given to pick the component robot arm moves down until the component is picked by the help of suction gripper once is gripped start moving towards transporter and stop by recognizing metal part placed exactly at 90˚ with the help of inductive sensor .and then place the part on the transported work table . Once the engraving operation completed through transporter the part come back to near robot arm then signal gives to the robot then it will pick the engraved component by the suction gripper and start moving towards finished part tray and stop at 90˚ exactly by recognizing metal part by the sensor and drop the part in the tray and came back to its home position. And cycle repeats for every new parts to be engraved.

Benefits:

- Completely eliminate human interventions
- Hence safety operation with respect to laser beam
- No damage to the part to be engraved since using to grip by using soft vacuum gripper

Specification:

Length x Width x Height: 300x250x250mm

Work volume of robot Arm: 250mm

Maximum angle of rotation: 360˚

Working Angle: 180˚

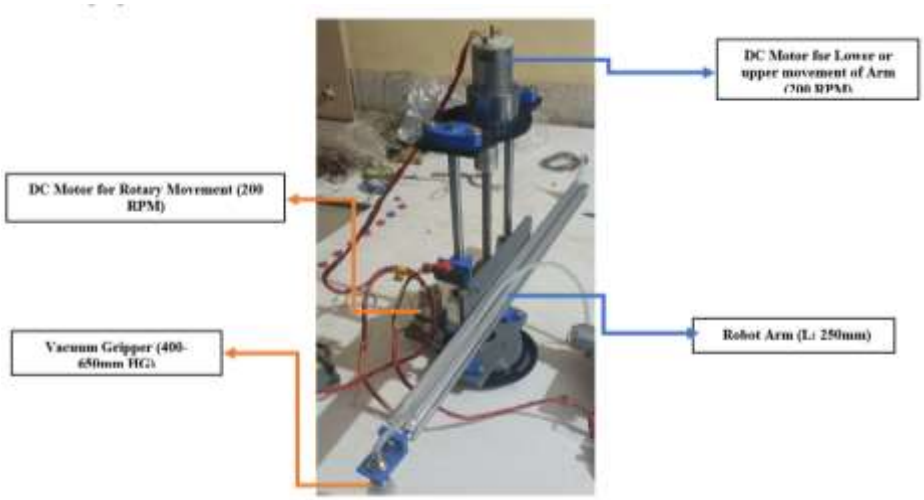

Figure 5: Cylindrical Robot

Fig 6 shown the final design and fabricated lassr machine with automatic loading and unloading using cylindrical robot .In this all 3 components

Interfacing together with the help of sensors and limit switches and PLC programing

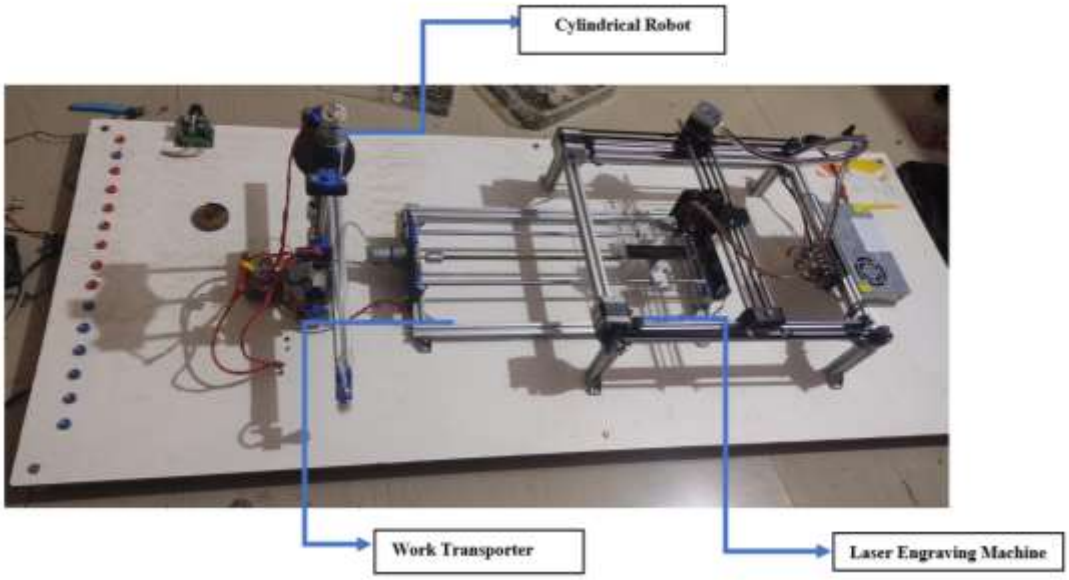

Figure 6: Final view of Assembly.

