Portable, Versatile and High Precision Laser Engraver

Jay Bhanushali
K J Somaiya Institute of Engineering & Information Technology, Sion, Mumbai
University of Mumbai, India
jjb@somaiya.edu

Raj Raikar
K J Somaiya Institute of Engineering & Information Technology, Sion, Mumbai
University of Mumbai, India
raj.raikar@somaiya.edu

Nilay Takarkhede
K J Somaiya Institute of Engineering & Information Technology, Sion, Mumbai
University of Mumbai, India
nilay.t@somaiya.edu

Dinal Varma
K J Somaiya Institute of Engineering & Information Technology, Sion, Mumbai
University of Mumbai, India
dinal.varma@somaiya.edu

Mrs. Sejal Shah
K J Somaiya Institute of Engineering & Information Technology, Sion, Mumbai
University of Mumbai, India
sshah@somaiya.edu

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 a CNC Laser Engraver that is also a compact, cheap and low power unit that is also easy to operate in order to reduce complexity, cost and manual work. The idea of open source laserGRBL – arduino based laser engraver is to use the Open Source LaserGRBL 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 example wood, Acrylic or plastic. The engraver will be able to engrave vector graphics in two (X & Y) axes of motion. Most of the engravers are designed in bi-directional movement and square type models. Whereas in this laser engraver, axes movements are mounted on each other and a belt driven mechanism is used for engraving. Laser engraver uses a very fine matrix of dots to form images, such that a line may appear continuous to the naked eye, it in fact is a discrete set of points.

Keywords- **Laser, CNC, LaserGRBL, engraver, G-code, arduino.**

I. INTRODUCTION

The CNC (Computer Numerical Control) is used in controlling machine tools. Laser Engraver is one of the tools that use CNC for the control of its tools. The Laser Engraver can be called as a printer for multiple surfaces. The Laser Engraver is a device which engraves an image, text, picture etc. by burning the surface of the material it is engraving on and creating a permanent mark which cannot be removed easily. The laser engraving industry is used from engraving on drink glasses to engraving on fine medical devices used in surgeries. The goal here is to create a general purpose laser engraver with minimum cost, power and technical operating demands.

Ordinarily a laser etcher would cost in thousands or even lakhs of rupees, cumbersome and colossal to fit. That is the reason behind why many do not actually select to utilize a laser engraver on individual or limited scope premise. Thus if a laser engraver however advantageous as a printer may be made, an ever increasing number of individuals would begin utilizing the gadget and another period of innovation and accommodation can be brought to the overall buyer.

The thought behind this task is to make a little two axis CNC machine which can imprint 2D and grey scaled pictures or pictures with assistance of a high watt copying laser module on a superficial level which can be a paper, wood, acrylic. It utilizes two stepper motors as direct actuators on every hub X, Y. While etching, the legitimate synchronization of this hub for example stepper motors is the most difficult errand. As proposed,

the machine will be worked inside a little design. Whole design will be constructed from acrylic or aluminium segments. To keep the least weight conceivable, aluminium will be preferred.

II. RELATED WORK

This section presents, in brief, existing literature related to the use of various CNC Laser Engravers available in the market.

Sonali Dhanwade et al have done research on building up a composing machine which helps the students or office people to compose. It is utilized to compose the characters, words from reports with the assistance of equipment and programming. They use UNO arduino, servo motor, GRBL shield, motor driver and benbox programming, stepper motor (taken from old DVD). The primary benefit of this proposed framework is to simply perceive the record from the PC which needs to compose on paper utilizing this essayist machine with no problem. It will lessen the responsibility just as your time. They centre around diminishing the size of the equipment so the absolute framework will decrease. [1]

Infantantoabishek.J et al have done research Mini CNC Engraver Machine which is like a CNC processing machine. It decreases worksheet build up and recurrence of blunders. They have 3 dimensional (X, Y & Z axes) working territories of 230mm x 290mm. This machine can etch on plastic, steel, aluminium, wood and so on It gives the better exactness precision at serious advancement cost. With the assistance of G code, it gives better profitability and decreases the responsibility likewise it gives the data about the places of all the stepper engines on the PC screen so we can without much of a stretch begin or stop the framework engine at whatever point we need. [2]

