Design, Testing and Simulation of Cost Effective Laser Engraving Machine

Swapnil Dalvi[1], Deepti Thigale[2], Chetana Totre[3], Harshada Auti[4] ,Yogesh Maske[5]

[1,2,3,4,5] *Department of Mechanical Engineering, MIT Academy of Engineering (Alandi), Maharashtra, India*

ABSTRACT

This paper presents a Design, testing and simulation working model of laser engraving machine. In this paper cost- effective laser engraving machine designed. Laser beam is suitable for cutting paper, wood Fiber material plastic. Inscape is software where text or image can be edited and G-code for that text can be generated. G-code plugin extension is used for generate G-code. Many types of industrial lasers like, carbon dioxide (CO2) laser and fiber laser, semiconductor laser are available in market for laser engraving. Laser GRBL software is used for image preview and simulation purpose. Here developed of design of CNC laser engraving machine interface with laser device by using Laser GRBL software and Arduino as controller.
Keyword: - Laser, engraving, Arduino, Inkscape, Laser GRBL.

1. INTRODUCTION

Laser is used to engrave or mark on object. In laser engraving the material is removed from top surface with specified depth. Laser marking is different from laser engraving process in which laser is used to engrave on object. In laser marking it is only the discoloring the surface but in laser engraving it engrave on surface. Engraving process requires the inks and bit heads which engrave on surface but in laser engraving it requires only laser. Laser is main component for laser engraving process. These properties are unique from the alternative engraving process where inks and bit heads are required and also maintenance of it is necessary. For thermal and electrical connection, the electronic component is required. Integrated circuit is used as electronic component for electrical and electromagnetic effects.

There can also use laser scanning for removal material volume and surface quality by varying pulse frequency. The laser engraving is effectively used to engrave on different types of wood material. Estimate the removal material by using the depth of engraving. There are many advantages of laser engraving such as non-contact working, scanning speed, high flexibility, high repeatability and high automation.

2. LITERATURE SURVEY

Mr. Sachin Patel (2015) has been discovered the influence of process parameters like laser power ,scanning depth, laser frequency on material removal rate, surface roughness & Engraving depth by experimentally. In these paper author describes many types of laser like carbon dioxide (CO2) laser and neodymium –dopes yttrium Aluminum garnet laser, semiconductor laser, fiber laser which are used for lase engraving process. The author recently performs laser engraving of stainless steel 316. Material is removed by lase process called as laser engraving machining process.

In 2010, Janez Diaci and their team of university of Ljubljana published paper on "Rapid and flexible laser marking and engraving of tilted and curved surface. This paper describes that Industry Laser Engraver is used to engrave on horizontal 2D surfaces but here we can engrave on curved inclines surface with 3D dimensional laser measurement system. Here we used same laser source and optics which is used in other engraver with some additional hardware components. There are two types of laser regime is used-1) Low power CW laser regime is used to measure the 3D shape of work piece surface 2) High peak powered Laser regime is used for processing. By using low power laser regime we get the projection of our work piece shape so need to exact positioning or orientation of our work piece before processing as automatic projection of work piece takes place. This paper demonstrates the 2D and 3D laser engraving method with its advantages and disadvantages. This method is applied for engrave on curved and flexible Here with the help egg example the whole process is explained. For beam movement in X and Y direction , Galvo motors and a linear translator for positioning the work piece along the Z-axis is used .The measurement of work piece is takes place within 10 sec. Here custom software is developed which measure and then project the laser can beam according to input given.

In 2015, Georgi M. Martinov published paper on an approach to building specialized CNC system for Laser Engraving machining. This paper describes the main problem for material processing with impulse laser emission is necessary to maintain impulse frequency in fixed interval .The traditional control method with impulse confirmation waiting could be realized in any NC system .The experiment shows that the developed

approach allows to greatly increase the processing speed compared to the method with impulse confirmation waiting .Hence the increases the 30- 50% is achieved.

Alexander Stepanov (2015) gives an idea of engraving of paper by using laser. The laser is useful in processing of paper materials was discussed in paper. It discovered that laser is useful to engrave on all natural wood-fiber based materials. Nowadays due to development of laser engraving (especially development of CO_2 technology) which is less costly, laser engraving on paper material has started to become more widely used. It is more efficient. There, some reviews on research paper were discussed.

