PRINTED CIRCUIT BOARD PLOTTER

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بسم الله الرحمن الرحيم

ABSTRACT

Because of the fast development of innovation, the use and use of Computer Numeric Control (CNC) machine in ventures are expanded. The manufacture of productive Computer Numeric Control (CNC) machine is utilized to lessen cost and many-sided quality of machine. Point of proposed work is to manages the outline of programmed smaller than normal CNC machine for PCB drawing. The thought behind our venture is to outline a PCB based CNC machine with minimal effort by joining highlights of PC with UNO controller in an Arduino. A G code is utilized for entire framework task, G code is only a dialect in which individuals tell computerized machine instruments 'How to make something'. The How is characterized by guidelines on where to move and how quick to move.

CERTIFICATE FOR CORRECTNESS AND APPROVAL

Certified that work contained in the thesis – PCB Plotter carried out by **NC Muhammad Ibrahim Khan**, **NC Sana Fayyaz**, **NC Arham Tasleem**, **NC Muhammad Haris** in supervision of **Assoc. HOD Dr. Muhammad Imran** for partial fulfillment of Degree of Bachelor of Electrical (Telecomm) Engineering is correct and approved. Approved by

_____

Assoc. HOD Dr. Muhammad Imran

EE DEPARTMENT

MCS

DATED:

_____

DECLARATION

The work, or any of its portion, written in this thesis has not been submitted for provision of any another award or qualification, either at this institute or elsewhere.

DEDICATION

In the name of Allah All Mighty, the Most Gracious, the Most Benevolent Dedicated to our parents and our supervisor, who proved to be unwavering pillars of support and encouragement in helping us complete a work of the order of this magnitude.

ACKNOWLEDGEMENTS

We would like to thank Allah All Mighty for bestowing upon us, His countless and incessant blessings. Whatever we have achieved, we owe it to Him, in totality. We are also highly obliged to our friends and families for their unflinching support which has helped us achieved all the milestones of our lives.

We are extremely thankful to our project supervisor, Dr. Muhammad Imran Assoc. HOD from MCS who in addition to providing us with valuable technical help and guidance also provided us moral support and encouraged us throughout the development of the project.

We are also grateful to all faculty and staff of MCS who supported and guided us during our course work. Their support, knowledge insight, advice, training and guidance facilitated us in completing this difficult task.

Finally, we are indebted to Electrical (Telecomm) Department of the Military College of Signals, NUST.

In the end we would like to acknowledge the support provided by all our friends, colleagues and a long list of well-wishers whose prayers and faith in us propelled us towards our goal.

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CHAPTER: 1 INTRODUCTION

1. INTRODUCTION

A printed circuit board (PCB) is the board base for physically supporting and wiring the surface-mounted and socketed components in most of electronic circuits. The PCB bakes in an industrial oven to melt the solder, which joins the connections. Most PCBs are made from fiberglass or glass-reinforced plastics with copper traces.

PCB plotting is an essential step in electronics development for structuring, drilling, and milling of circuit boards. This allows developers to test ideas and easily make. The rapid prototyping method turns a sheer idea into a sample circuit board, which is ultimately used to manufacture a new product. [2

1.1 Overview

Digitally controlled plotters developed from before completely simple XY-writers utilized as yield gadgets for estimation instruments and simple PCs. Pen plotters print by moving a pen or other instrument over the surface of a bit of paper. This shows that plotters are vector graphics gadgets, instead of raster graphics. Pen plotters can draw complex line workmanship, including content, yet do as such gradually on account of the mechanical development of the pens.

They are frequently unequipped for effectively making a strong locale of shading, however can incubate a territory by drawing various close, customary lines. Plotters offered the quickest method to proficiently create extensive illustrations or shading high-determination vector-based work of art when PC memory was exceptionally expensive and processor control was extremely constrained, and different kinds of printers had restricted realistic yield capacities.

1.2 Problem statement

- PCB Designing is a difficult task when done by hand.
- It is a time taking process as it involves printing, etching, ink removing and drilling.

Therefore, we aim to design a system that reduces PCB fabrication from hours to minutes.

1.3 Objective

Our main goal is combining the concept of PCB and X-Y plotter in a single hardware, which draws proteus design on a sheet of insulated material such as fiberglass using a conductive pen that eliminates the process of etching and makes PCB designing fast and easy and gain flexibility.

1.4 Scope

- Plotters can chip away at huge sheets like at least 2 feet of paper and still keep up brilliant determination. Effectiveness, precision and speed are for the most part traits of a plotter. Plotters can spare all examples and formats on circle and dispense with the problem of loading similar examples or layouts again and again. Furthermore, a similar example can be drawn a large number of time with no corruption. This project will make:
- Task of PCB designing fast and efficient
- Can also be used for general 2D printing
- University laboratories where students work on PCBs
- Industries where electronics are invariably based on PCBs

1.5Organization of Document

This document is divided into six main sections:

- First section lays the introduction and basis of the project
- Second section summarizes the literature we have consulted regarding the project and the previous research on the topic
- The third section emphasizes on the project requirement specifications
- Fourth section contains design methodology
- Fifth section includes plotter design and specifications
- Integration of motors with software is explained in sixth section
- Section seven includes code implementation
- Eighth section is particularly about Hardware integration and complete working module
- Section nine includes the preparation of conductive ink for circuits
- Final sections include future work, appendix and references

CHAPTER: 2

LITERATURE REVIEW

2. LITERATURE REVIEW

PCB (Printed Circuit Board) is utilized to mechanically bolster and electrically associate electronic segments utilizing conductive pathways, tracks or flag follows scratched from copper sheets overlaid onto a non-conductive board. Segments are associated through the conductive material beneath a non-conductive board, the basic conductive material utilized as a part of bundled PCB are generally copper, since copper is shabby and normal. It includes the following steps:

- First the circuit is printed on a sticker paper through a laser printer or a photocopying machine
- After this the design is ironed over the copper side of the PCB, ironing it above the copper side of the board will paste the circuit to the PCB board
- After the circuit is pasted to the PCB board, it is dipped in an etching solution like Ferric Chloride for some time
- PCB board is then washed with water to remove the etching solution
- Remaining ink is removed with thinner, to uncover the unetched copper part

In this process of PCB printing, following limitations occur:

- PCB Designing is a difficult task when done by hand
- It is a time consuming process, might take hours
- Design might get misprinted resulting in incomplete wiring

To overcome these limitations an idea of printed circuit board plotter is brought into existence. It is basically an application or extension of MR-PEN made by SGT Bassit Ali in 2016.