R. Balathangam et al have done the planning and advancement of an arduino controlled composing robot. The principle objective of this machine is to create a composing robot by discoursomposing robot visual fundamental programming e acknowledgment strategy. In this cis utilized and for discourse acknowledgment, arduino microcontroller has been utilized. To begin with, the client is to take care of the message by means of a mic that will be sifted by speaker and low pass channel. At that point, the simple sign is given to the PC with Microsoft visual fundamental studio. Utilizing discourse to message transformation calculation simple sign changed over into text rely upon the client's information. At that point the changed over text will ship off the arduino regulator utilizing sequential link. [3]

Kajal and Kranti (2016) implemented the programmed smaller than expected CNC machine for PCB drawing and penetration. The framework is
intended to create the minimal effort CNC to bore and increment the adaptability of the machine. The whole cycle is utilized by G-code. They recognized that the development of stepper engines should be possible by changing over the machine code into beats. This should be possible by utilizing G-code interfaced with ATMEGA 328. The G-code with the equipment arrangement gives better precision and diminishes the responsibility. [4]

Lin li “The advances and characteristics of high power diode laser materials processing”. The creator presents an audit of the immediate uses of high force diode lasers for materials preparing including binding, surface change, welding, scribing, sheet metal bowing, checking, etching; paint stripping, powder sintering, union, brazing and machining. An audit on high-power diode laser applications for materials preparing has been done. These highlights incorporate better surface completion, less warmth influenced zone, better shaft assimilation, better morphological attributes, more predictable and repeatable outcomes, less breaks and less porosity age. The shortcomings of the powerful diode lasers incorporate high shaft, bar retention reliant on work piece tones and the trouble to deliver high-top fueled short-beat pillar straightforwardly (Q Switching) [5]

III. PROPOSED APPROACH

The first approach to the Portable,Versatile and high Precision Laser Engraver was to make a low cost,low power high precision laser engraver for small scale and cost effective workload such as small DIY art workshops and engineering institutes. So a laser engraver with a low cost controller such as the arduino uno with a cnc shield for controlling the assembly with A4988 motor drivers were used for this design. The arduino acts the brain of the system as the system read the G-code and plots using the laser according, each and every pixel of the drawing is stored by the arduino and is then sent to the system in the form of coordinates and and the cnc shield is used as a bypass for the arduino as it cannot handle the amount of power the system draws and hence the power is drawn from the shield with the

amount prescribed by the arduino uno. As every motor has a different construction hence to drive the Nema 17 stepper motor the A4988 motor drivers are used, which also enable enhanced motor driving techniques such as micro stepping.

The cnc assembly moves from the above configuration the engraver of this system which is a 500 mW diode type laser engraver which is a compact type of laser which engravers on various surfaces which will be proposed further.The laser was subjected to a 3 hrs of back to back engraving hence it is safe to say that the laser can at least have a 3 hour engraving session without any cooldown.

The Laser is 55cm in length, 35cm in breadth and 18 cm in height.It weighs around 7 kgs and all over a rectangular shape, hence it justifies the portability statement that it carries.The laser can engrave on a variety of surfaces such as cardboard,wood,MDF and acrylic which are the main materials mainly used in small scale application hence justifying the versatility department.

The laser is very precise as it engraves 1 mm for 3 times which can be changed according to the requirement and also the speed of the motor is kept such that it engraves 500mm/min. We can increase the speed, but it deteriorates the image engraved. Thus for current laser it is recommended to use normal speed.

Hardware:

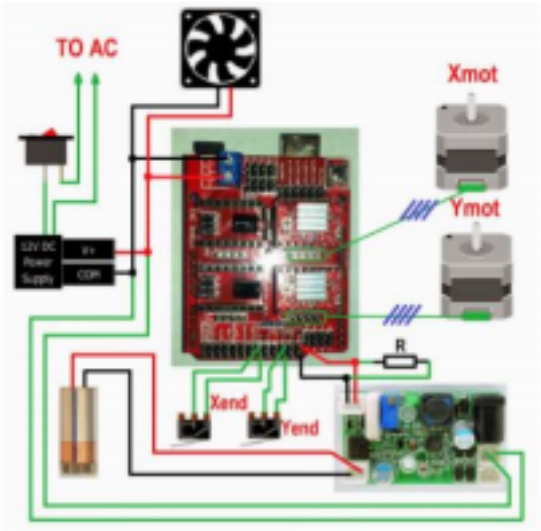

Figure 4: Circuit Diagram

• The system comprises various parts such as arduino uno, CNC shield, Stepper motor, Limit switches and Laser Diode with the TTL controller.

• It also has a lot of mechanical parts such as screw rods, coupling shafts, Acrylic body, pillow block bearing, steel rods, linear bearing slider etc.