In 1993, Yusoff discovered the marking of Integrated circuit (IC) packages with neodymium-doped yttrium aluminum garnet lasers. It has become widely accepted technique in the microelectronics industry. The author also presents discussion and literature review of various methods. He describes the mechanism of laser marking of plastics and ceramics IC packages. The effect of materials properties such as absorptivity and the melting point on the mark legibility characteristics are reviewed. He describes the effect of the marking parameters such as power, density, focal position and marking speed on the mark legibility characteristics are reviewed .Mark legibility characteristics are the mark contrast and the mark width. Here also the limitations and advantages of marking of IC packages are discussed.

3. DESIGN

3.1 Components

Arduino – Arduino is a platform or board to program. Arduino is designed for those who creating interactive objects or environments which is easily accessible to artists, designers, and anyone interested. The Arduino gives the instruction to for engrave image row by row. A simple Processing sketch was created and stream into instruction file. The data is transferred via the virtual serial port connection to the Arduino.

Relay – Relay 5V module is board interfacing and it can also directly control by the microcontroller such as Arduino, AVR, PLC, ARM etc. It required low level triggered control signal (3.3-5.5 VDC) to control relay. The relay is digital switch which is capable to switching much higher voltage and current your normal Arduino boards

Laser- Laser cutting works by directing the output of a high-power laser most commonly through optics. The high voltage laser beam is directly penetrate on the material, which then either melts, burns, vaporizes away, and we get the engraving shape or image.

CNC shield- CNC shield V3 is used as driving shield for engraving machines, fully compatible with UNO R3. So you just need to place and match the pins with UNO R3 control board when using. It has total 4 Driver Ic pin slots for stepper motor drive modules to drive 4 stepper motors. Each stepper motor only needs 2 IO ports, so 4 IO ports is enough to manage 2 stepper motors, very easy to use. This shield can make quick work for in your Engraving project.

DVD writer- DVD stepper motor control board 2 phase 4 wire x2 can be used for making mini pen engraver machine,3d printer and laser engraver can be driven thought A4988 and l293d Driver IC. It can be control by GRBL controller.

Driver IC- At the heart of the A4988 driver you will find a chip made by Allegro Micro Systems: the A4988 DMOS Micro stepping Driver with Translator and Overcurrent Protection. This motor driver IC interfacing with a microcontroller super easy as you only need two pins to control both the speed and the direction of the stepper motor.

GRBL Software- GRBL is a high-performance software for controlling the motion of machines that move, that make things, or that make things move, and will run on a straight Arduino. If the maker movement was an industry, Grbl would be use as an industry standard. Most open source 3D printers controlled by Grbl.

Arduino Software- The Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on operating system like Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other software. This software can be used with any type of Arduino board.
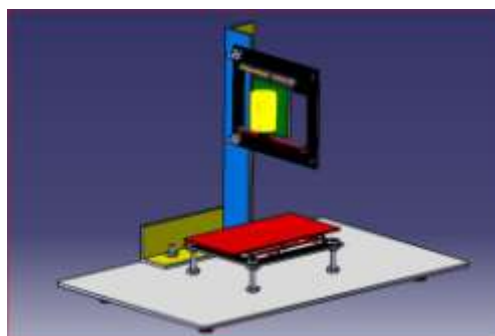
3.2 Design in Catia

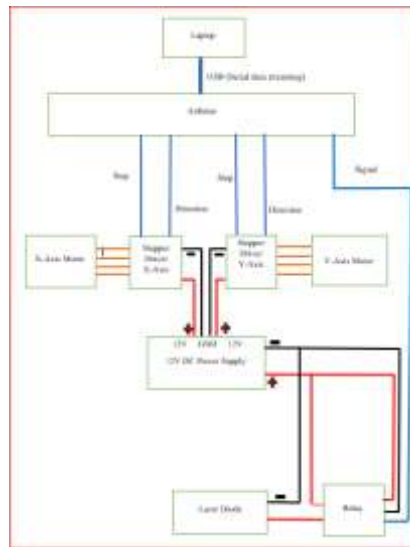Fig -1: Cad Model of Laser Engraving Machine

3.3 Circuit Diagram

Fig -2: Laser Engraving Machine Working Circuit Diagram

3.4 Software Results

The Inkscape is the very easy to use software for to create G-code file. It's a vector graphic software can run on all operation system. There is G-Code Tool plugin which is built as G-Code Extension. Here we will use that Tool plugin to create G-code file.