2.1 Existing literature

Mr. Pen is an XY Plotter that can utilize different pens to draw anything which can be converted into G-Code. It is a drawing robot that actually draws with real pens. From being your partner at work, signing your documents to your personal sketch bot it can do that all. Designing overlays for the maps and getting them over to the telic sheets Mr. Pen can get it done in a couple of minutes.

2D plotting is being used since years and initially the plotter used the technique of dot matrix printers which uses a print head that moves back-and-forth on the page striking an ink ribbon at the front of the tool head. Using this method, it is not possible to rewrite or append something more to the already oriented line, as it cannot be aligned back at the exact angle. This mechanism was based on striking of tool, therefore the use of pen was not possible. By designing a system based on Cartesian coordinate robot principles the conventional problems can be eliminated providing quality 2D plotting which will be fast and multitoned. The striking mechanism is to be replaced by stroking mechanism with a prime target to replicate fonts, Urdu writings and personal signatures. Mr. Pen is an XY Plotter that can utilize different pens to draw anything which can be converted into G-Code. It is a drawing robot that actually draws with real pens. From being your partner at work, signing your documents to your personal sketch bot it can do that all.

Designing overlays for the maps and getting them over to the telic sheets Mr. Pen can get it done in a couple of minutes. You can place it in your child's room serving as a digital white board while your child is exploring his creativity on the tablet Mr. Pen will make it real on the board.

The written artifacts placed in museums are too old, and need frequent treatments for preservation. Mr. Pen has identified the need to recreate the same while keeping the originality factor as high as possible.

CHAPTER: 3

DESIGNANALYSIS

3. DESIGN REQUIREMENTS

3.1 Stepper Motor

Stepper motors are DC engines that move in discrete advances. They have numerous loops that are sorted out in bunches called "stages". By empowering each stage in grouping, the engine will pivot with extra special care.

Figure 1: Stepper motor

We have used **Nema 17 stepper motor** in our project for:

- **Positioning of pen** – Since steppers move in precise repeatable steps, they excel in applications requiring precise positioning such as 3D printers, CNC, Camera platforms and X, Y Plotters.
- **Speed Control of pen** – Precise increments of movement also allow for excellent control of rotational speed for process automation and robotics.
- **Low Speed Torque** - Normal DC motors don't have very much torque at low speeds. A Stepper motor has maximum torque at low speeds, so they are a good choice for applications requiring low speed with high precision.

3.2 Servo Motor

A servomotor is a rotational actuator or direct actuator that takes into account exact control of rakish or straight position, speed and increasing speed. We have used **micro servo motor SG90** in our project for the movement of pen.

Figure 2: Servo Motor

3.3 CNC Shield

The Arduino CNC Shield makes it simple to get your CNC extends up and running in a couple of hours. It utilizes open source firmware on Arduino to control stepper engines. We will use **CNC shield** or **ramp 1.4** for our project

Figure 3: Arduino CNC Shield

3.4 Conducting Pen

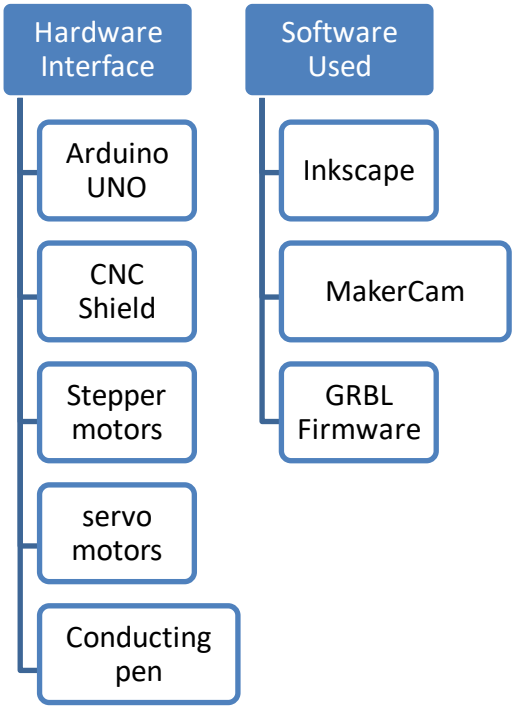
It is a sort of pen containing conductive ink that can be utilized to draw circuits quickly on adaptable substrates. They would then be able to join unique electrical parts on the drawn lines which enable the electrical streams to go through the segment.

Figure 4: Conducting Pen

CHAPTER: 4
METHODOLOGY

4. METHODOLOGY

Hardware and software approach used in the development of this project are explained in detail in this section.



4.1Establishment

4.1.1 Description

System level shall establish a connection between Application Front End and Firmware. Its priority is high.

4.1.2 Response Sequences

Connection shall be established between Application Front End and Firmware via System Level before any processing is to be done.

4.1.3 Requirements

The connection shall be established between the sub-systems and system will now ask the user to load the SVG.

4.2Load PDF from Proteus

4.2.1 Description

User shall give PDF file through application front end that should be accepted by the system and further processed. It has a High Priority.

4.2.2 Response Sequences

PDF file shall be opened in the Inkscape which convert it into SVG file and system will accept and successfully load it. If there is an error in the file or the loading process, the system shall not proceed further. It will convert the PDF file into SVG file.

4.2.3 Requirements

SVG file shall be successfully loaded into the system and Application front end will respond to show the loaded file.

Application front end should prompt user to view the loaded SVG file.

4.3Convert SVG File

4.3.1 Description

When the SVG file is loaded in the system, it should then be converted into G-code type code object file so that it can be processed. It has a high priority.

4.3.2 Response Sequences

Loaded SVG file shall be read and converted by our system into a G-code type code object file which then shall have the instructions to proceed further with the drawing procedure.

4.3.3 Requirement

The system should convert SVG file into G-code type code precisely.

Application front end should now prompt user to open and view the final converted G-code type code before we execute it and start drawing.