• The arduino processes the code and sends a signal to the CNC shield which provides power to the motor according to the signal given by the arduino uno.

• The arduino uno then commands the stepper motor to move the assembly with the help of a screw rod on which the laser is mounted and the assembly moves according to the design.

• The TTL signal from the CNC shield to the TTL controller gives 0 as for laser being off and 1 for laser being on. The default is always 0 as for the laser being off.

• The limit switches warn the assembly of its maximum position.

Software:

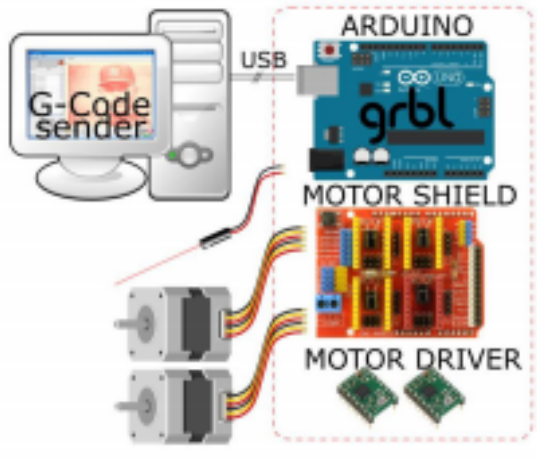

Figure 5: Working

The working of this software is as follows: • It takes an image as input and loads it onto the software to display.

Figure 6: Import Image

• The user can then set different parameters to tune the image. Different parameters like speed of the stepper motors, power of the laser and control the laser along with the movement of stepper-motors.

Figure 7: Configuring Laser and Image Specifications

• The software then internally converts the image into the G-Code coordinates that are then fed to the arduino that controls the Laser and stepper motor.

Example G-Code:

```
G0 X10 Y10 (Move to position X10, Y10)
M3         (Turn on Laser)
G1 X20 Y10 (Linear move to X20, Y10)
```

Figure 8: On-going Engraving Process

• The arduino then transfers the G-Code coordinates onto the Laser along with the set of instructions for example where to start, intensity required and so on.

• The result obtained is a beautifully engraved intricate and precise image that is customized to the needs and satisfaction of the user.

IV. RESULTS

In this section, the results are observed through engraving onto the different surfaces.

The outcome acquired is a wonderfully engraved complex and an exact picture that is modified to the requirements and fulfilment of the user.

Figure 9: Cardboard

Figure 10: MDF

Figure 11: Wood

Figure 12: Acrylic

As shown in figure 9, 10, 11 and 12 the surfaces used are cardboard, MDF, wood and acrylic respectively. The results obtained are exactly the same as the design provided in laserGRBL software.

All the above results were obtained in a span of 23-30 mins of time.The machine was set for engraving at 300 DPI for 20*20 cm which results in image of 1600*1600 pixels.

From the Observations made the circuitry has negligible consumption and the stepper motor take 12 volts 0.4 amps which leads to a consumption of 4.8 watts and as the system has two motors it gets to a 9.6 watts rating.The laser has a power rating of 500 mW which intotal leads to system consumption of 10.1 watts.
If we take it for financial basis the engraver runs for about 10 paisa/hour.

V. CONCLUSION

By assembling the Laser Engraver it can be concluded that the CNC machine is cost effective, accurate and easy to operate. It operates on two axes of motion in order to engrave vector graphics or text on a given surface. It engraves on basic surfaces which are used in day to day life like cardboard, wood, Acrylic and MDF. It can be used for basic designing and text writing on surfaces which are needed for various applications. With a lot of new technologies being developed nowadays, this open source laserGRBL – arduino based laser engraver
serves to provide a good platform for future development for the Laser Engraving system and even other systems.

VI. FUTURE WORK

Future plan of work will be implementing the system using the whiteboard concept where the users will be able to draw their desired designs inside the software itself and not take any help from other external design softwares. For the laser to engrave on glass a high power laser is required. Further a more efficient and reliable laser that will be beneficial for long term usage and will be cost effective.

