Open Source LaserGRBL – Arduino Based Laser Engraver

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 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.

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 researched on composing machine which is helpful to people for composing. They use UNO arduino, servo motor, GRBL shield, motor driver and benbox programming, stepper motor. The main goal of this machine is to compose on paper the coordinates that are provided by the user through computer application. Therefore it reduces the time taken and increases productivity. The form factor of this machine has been reduced in size in order to make it portable and easy for people to relocate and use it efficiently. [1]

Infantantoabishek.J et al a CNC Engraver decreases the amount of errors. It works on 3 axes mode. It engraves finely on plastic, wood, aluminium and steel. It is low cost with high precision while engraving. It uses G-code to maximize efficiency with in turn reduces several other dependencies. The surface area is of 230mm x 290mm indicating that it is compact and easy to use. It reduces man power. [2]

R. Balathangam et al arduino controlled composing robot. In this composing robot visual fundamental programming is utilized and for discourse acknowledgment, arduino microcontroller has been utilized. To begin with, client is to take care of message by means of 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]

Lin li “Characteristics of diode laser processing materials”. Used for diode lasers for preparing the materials required. 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) [4]

III. PROPOSED APPROACH

The first approach to the Open Source LaserGRBL – arduino based laser engraver was that to take the pixels of the images and send each pixel onto the arduino to engrave. This methodology will engrave the whole image pixel by pixel so that it is very precisely engraved onto the surface. The main drawback of this approach is that taking each pixel out of the image and sending it to the arduino required a lot of processing time along with a large storage of temporary memory buffer. This made the whole process a lot slower and ultimately not feasible for implementation.

The final decision was made to use the laserGRBL software that is open source for usage and provides a lot of features as well as custom settings related to the Laser as well as tuning the image according to the user needs. The stepper motor configurations are also available to control through the laserGRBL software. This software can monitor and control the Laser power so that the intensity of the engraved design can be customized as per needs and requirements of the user.

IV. MATHEMATICAL MODELLING

Image is uploaded on laserGRBL software and then image is converted into G-code, which then is fed to an arduino uno. If the size of G-code is within the memory limit of the arduino then it executes the code, else it throws an error saying exceeding arduino memory which displayed on the GRBL software. If no error message is generated, the arduino sends the G-code in the form of coordinates for plotting to the CNC shield. The CNC shield engraves on the specific coordinates by controlling the motors with PWM signals provided via arduino uno. The motors and laser start acting according to the coordinates sent by the CNC shield via arduino uno. If power loss occurs it asks whether to restart the process from the beginning or continue from where it stopped. After engraving is done both the axis return at origin (home position).

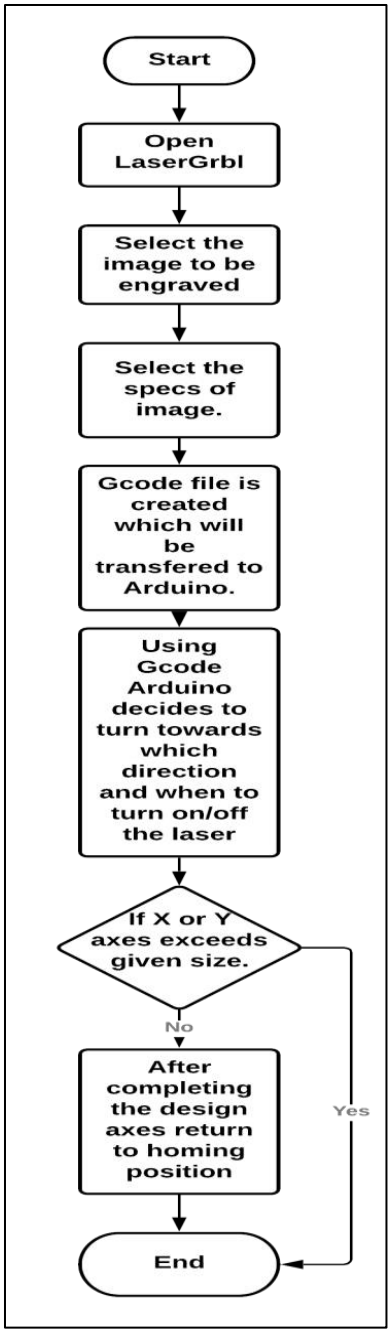

Figure 1: Flow Chart

V. TECHNICAL SPECIFICATIONS

To demonstrate the proposed approach, there was an extensive research involved in studying the technical aspects of the different softwares that were compatible for usage with the hardware requirements.

G-Code: G-code incorporates a progression of order for situating, moving, instrument the executives. G-

code guidelines are given to a machine regulator (mechanical PC) that advises the motors where to move, how quickly to move, and what way to follow. G-codes, likewise called preparatory codes, are any word in a CNC program that starts with the letter G. By and large it is a code telling the machine apparatus what sort of activity to perform, such as:

- Fast development (transport the instrument as fast as conceivable in the middle of cuts)
- Controlled feed in an orderly fashion or circular segment.
- Arrangement of controlled feed developments that would bring about an opening being exhausted, a work piece cut (steered) to a particular measurement, or a profile (form) shape added to the edge of a work piece
- Set tool information such as offset
- Switch coordinate systems

LaserGRBL: LaserGRBL is intended to converse with control board dependent on arduino uno and GRBL firmware. LaserGRBL is a G-code streamer for laser engraver. The latest version of laserGRBL comes with "Laser Mode" that is specifically configured to work with the arduino setup containing Laser units. LaserGRBL is very fast in execution when compared to other G-code streamer softwares available in the market. It also comes with the customization of laser speeds so that all types of hardware can keep up with the software commands. The major benefit of laserGRBL is its inclusion of a "Vectorization Tool" that enables to open any image/logo downloaded from internet and clean the entire disturbance from the image for example jagged edges, watermarks, blurry content and engrave it with best quality.