4.4Start Drawing/Execute code

4.4.1 Description

After the successful and error, free conversion of SVG file into G-code type Code, commands shall be sent to firmware for execution one by one and drawing of circuit will now begin.

4.4.2 Response Sequences

System will transmit commands from software end one by one upon the requests from firmware for execution and also will communicate back the wait signal to software end from firmware after successful execution of that command.

4.4.3 Requirements

System should keep the transmission of commands and acknowledgements smooth and no fluctuating.

System should immediately and automatically halt in case of any error in the command to avoid any permanent damage to final output drawing.

Status of drawing should be displayed at application front end from starting until the last command is executed.

4.5Emergency Stop

4.5.1 Description

System shall have this function at application front end and at hardware level as well to stop the drawing instantly just when this command is given or a button is pressed at hardware end.

4.5.2 Response Sequences

When the function is called, drawing at once stops and pen lifts up. The entire connection is re-established.

4.5.3 Requirements

The pen should immediately stop drawing and lift up at the current position. Connection should re-establish.

4.6Pick and Place Pen

4.6.1 Description

Pen can be picked and placed at current position and it is controllable through firmware. It shall only require connection to be established when controlling it from application end.

4.6.2 Response Sequences

We can lift pen and put it into any position.

4.6.3 Requirements

The pen should drop and lift up in the idle state and this could be done via application end (connection required) as well as via firmware (connection not required).

4.7 Flowchart

Flow chart of the whole procedure is as follows:

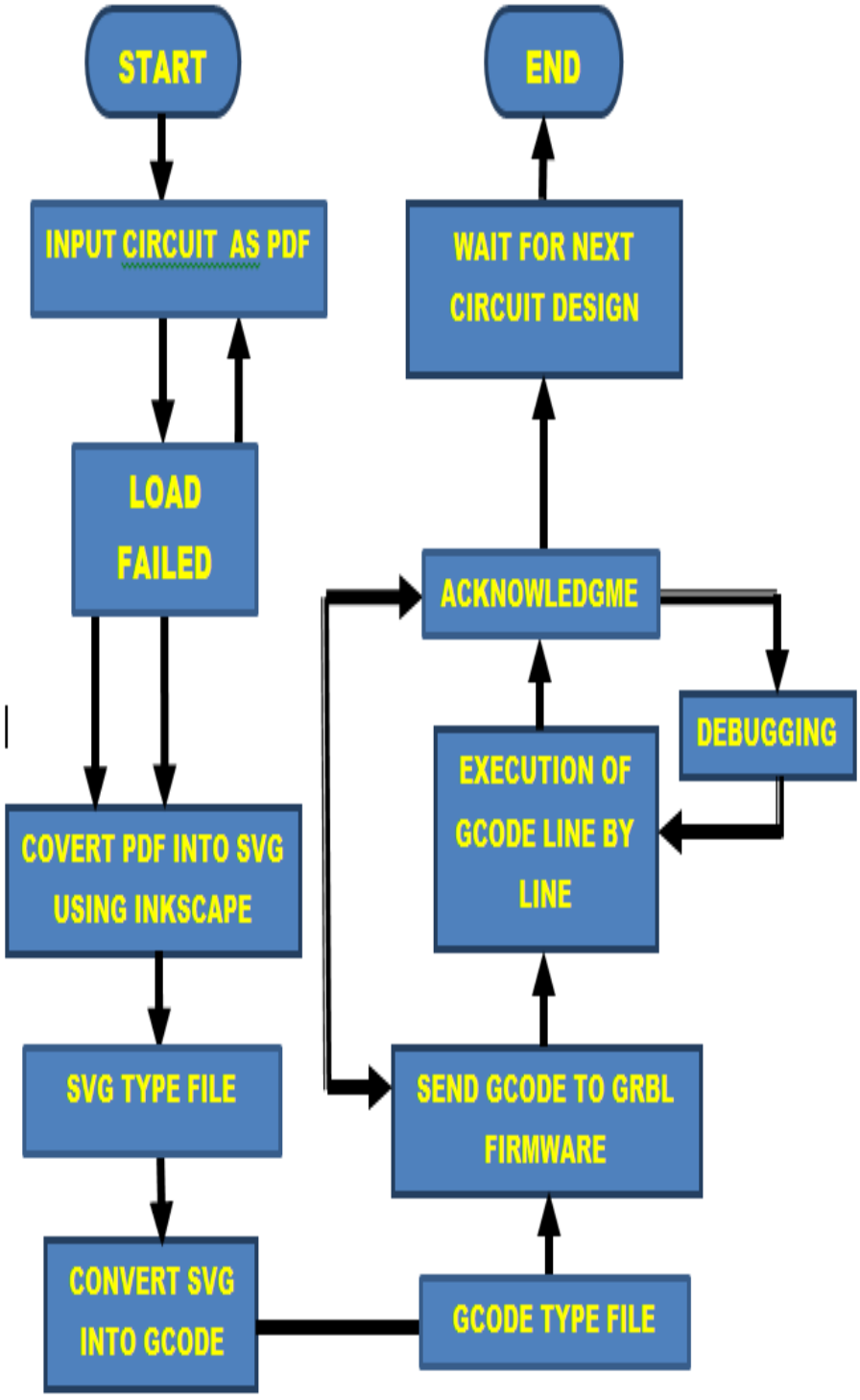


Figure 5: Flow Chart

CHAPTER: 5

HARDWARE DESIGN

5. PLOTTER DESIGN

5.1 3D- Model of Plotter

An extremely versatile machine, designed to serve a wide variety of everyday and specialized drawing and writing needs. It takes commands from computer in the form of GCODE to produce writing that appears to be handmade, complete with the unmistakable appearance of using a real pen (as opposed to an inkjet or laser printer) to address an envelope or sign one's name. And it does so with precision approaching that of a skilled artist, and using an arm that never gets tired. It can be used for almost any task that might normally be carried out with a handheld pen but here in this project this design is particularly focused on PCB printing.

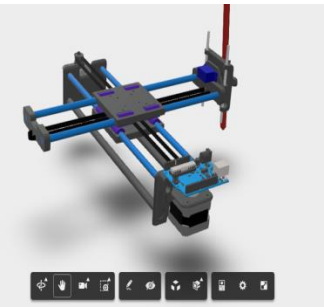


Figure 6: Plotter Design

5.2 Proteus Design

Proteus is software used to create circuits and test their working. This sample design is created using Proteus which gives out the image of the circuit as a PDF file. This PDF file is then converted into SVG file using Inkscape.