VII. ACKNOWLEDGEMENT

We would like to thank the University of Mumbai for partly funding the open source laserGRBL – arduino based laser engraver. We would also like to extend our sincere gratitude to K. J Somaiya Institute of Engineering and Information Technology for supporting us in every way possible by providing all the necessary facilities and equipment to build the open source laserGRBL – arduino based laser engraver. We would like to thank Dr. Milind Nemade, Head of Electronics Department for bringing out the best in us, always motivating us to deliver the best possible outcome in terms of technological aspect. We would also like to express special thanks to the guide – Mrs. Sejal Shah for mentoring us throughout the planning and building of the open source laserGRBL – arduino based laser engraver. Her advice and knowledge helped to overcome some of the hurdles beforehand and also helped to have an overall thorough understanding of the open source laserGRBL – arduino based laser engraver to be built.

VIII. REFERENCES

[1] Sonali Dhanwade, Reshma Magar, Asmita Deshmukh, “KC draw using arduino”, International Research Journal of Engineering and Technology (IRJET) volume 06 issue 04, April 2019

[2] Infantanto Abishek.J, Nandhagopal.V. S, Kesavan.S, Hakkim.M, Sivakumar.S, “Mini CNC Engraver Machine”, International Journal of Advanced Research in Basic Engineering Science and Technology
(IJARBEST), Volume 4 issue 3, March 2018

[3] R. Balatharangam, P. Madhu Priya, R. Pavithra, Prithiviraj, U. Poornima, “Design and
Development of arduino Controlled Writing Robot”, International Research Journal of Engineering and Technology (IRJET) volume 04 issue 04, April 2017

[4] KajalJ.Madekar, Kranti R. Nanaware, PoojaR.Phadtare and Vikas.Mane,” Automatic mini CNC machine for PCB drawing and drilling.” International Research Journal of Engineering and Technology, vol. 3 Feb.2016.

[5] Lin Li, ”The advances and characteristics of high-power diode laser materials processing” Optics and Lasers in Engineering 34 (2000) 231\}253.

[6] J. MartheynBerbesi, K. Saumeth, F. Pinilla,”Parallel Control Firmware for CNC Milling Machine Based in Arduino”, IEEE, 2017.

[7] PavelSofer, Jaromir kuta, Jan Gebauer, “Drilling of Circuit Boards Using CNC Controlled by Programmable Logic Controller”, International Carpathian Control Conference, 2012.

[8] N.Balasubramanyam_and Prof. Smt. G. Prasanthi, “Design and Fabrication of an Automatic PC-Based Drilling Machine”, HCTL Open International journal of Technology Innovations and Research, Volume 7, January 2014.

[9] P.A. Sherring da Rocha Jr., R.D.S. Souza, and M. Emilia de Lima Tostes, "Prototype CNC machine design", Journal of Energy and Power Engineering, vol. 6, pp. 1884- 1890, 2012. M. Young, Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[10] Roshni Ghodmare, Sonali Tandulkar, Prof. C.D.Raut, “PCB engraving and drilling machine”, International Journal of Research in Science and Engineering, vol. 3, Mar 2017.

[11] S. S. Sarguroh, A. B. Rane, S. A. Korgaonkar and D. S. S. Sudhakar, "Elimination of Proprietary Control for Computerized Numerical Control (CNC) Machine", *Journal of Basic and Applied Research International*, vol. 17, no. 3, pp. 211-217, April 2016.

[12] Saif Aldeen Saad Obayes, Ibtesam R. K. Al Saedi, Farag Mahel Mohammed, “Prototype Wireless Controller System based on Raspberry Pi and arduino for Engraving Machine", ResearchGate DOI: 10.1109/UKSim.2017.20, April 2017.

[13] Matt Henry et al.,”Cutting flexible printed circuit board with a 532nm Q-switched diode pumped solid state laser” Paper M804.

[14] C. Leone, S. Genna, G. Caprino, I. De Iorio, “AISI 304 stainless steel marking by a Qswitched diode pumped Nd:YAG laser” Journal of Materials Processing Technology.

[15] Jozef Wendland et al.,”Deep engraving of metals for the automotive sector using high average power diode pumped solid state lasers” Paper 1901.

[16] S.H. Masood, Kelly Armitage, Milan Brandt, “An experimental study of laser assisted machining of hard-to-wear white cast iron” International Journal of Machine Tools & Manufacture 51 (2011) 450–456.

[17] P. Laakso, S. Ruotsalainen, H. Pantsar, R. Penttila,” Relation of laser parameters in color marking of stainless steel”.

[18] Adelmann, B. and Hellmann, R. (2011), “Fast laser cutting optimization algorithm”, Physics Procedia, 12, 591-598.

[19] Black, I. and Chua, K. L. (1997), “Laser cutting of thick ceramic tiles”, Optics and Laser Technology, 29, 193-205.