Step 1: Import the image or Write the text into the Inkscape with the default setting.

Step 2: convert object to the path. So, that plugin can generate g-code by this path.

Step 3: choose the tool (a virtual cutter) for engrave in the software.

Step 4: After that change the parameter like Diameter, Feed speed etc.

Step 4: Set the orientation points, here we choose the "2 points mode", and set the Z surface to 0, the Z depth to -1 (the cutter will to 1mm under the surface to start engraving).

Step 5: Choose path to the G-code with the extension of G-code plugin and we get the g-code file.

Step 6: Load the G-code file in the laser GRBL Controller we get the image preview with engraving path.

3.5 G-Code for example-

```
M05 S0 G90 G21
G1 F1000
G1 X27.7864 Y18.785 G4 P0
M03 S250 G4 P0
G1 F750.000000
G1 X24.769 Y18.785 G1 X24.769 Y8.5339 G1 X22.2771 Y8.5339 G1 X22.2771 Y18.785 G1 X19.2596
Y18.785 G1 X19.2596 Y21.2433 G1 X27.7864 Y21.2433 G1 X27.7864 Y18.785 G4 P0
M05 S0G1 F1000
G1 X18.1824 Y8.5339 G4 P0
M03 S250 G4 P0
G1 F750.000000
G1 X12.5238 Y8.5339 G1 X12.5238 Y10.7872 G1 X14.1072 Y10.7872 G1 X14.1072 Y18.9899 G1 X12.5238
Y18.9899 G1 X12.5238 Y21.2433 G1 X18.1824 Y21.2433 G1 X18.1824 Y18.9899 G1 X16.599 Y18.9899 G1