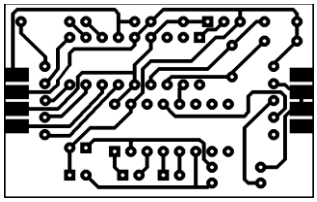


Figure 7: PCB Circuit Design

CHAPTER: 6

INTEGRATION OF MOTORS WITH SOFTWARE

6. INTEGRATION OF SOFTWARE WITH MOTOR

Step 1:

A circuit design is prepared in PDF format using Proteus software.

Step2:

The circuit design is then loaded to Inkscape to convert it into SVG (Scalable Vector Graphic) format.

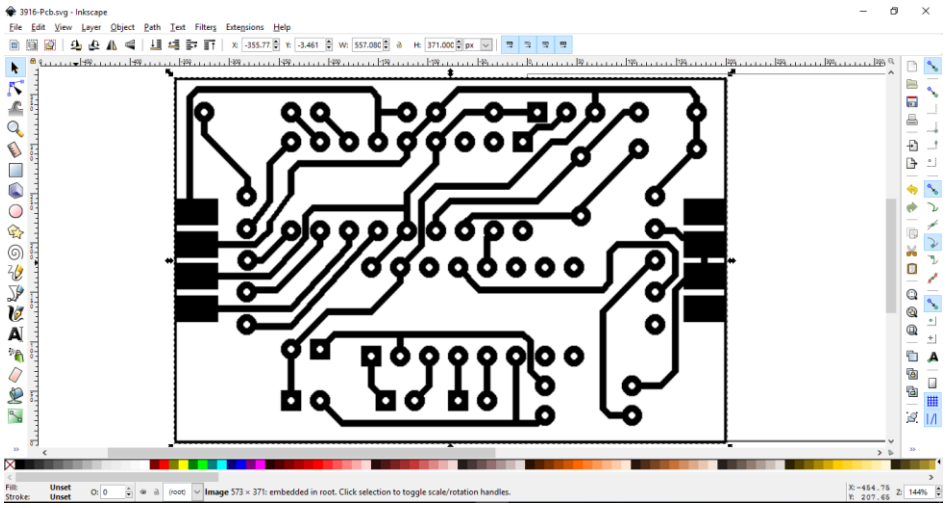


Figure 8: SVG file from Inkscape

Step 3:

The output from Inkscape is then uploaded on MakerCam which generates a Gcode for the circuit design in SVG format.

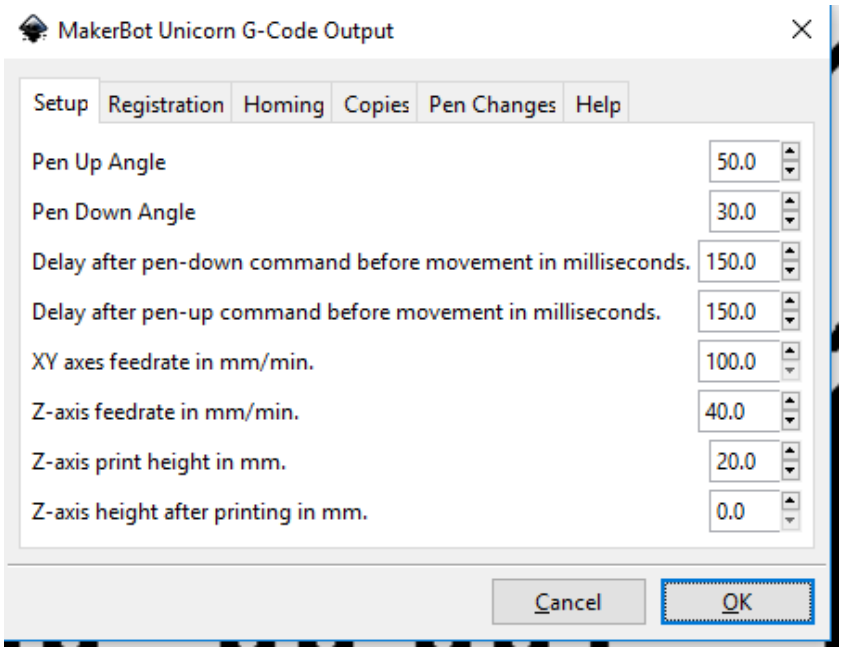


Figure 9: Generation of G-CODE

Step4:

For the pen to move in the desired directions, the Gcode commands are to be converted to stepper signals using a Grbl firmware like Grbl controller or candle. This moves the pen in X, Y and Z directions using two steppers and one servo motor.

Grbl is designed to work on Arduino. Arduino Uno needs to be flashed with Grbl by simply adding the Grbl library to Arduino IDE.

When this is done, the Grbl, which is a Gcode interpreter, will convert the Gcode commands to stepper signals which will move the motors. The stepper signals will be sent to the motors through connecting the motors to the Arduino board.