Operation procedure

Material preparation

- Work part has to be used for engraving to be checked for damage or any crack.
- If ok then load the work part in to the tray

Home Position

- Once power switch ON, First needs to be ensured the home position of cylindrical robot arm, Transporter, and as well as laser machine head as per the PLC program defined.

Loading Of work

- Once home poisons has to be confirmed ,press the Start button(Green) then vacuum pump to be activated at the same time cylindrical robot arm start moving downwards till touches to limit switch.
- The vacuum gripper which is attached to the robot arm can pick the parts from the tray due its sucking action.
- Then the robot arm start rotates towards transporter at an angle 90˚ and stop moving when sensor recognizing the metal strip placed. After few second of delay the vacuum pump power cut off to be done automatically as per the plc program of instructions .then drop the work part on the Transporter.

Feeding of work

- Once work part received the transporter start moving towards laser engraving machine until its touches the limit switch then transporter stop its movement.
- At this position, the work part is ready for engraving or cutting operation.

Laser Engraving operation

- Now press start button in the laptop device and transfer the required image for engraving operation with the help of GRBL software.
- This software automatically generates the G-Code and M-codes to complete the engraving of given image.

Auto Unloading of work

- After completion of Engraving operation, laser head goes back to its home poison and touches the limit switch.
- Then transporter start moving backward, towards robot arm until touches the limit switch then it will stop.

- Then robot arm pick the engraved part with the help of vacuum gripper and turn again 90˚ and stop when sensing metal strip recognized by inductive sensor.
- After that vacuum pump got disconnect then drop the work part in to the tray automatically and returns back its home poison by moving 180˚
- Repeat the same process for every cycle.

III. RESULTS AND DISCUSSION

The Machine was successfully designed, Fabricated, and tested to ensure that it operated properly with a USB connection. When user-friendly software was employed, the machine demonstrated its ability to complete the assigned task.

Cylindrical robot and transporters are working successfully and involving greatly during automatic loading of work component and unloading of engraved part and made the system automatic.

The machine design was created using Solid Works software to visualize the layout. Solid Works was used to create a 3D representation to ensure accurate machine dimensions.

Testing are mainly carried out in two stages

1. considering automatic loading and feeding of work

The trail was taken manually without involving the transporter to feed the work part to the engraving machine and cylindrical robot which is used for automatic loading and unloading of work part. In this situation the work part placed manually under the laser head is required proper alignment of the work for effective engraving operations and took 40 sec to doing so for every component

Again trail has taken with involving the transporter to feed work part to engraving operation automatically by using cylindrical robot arm which is attached by vacuum gripper by which work picked and placed directly on the work table area which is attached to transporter. Once the work part placed as per the instruction given by the PLC programs the transporter feed the work directly to the engraving machine here no need of alignment of work hence will take very less time approximately 10 sec for work alignment. By introducing automation drastically reduce the work alignment time 75-80% approximately. Analysis charts shown below

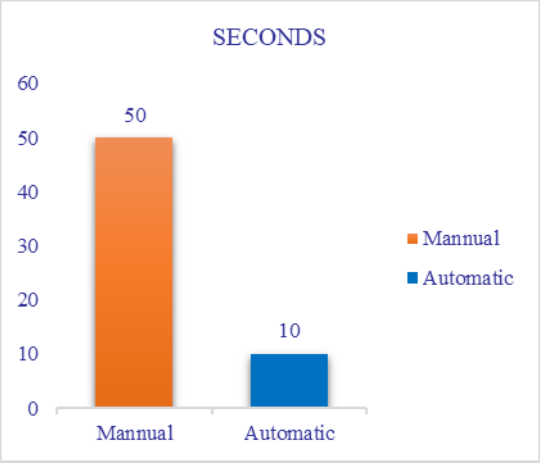

Figure 7: Work Piece alignment Time comparison

2. Considering speed and power of laser

During this trail majorly focusing on varying speed of the laser head movement with respect to power have been observed different results. Below charts shows the different results