Figure 2: Original Image

Figure 3: Vectorized Output

VI. WORKING

Hardware:

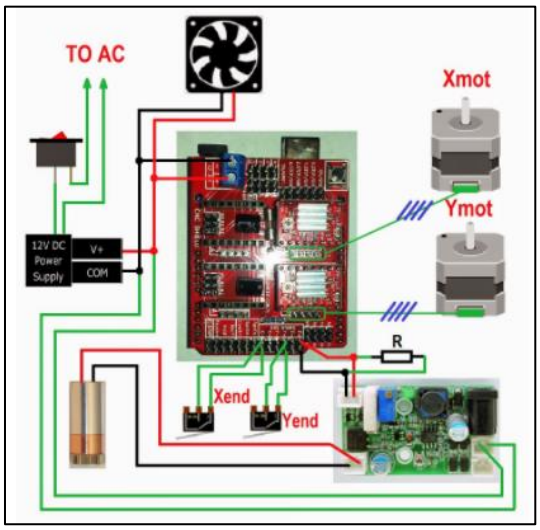

Figure 4: Circuit Diagram

- 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:

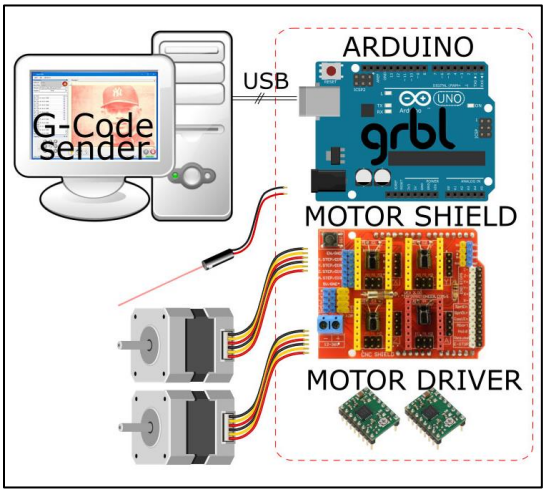

Figure 5: Working

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.

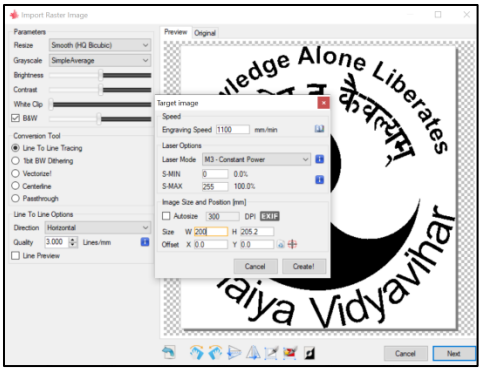

Figure 7: Configuring Laser and Image Specifications

- 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:

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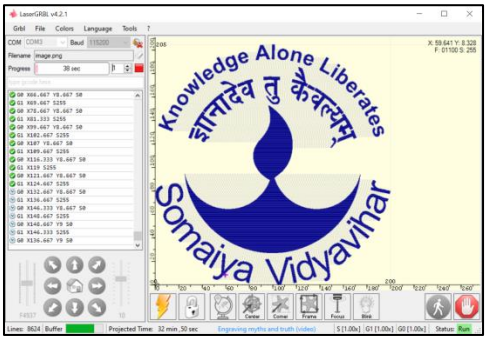

Figure 8: On-going Engraving Process

- 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 a precise image that is customized to the needs and satisfaction of the user.

VII. 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.

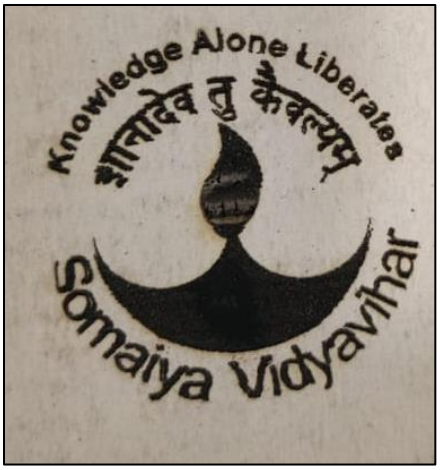

Figure 9: Cardboard

Figure 10: MDF

Figure 11: Wood

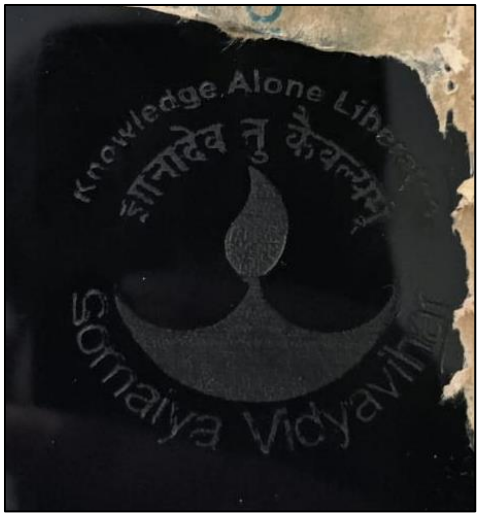

Figure 12: Acrylic

As shown in figure 9, 10, 11 and 12 the surfaces used are cardboard, MDF, wood and acrylic respectively. The results obtained are exact same to 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 takes 12 volts 0.4 amperes 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 in-total leads to system consumption of 10.1 watts.

VIII. 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.

IX. FUTURE WORK

Future plan of work will be implementing the system using the whiteboard concept where in 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.

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XI. REFERENCES

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