X16.599 Y10.7872 G1 X18.1824 Y10.7872 G1 X18.1824 Y8.5339 G4 P0
M05 S0 G1 F1000
G1 X10.4991 Y8.5339 G4 P0
M03 S250 G4 P0
G1 F750.000000
G1 X8.0203 Y8.5339 G1 X8.0203 Y17.0438 G1 X6.2292 Y11.5213 G1 X4.5096 Y11.5213
G1 X2.7186 Y17.0438 G1 X2.7186 Y8.5339 G1 X0.3695 Y8.5339 G1 X0.3695 Y21.2433 G1 X3.2637
Y21.2433 G1 X5.4376 Y14.8672 G1 X7.605 Y21.2433 G1 X10.4991 Y21.2433 G1 X10.4991 Y8.5339 G4 P0
M05 S0 G1 F1000 G1 X0 Y0
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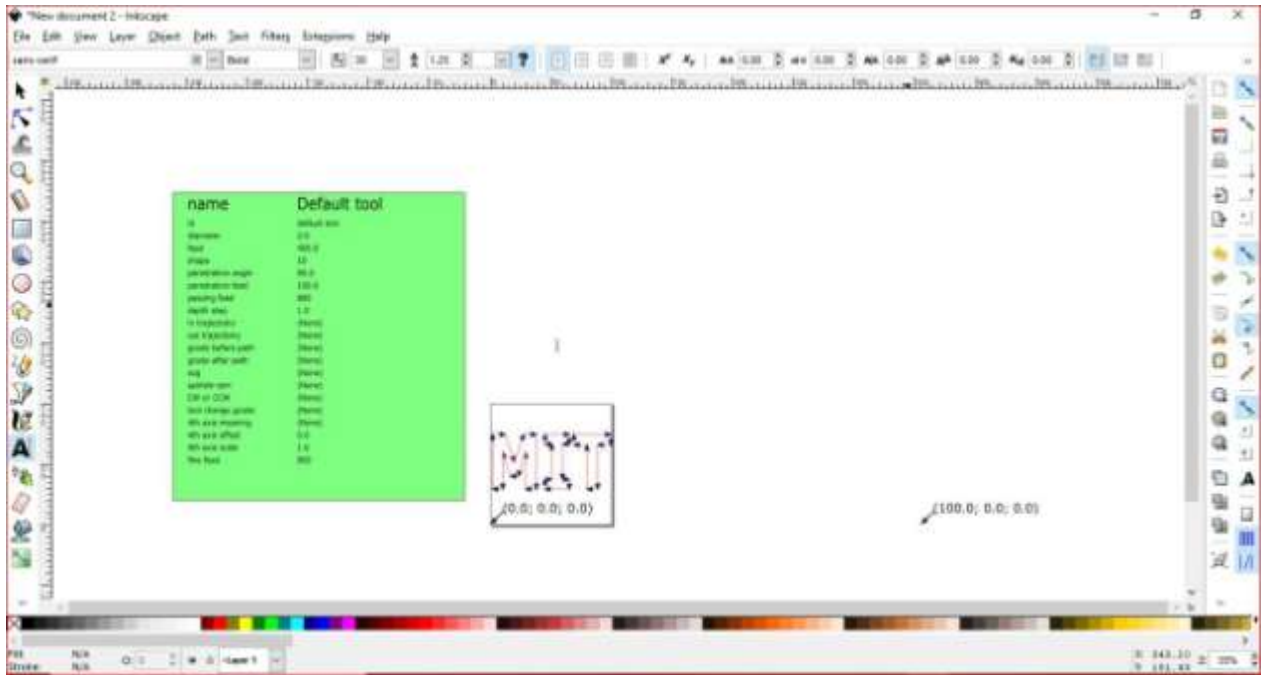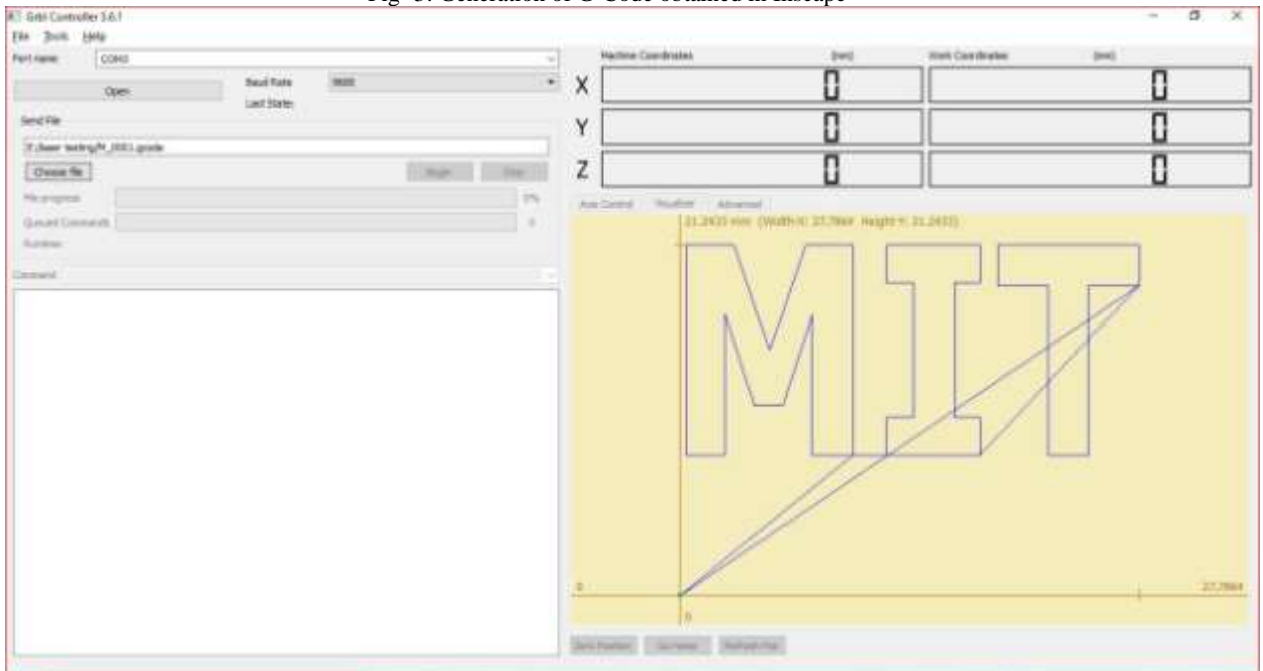
Fig -3: Generation of G-Code obtained in Inscape

Fig -4: Simulation of G-Code obtained in Laser Grbl

4. CONCLUSIONS

Conclusion is that the mini cnc machine is capable of doing some positioning and co-ordination in laser cutting and engraving application. Laser CNC machine can be determined by the engraving performance. From this research study, several conclusions can be drawn that the development of CNC 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-100mm, Y-100mm. The Mini-CNC machine developed is capable to doing and showing prototyping of some application in institute level to the students for learning of cost effective laser engraving or cutting machine.

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