

ELECTRONICS & CONTROL SYSTEM FOR LASER CUTTER

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Abstract: Laser cutting is a technology that uses a laser to cut materials, and is typically used for industrial manufacturing applications, but recently has been started to be used by schools for research purposes, small businesses, and hobbyists. The main principle in Laser cutting is to cut materials by directing the output of a high-power laser most commonly through optics. [1]

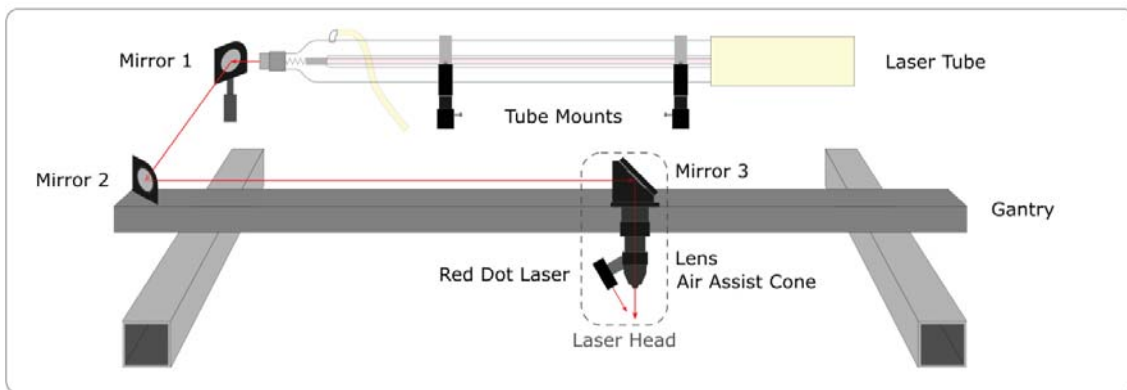
The work is mainly to refurbish an existing PCB cutter and convert into a laser cutting machine. This will be done by studying the working of the existing components, installing new and modifying existing mechanical parts, installing the necessary optics and finally developing a control system that will drive the laser cutter.

Keywords: Laser Cutter, Stepper motor, Laser tube, optics, Smoothie board, CNC, G-Code.

1 Introduction

The laser optics and CNC (Computer Numerical Control) are used to direct the laser beam generated onto the material that is to be cut. A typical commercial laser for cutting materials involves a motion control system to follow a CNC or G-code of the pattern to be cut onto the material. The focused laser beam is directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high-quality surface finish. Industrial laser cutters are used to cut flat-sheet material as well as structural and piping materials. [1]

The movement of the laser beam is achieved by the use of Optical Mirrors which are mounted on an X-Y axis table. By movement of the X-axis and Y-axis, the laser beam can be directed to different parts of the work piece. The displacement of the X-Y axis is generally carried out by motors preferably Stepper Motors which are controlled by a Microcontroller.



Pic.1 Basic Components of Laser Cutter

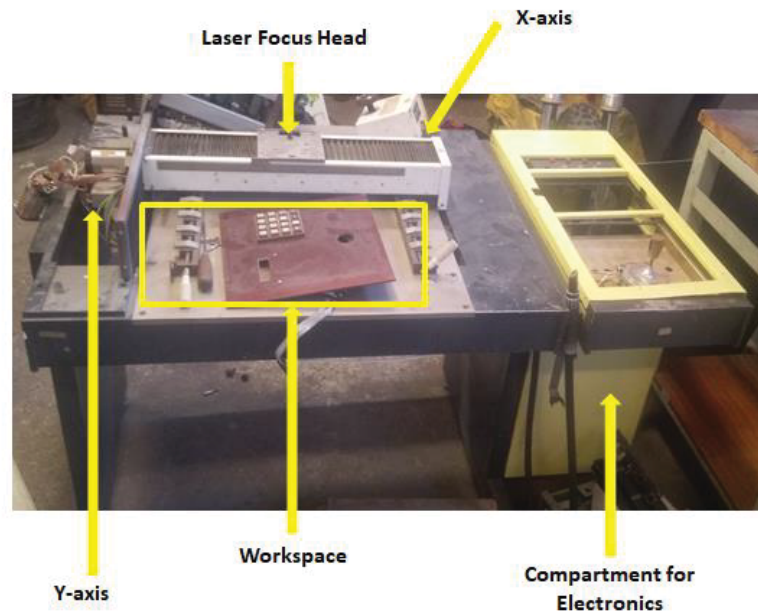
2 Scope of Work

The AIRSHIP Club under the Faculty of Mechanical engineering has in its laboratory an old PCB engraver that is approximately 50 years old. The main aim of my diploma thesis is to refurbish the PCB engraver and convert it into a Laser cutter/engraver with the purpose of the cutting Plexi glass into small components.