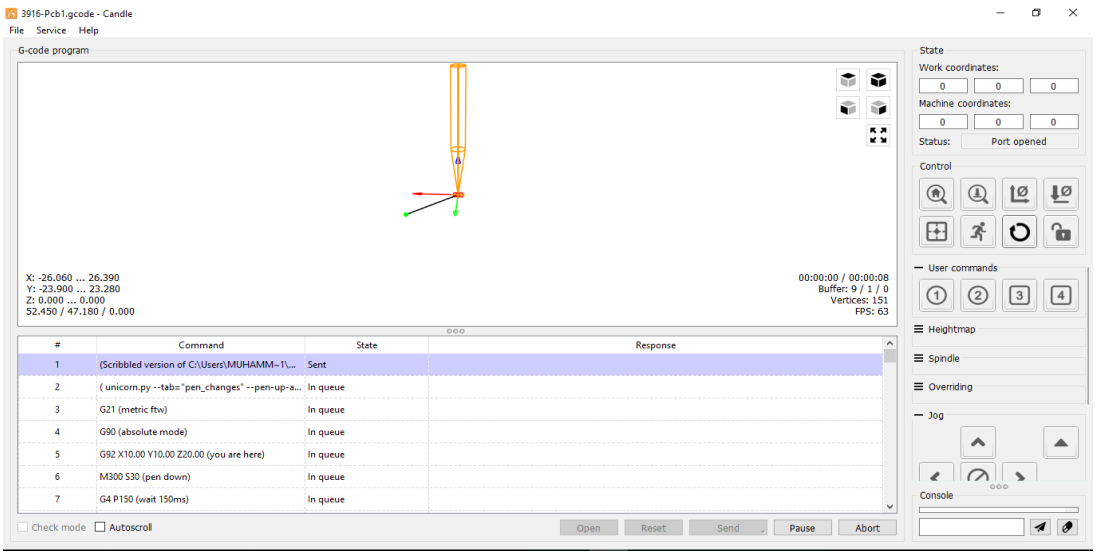


Figure 10: GRBL Firmware

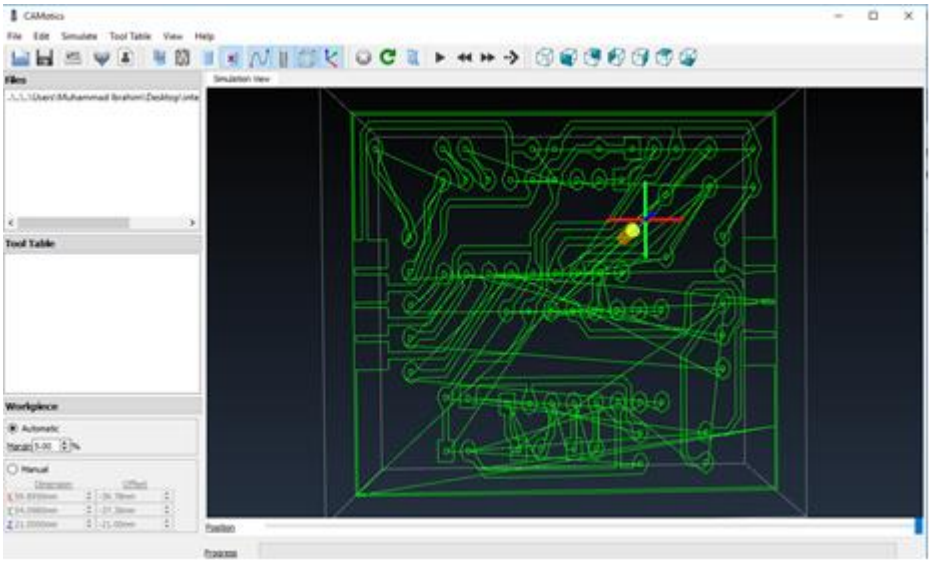


Figure 11: Simulation

Step5:

The Arduino does not provide sufficient amount of output current to drive a motor. A stepper motor, which requires 350mA current for operation, if connected directly to the microcontroller will result in not working motor and destroying the microcontroller due to high current.

Due to these reason motor drivers are used which provide the sufficient amount of power required for motor operation.

The motor drivers are installed on the CNC shield which is then mounted on the Arduino board. Make sure that the drivers are connected in the right direction.

Step6:

Now when the Gcode is sent to the Arduino carrying the Grbl library, the stepper signals are sent to the motors which draw their power from the drivers and move in the desired directions.

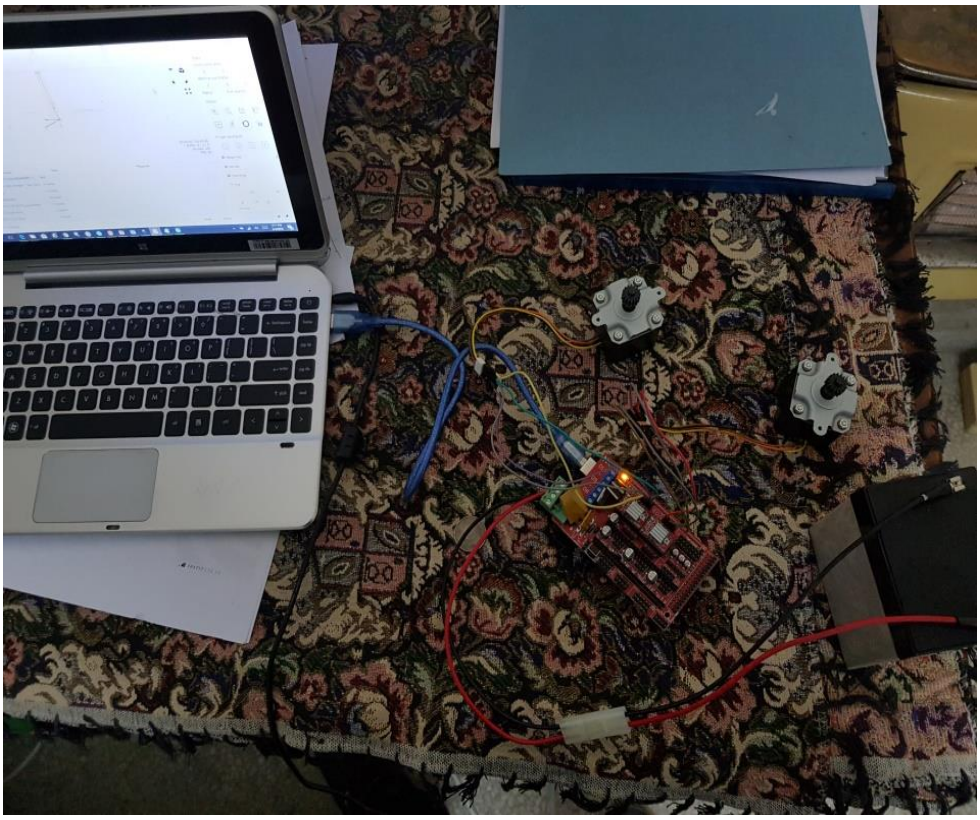


Figure 12: CNC and Arduino Integration with motor

CHAPTER: 7

CODE IMPLEMENTATION

7. CODE IMPLEMENTATION

7.1 GRBL Library

GRBL Library is added in Arduino IDE software to make GCODE compatible with Arduino.

```
#include <grblmain.h>

Void setup ()

{

StartGrbl ();

}
```