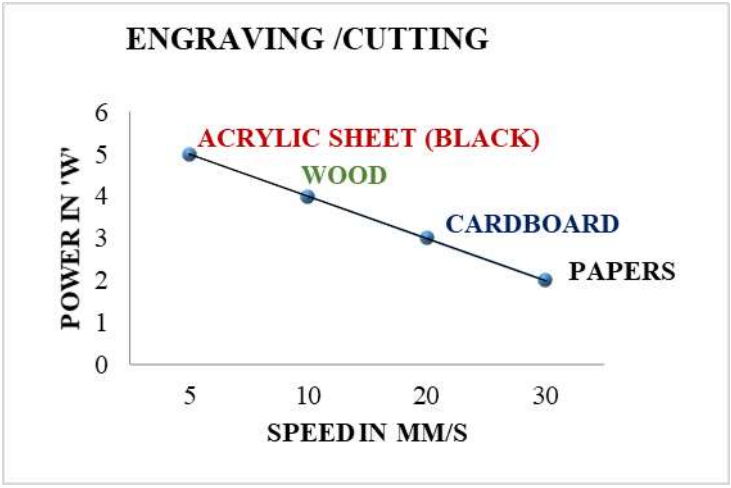

Figure 8: Comparison Chart between speed and power of Laser

Output of the project:

Figure 9: Logo of our Institution engraved

Figure 10.Result of Engraving

IV. CONCLUSION

Conclusion is that the mini cnc concept portable laser engraving with auto loading and unloading machine is capable of doing some positioning and co-ordination in laser cutting and engraving application. This Laser machine can be determined by the engraving performance. From this project, several conclusions can be drawn that the development of this machine can be interfaced with laser device by using Laser GRBL software and Arduino as controller. The internal working area of machine is approximately: Length x-190mm, Y-140mm. This machine has developed to capable of doing and showing prototyping of some application in institute level to the students for learning of cost effective laser engraving or cutting. This project is portable and customized to a table top size which is doing same function what huge machine done in industry. Hence easily can make proto type parts from this machine and with the less investment.

In many higher educational institutions in India (and other developing countries), due to the high cost of commercial, huge size Laser engraving machines along with automatic loading and unloading , students' exposure to hands on learning of Laser machining is limited to demonstrations by the lab technician or programming for computer animation/simulation. By developing this kind of table top portable machines can help the students to study the machines and hand on training by applying various programming's.

REFERENCES

[1] P. Jamaleswara Kumar et.al, Design and fabrication of portable laser cutting and engraving machine - International Journal of Engineering and Technology, 2012

[2] Jayaprasad V et.al, Design and development of CNC based laser engraver - International Journal of Scientific & Engineering Research, 2017

[3] D. O. Shirsath et.al, CNC machine based on laser engraver using Arduino Uno -, International Journal of Science Technology & Engineering, 2017

[4] Parinav et.al, Development of laser cutting and engraving machine - International Journal of Science Technology & Engineering, 2018

[5] Radovanovic M. et.al, 2000, Working Quality by Laser cutting and en-graving machines, Proc. of the 7th Intern. Conf. on Tribology, Bu-dapest, Hungary, pp. 255-258., 2000

[6] Jamaleswara Kumar, et.al, Evaluation of Mechanical Properties of Natu-aral fiber of reinforced composit (IJCSER), Vol. 4, Issue 5, pp 77-86, 2020

[7] Vaxevanidis N.M., Petropoulos G., Dašić P., Mourlas A. et.al, Multi-parameter analysis of surface finish in electrodischarge ma-chining of tool steels, Proc. on CD-ROM of 6th Intern. Conf. ″ Re-search and Development in Mechanical Industry - RaDMI ″, Budva, Montenegro, pp. 9-16, 2006,

[8] Joshua D. Ramos, et.al "Design and Testing of Components for a Low Cost Laser Cutter", Massachusetts Institute of Technology, 1995.

[9] Milton Keynes, RNR Associates, et.al "Diode lasers now pushing the power limits", UK, 2008.

[10] J Dong, C Yuan, J.A Stori, P.M Ferreira et.al, "Development of a high-speed 3-axis machine tool using a novel parallel kinematics X-Y table", Department of Mechanical and Industrial Engineering, University of Illinois, USA, 2012.

[11] Bullinger H-J,et.al Aside from the energetically loaded laser-active medium the crystal, liquid or gas – it is necessary to feed back the generated photons into the medium using a Technology Guide, 2009