The project would be a joint work between the AIRSHIP Club and Department of Instrumentation and Control Engineering with the former taking care of the hardware construction and the latter developing the electronics and control system for the Laser Cutter.

Scope of my work for the part of Project 3:

1. Perform a case study of the existing PCB engraver and identify the functioning of its key components.
2. Study the working and technologies of Laser Cutters and the components required to build one.
3. Prepare and propose a Bill of Material to purchase components required.
4. Test and see the possibility of using the existing stepper motors.



Pic.2 Existing Setup

3 Component Requirement

After undertaking a detailed case study of laser cutter used in industries and those used by hobbyists, we concluded the components that will be needed to build the laser cutter. The components required were classified into two parts, the parts for building the laser and the parts for the control system.

Components to be needed for building the laser cutter:

1. CO2 Laser Tube
2. Laser Power Supply
3. Optics (Focusing Lens, Mirror and Lens Stands)
4. Water Pump
5. X-Y axis table (Existing)

Components for the Control of the system:

1. Smoothie Board
2. Stepper Motors (Existing)
3. Driver for Stepper Motors
4. LCD Screen for the Smoothie Board

4 Bill of Material

Taking into account of the limited budget we had, we had to request different quotations from many suppliers from China, Germany and The Czech Republic and also for different configurations of the Laser Cutter.

The final and approved Bill of Material is shown below:

Table.1

Item	Cost (CZK) (Approx.)
50 Watts Laser Tube	3500
50 Watts Laser Power Supply	1600
Optics	3000
Water Pump	900
Smoothie Board	2000
LCD Screen For Smoothie board	250
Total	11,250

5 Testing

5.1 Stepper Motors

The stepper motors shown in this picture are approximately 50 years old. Because of this we were unable to find any catalogues providing more information about them. Hence we had to test them step by step.

However, we know that these motors are Unipolar motor with 8 leads. The existing PCB printer has 5 available stepper motors.

Stepper Motors Test 1

In the first test, we tried to find which leads were paired. We did this by measuring the resistance across the leads and we were unable to find which leads were paired. We then gave a supply directly to the motors and found that torque was produced in the motors. All 5 motors passed this test.

Results of Testing

Table.2

Motor 1	
Ports	Ohms
1-2	41.4
3-4	42.3
5-6	41.5
7-8	42.0

Motor 2	
Ports	Ohms
1-2	40.6
3-4	40.9
5-6	40.8
7-8	41.2

Motor 3	
Ports	Ohms
1-2	42.3
3-4	40.9
5-6	41.0
7-8	40.3

Motor 4	
Ports	Ohms
1-2	40.8
3-4	41.2
5-6	40.8
7-8	41.8

Motor 5	
Ports	Ohms
1-2	42.1
3-4	42.0
5-6	40.4
7-8	40.8

Conversion from Unipolar to Bipolar Stepper

1. Since unipolar motors are less used these days, it was difficult to find a proper unipolar stepper motor driver with desired specifications like current control.
2. Hence, we decided to convert the unipolar stepper motor into a Bipolar Stepper motor. I did this by parallel connection of the ports.
3. To test the working of it, I connected the motors to a driver and with the help of an Arduino controller we tested the working of the motors.

Parallel Connection of the Ports

To convert the motors into Bipolar, we parallel connected the ports. In all the five motors, the ports which were connected in parallel are as follows:

Table.3

1	5
2	6
3	7
4	8

From the second test, we found that, only two of the five stepper motors were working and the other three were faulty. Since, 2 motors are required to drive each axis, another single and powerful motor has to be purchased to drive another axis. The new motor that is purchased is a bipolar stepper motor.

The parameters of the new motor are as follows:

Table.4

No of Leads	4
No of Phases	2
Step angle	1.8 ⁰
Mass	0.24Kg
Rated Voltage	3.57 V
Rated Current	1.5 A
Torque	1.5 N.m

5.2 X-Y Axis Table

With the motors which were working, I tested the movement of the X axis and Y axis of the table respectively and observed that both the axes worked with any problem.

The speed of the movement of the X-axis and Y-axis were measured and was found about to be 1cm/second.

6 Future Development

The scope of the work for Project has been successfully carried out. For the remaining part of the project, I will carry it on as my Diploma thesis. The work that has to be for the successful completion of the project is as follows:

1. Configure the Electronics for the machine.
2. Configure a Control System for the Laser Cutter using a Smoothie Board controller.
3. Test the working of the system.
4. Prepare the necessary documentation of the Laser cutter.

7 Conclusion

The objectives which were laid for Project III were successfully carried out. The components that are required to construct the Laser Cutter have been ordered and are to be shipped. The motors were tested and arrangements to purchase and install the new motor have been made.

References

[1] Laser Cutter 101, online < <https://github.com/Obrary/ebook-laser-cutter-101/raw/master/eBook/Laser-Cutter-101-eBook.pdf> >, accessed 26.10.2018,



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