7.2 GCODE Implementation

Gcode generated from Makercam is as follows:

g2 X-0.9314 Y1.1987 I-1.3041 J0.0415

g2 X-0.9322 Y1.1862 I-0.6569 J0.0334

g2 X-0.9327 Y1.18 I-0.1679 J0.0117

g2 X-0.9337 Y1.174 I-0.0554 J0.006

G1 X-0.9341 Y1.1736

G1 X-0.9346 Y1.1739

g2 X-0.9355 Y1.1797 I0.0488 J0.0113

g2 X-0.9361 Y1.1858 I0.1562 J0.0173

g2 X-0.9368 Y1.198 I0.6262 J0.0446

g2 X-0.9379 Y1.2225 I1.2536 J0.0647

g2 X-0.9392 Y1.2715 I4.9962 J0.1601

g2 X-0.9409 Y1.3697 I9.9603 J0.2216

g2 X-0.9428 Y1.5638 I38.9619 J0.4826

g20 G90 G40

(Follow path 1)

G0 Z0.2

T0 M6

G17

M3

G0 X3.2642 y0.0551

G1 Z-0.025 F20

G3 X3.2634 y0.059 I-0.0173 J-0.0014 F40

G3 X3.2619 y0.0624 I-0.0148 J-0.0047

G3 X3.2596 y0.0651 I-0.0098 J-0.0059

G3 X3.2575 y0.0662 I-0.0031 J-0.0036

G3 X3.255 y0.0664 I-0.002 J-0.0088

G3 X3.2141 y0.0628 I0.1143 J-1.2652

G3 X3.1878 y0.0599 I0.2237 J-2.097

g2 X3.1615 y0.0569 I-0.2158 J1.8073

g2 X3.1401 y0.0549 I-0.1254 J1.1978

g2 X3.1187 y0.0534 I-0.0548 J0.6321

g2 X3.1148 y0.0535 I-0.0011 J0.0204

g2 X3.1096 y0.0546 I0.0068 J0.0497

G1 X3.1089 y0.055

G1 X3.109 y0.0556

g2 X3.1129 y0.0569 I0.0083 J-0.0184

g2 X3.1215 y0.0584 I0.0236 J-0.1061

g2 X3.1582 y0.0632 I0.2724 J-1.9491

G1 X3.2026 y0.0686

G1 X2.4218 y0.07

g2 X2.0997 y0.0707 I1.3926 J744.9583

g2 X2.0997 y0.0707 I1.3926 J744.9583

g2 X1.8697 y0.0713 I0.8748 J380.0572

g2 X1.7611 y0.0716 I0.6366 J219.0034

g2 X1.7012 y0.0719 I0.2266 J66.6052

g2 X1.6709 y0.072 I0.1501 J34.892

g2 X1.6551 y0.0721 I0.0485 J9.3871

g2 X1.6471 y0.0722 I0.033 J4.8187

g2 X1.643 y0.0722 I0.0108 J1.267

g2 X1.6388 y0.0723 I0.0052 J0.4412

G1 X1.6387 y0.0723

G1 X1.6383 y0.0728

G1 X1.6384 y0.0736

g2 X1.6392 y0.0745 I0.0031 J-0.0019

g2 X1.6408 y0.0757 I0.0077 J-0.0092

G1 X1.6416 y0.0759

g2 X1.6503 y0.0763 I0.0162 J-0.2272

g2 X1.6595 y0.0766 I0.0211 J-0.6466

g2 X1.6783 y0.0768 I0.0492 J-2.6855

g2 X1.7167 y0.0771 I0.0639 J-5.6508

g2 X1.8033 y0.0774 I0.13 J-28.7579

g2 X1.9631 y0.0775 I0.0993 J-65.7631

g2 X2.4225 y0.0768 I-0.4998 J-543.4576

g2 X3.1116 y0.0924 I0.0027 J-0.002

g2 X3.1126 y0.0925 I0.001 J-0.0028

g2 X3.1189 y0.0924 I0.0004 J-0.1142

g2 X3.125 y0.092 I-0.0139 J-0.2673

g2 X3.1352 y0.0912 I-0.0562 J-0.7492

g2 X3.1568 y0.0891 I-0.108 J-1.2176

g2 X3.1852 y0.0858 I-0.2245 J-2.1045

G3 X3.2246 y0.0813 I0.3921 J3.257

G3 X3.2403 y0.0799 I0.0561 J0.519

G3 X3.2559 y0.0794 I0.0132 J0.1703

G3 X3.2586 y0.0801 I-0.0001 J0.0058

G3 X3.2599 y0.0816 I-0.0014 J0.0025

G3 X3.2619 y0.0888 I-0.0385 J0.0145

G3 X3.2629 y0.0964 I-0.0784 J0.0141

G1 X3.2634 y0.1294

G1 X1.2384 y0.1294

G1 X-0.7866 y0.1294

G1 X-0.7866 y0.1067

G3 X-0.7861 y0.0968 I0.0993 J0

G3 X-0.7849 y0.09 I0.0481 J0.0048

G3 X-0.7825 y0.084 I0.022 J0.0054

G3 X-0.7807 y0.0827 I0.0025 J0.0014

G3 X-0.7782 y0.0825 I0.002 J0.0088

G3 X-0.7578 y0.084 I-0.0352 J0.6175

G3 X-0.7373 y0.086 I-0.1143 J1.2652

G3 X-0.7111 y0.089 I-0.2237 J2.097

g2 X-0.6848 y0.0919 I0.2157 J-1.8069

g2 X-0.6633 y0.094 I0.1254 J-1.1977

g2 X-0.6419 y0.0955 I0.0548 J-0.632

g2 X-0.638 y0.0953 I0.0011 J-0.0204

g2 X-0.6328 y0.0943 I-0.0068 J-0.0497

G1 X-0.6321 y0.0938

G1 X-0.6322 y0.0933

g2 X-0.6361 y0.092 I-0.0083 J0.0183

g2 X-0.6447 y0.0904 I-0.0236 J0.106

g2 X-0.6814 y0.0856 I-0.2729 J1.9504

G1 X-0.7259 y0.0803

G1 X0.0551 y0.0788

g2 X0.3773 y0.0781 I-1.5663 J-807.3529

g2 X0.6073 y0.0775 I-0.9633 J-411.8392

g2 X0.7159 y0.0771 I-0.6876 J-237.2821

g2 X0.7758 y0.0769 I-0.242 J-72.1281

g2 X0.8061 y0.0768 I-0.1581 J-37.7712

g2 X0.8219 y0.0767 I-0.0506 J-10.1506

g2 X0.8299 y0.0766 I-0.034 J-5.2069

g2 X-0.6584 y0.0577 I0.0562 J0.7492

g2 X-0.68 y0.0598 I0.108 J1.2176

g2 X-0.7084 y0.063 I0.2245 J2.1046

G3 X-0.7418 y0.0669 I-0.6886 J-5.721

G3 X-0.753 y0.0681 I-0.0738 J-0.6446

G3 X-0.7693 y0.0693 I-0.0305 J-0.3151

G3 X-0.7761 y0.0691 I-0.0025 J-0.0554

G3 X-0.7824 y0.0677 I0.0017 J-0.0218

G3 X-0.7852 y0.0656 I0.0023 J-0.0057

G3 X-0.7862 y0.0633 I0.0053 J-0.0038

G3 X-0.7873 y0.0568 I0.0443 J-0.0109

G1 X-0.7882 y0.0475

G1 X-0.7924 y0.0589

g2 X-0.7936 y0.0637 I0.0206 J0.0076

g2 X-0.7945 y0.0752 I0.119 J0.0152

g2 X-0.7945 y0.0869 I0.1707 J0.0052

g2 X-0.7937 y0.0985 I0.1728 J-0.0065

G3 X-0.7928 y0.1102 I-0.2023 J0.0214

G3 X-0.7927 y0.1196 I-0.1288 J0.0061

G3 X-0.7935 y0.1286 I-0.0653 J-0.0016

G3 X-0.7944 y0.1304 I-0.003 J-0.0005

G1 X-0.7946 y0.1306

g2 X-0.7948 y0.1355 I0.1358 J0.0102

g2 X-0.795 y0.1404 I0.3883 J0.015

G3 X-0.7944 y0.1304 I-0.003 J-0.0005

G1 X-0.7946 y0.1306

g2 X-0.7948 y0.1355 I0.1358 J0.0102

g2 X-0.795 y0.1404 I0.3883 J0.015

g2 X-0.7952 y0.1499 I1.4632 J0.038

g2 X-0.7955 y0.1685 I2.842 J0.0555

g2 X-0.7959 y0.2044 I10.515 J0.1361

g2 X-0.7965 y0.2752 I20.0404 J0.191

g2 X-0.7971 y0.4035 I65.726 J0.3943

g2 X-0.7979 y0.6751 I113.9424 J0.4612

g2 X-0.7982 Y1.0551 I222.8793 J0.3707

G3 X-0.871 Y1.9763 I0 J-2.4342

G3 X-0.8887 Y1.976 I0.0146 J-1.6712

G3 X-0.9063 Y1.9755 I0.0175 J-0.9065

G3 X-0.9098 Y1.9752 I0.0014 J-0.0358

G3 X-0.9125 Y1.9732 I0.0005 J-0.0035

G3 X-0.9124 Y1.9695 I0.0038 J-0.0018

G3 X-0.9094 Y1.9648 I0.0261 J0.0136

G3 X-0.8961 Y1.9489 I0.316 J0.2508

g2 X-0.8872 Y1.9384 I-0.2339 J-0.2061

g2 X-0.8814 Y1.9307 I-0.1194 J-0.0961

g2 X-0.8789 Y1.9269 I-0.0711 J-0.0502

g2 X-0.8776 Y1.9247 I-0.0221 J-0.0139

g2 X-0.8769 Y1.9225 I-0.0077 J-0.0039

G1 X-0.8771 Y1.922

g2 X-0.882 Y1.9211 I-0.0037 J0.0064

g2 X-0.8903 Y1.9241 I0.0037 J0.0235

g2 X-0.8981 Y1.9297 I0.0243 J0.0412

g2 X-0.9087 Y1.9406 I0.0806 J0.0896

G1 X-0.9226 Y1.9567

G1 X-0.9255 Y1.5654

g2 X-0.9274 Y1.3717 I-38.8437 J0.2874

g2 X-0.9291 Y1.2728 I-10.1342 J0.1255

g2 X-0.9304 Y1.2235 I-5.1171 J0.1133

g2 X-0.9823 Y1.9333 I0.0241 J-0.0083

g2 X-0.969 Y1.9493 I0.1495 J-0.1106

G3 X-0.9605 Y1.9589 I-0.1686 J0.1568

G3 X-0.9551 Y1.966 I-0.086 J0.0714

G3 X-0.951 Y1.9731 I-0.0341 J0.024

G3 X-0.9514 Y1.9742 I-0.0008 J0.0004

G3 X-0.953 Y1.9748 I-0.0021 J-0.0036

G3 X-0.9644 Y1.9757 I-0.0216 J-0.1863

G3 X-0.9758 Y1.9762 I-0.0205 J-0.3761

G3 X-0.9904 Y1.9764 I-0.0146 J-0.6079

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g2 X-1.0142 Y1.9768 I0.0058 J0.3279

g2 X-1.0185 Y1.977 I0.0076 J0.1647

g2 X-1.0205 Y1.9772 I0.0025 J0.0344

g2 X-1.0217 Y1.9776 I0.0006 J0.0043

G1 X-1.0217 Y1.9778

G1 X-1.0209 Y1.978

g2 X-1.0114 Y1.9784 I0.0202 J-0.3673

g2 X-1.0022 Y1.9786 I0.0271 J-0.9336

g2 X-0.9862 Y1.9789 I0.054 J-2.821

g2 X-0.9524 Y1.9792 I0.0638 J-4.7318

g2 X-0.9065 Y1.9794 I0.0551 J-8.6912

G1 X-0.7953 Y1.9795

G1 X-0.795 Y2.0214

g2 X-0.7945 Y2.0386 I0.4352 J-0.003

g2 X-0.7936 Y2.0514 I0.2394 J-0.0111

g2 X-0.7928 Y2.0574 I0.1434 J-0.0144

g2 X-0.7922 Y2.0609 I0.0488 J-0.007

g2 X-0.7912 Y2.0642 I0.0193 J-0.0042

G1 X-0.7906 Y2.0648

g2 X-0.7893 Y2.0645 I0.0004 J-0.0012

g2 X-0.7878 Y2.0624 I-0.0035 J-0.0042

g2 X-0.7869 Y2.0593 I-0.0129 J-0.0051

g2 X-0.7866 Y2.0546 I-0.0308 J-0.0047

G1 X-0.7866 Y2.054

g2 X-0.7866 Y2.0529 I-0.8255 J0.0021

G3 X-0.7862 Y2.0454 I0.064 J-0.0002

G3 X-0.7855 Y2.0431 I0.0069 J0.0008

G3 X-0.7831 Y2.0407 I0.0048 J0.0024

G3 X-0.7774 Y2.0391 I0.0073 J0.0148

G3 X-0.7711 Y2.0389 I0.0044 J0.0442

G3 X-0.7553 Y2.04 I-0.0119 J0.2795

G3 X-0.7466 Y2.041 I-0.0526 J0.5297

G3 X-0.7124 Y2.045 I-0.9348 J8.0538

g2 X-0.6654 Y2.0502 I0.2856 J-2.3725

g2 X-0.6462 Y2.0516 I0.0399 J-0.3974

g2 X-0.6364 Y2.0518 I0.0081 J-0.1572

g2 X-0.6331 Y2.0515 I-0.0002 J-0.0181

g2 X-0.6322 Y2.0505 I-0.0002 J-0.0011

g2 X-0.633 Y2.0491 I-0.0015 J-0.0001

g2 X-0.6344 Y2.0486 I-0.0023 J0.004

g2 X-0.6489 Y2.0461 I-0.0751 J0.4015

g2 X-0.6635 Y2.0441 I-0.1274 J0.8485

CHAPTER: 8

HARDWARE IMPLEMENTATION

8. HARDWARE IMPLEMENTATION

8.1 Components Integration

8.1.1Integration of Arduino and CNC Shield with Plotter

CNC shield is mounted on Arduino and its drivers are connected with motors.

Figure 13: Integration of CNC Shield and Arduino with Hardware

8.1.2 Pen holder

Servo motor is attached to the pen holder which moves the pen up and down and nema17 is responsible for moving the pen on the substrate to draw the required design of circuit.

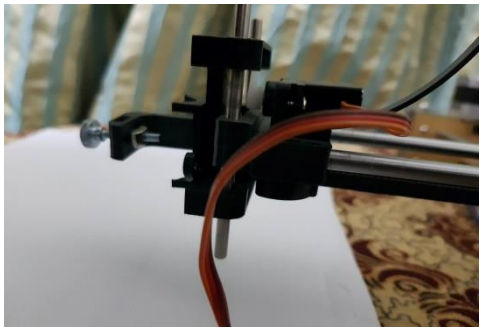


Figure 14: Pen Holder

8.1.3 Complete Working Module

After integration of all the components complete working model of PCB Plotter.

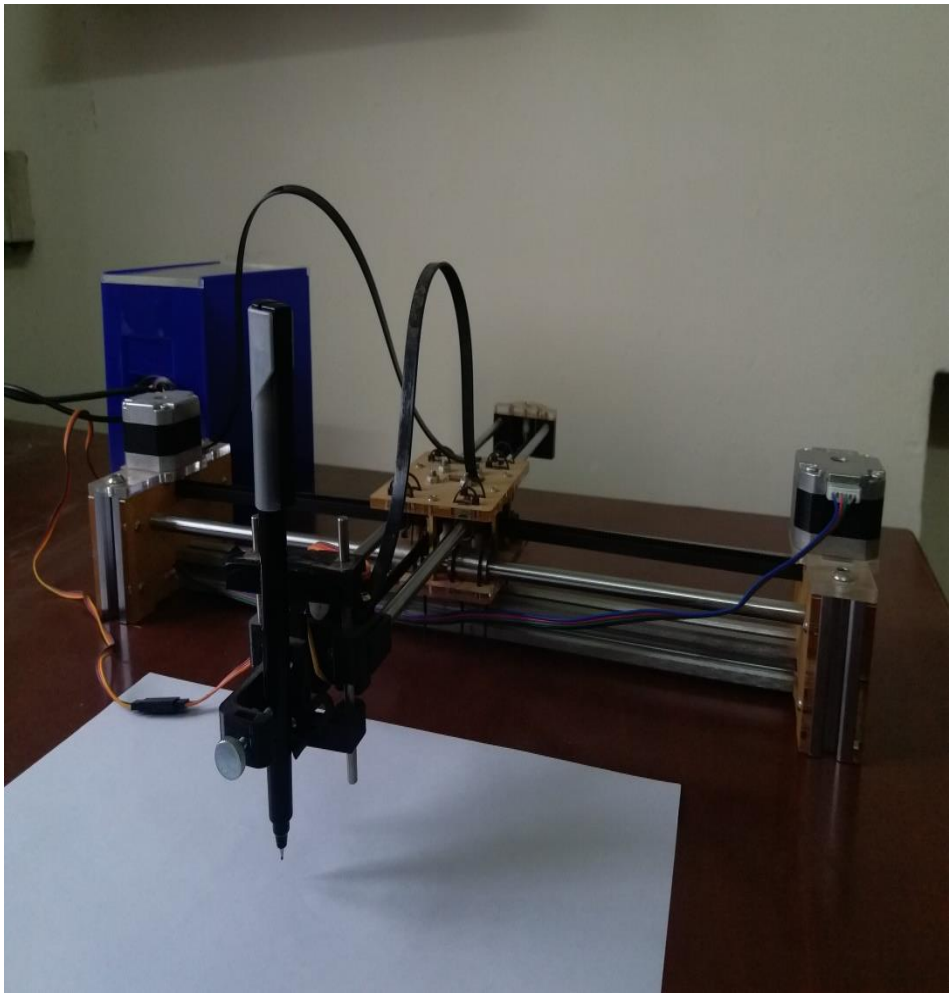


Figure 15: Complete Hardware of Plotter

CHAPTER: 9

CONDUCTIVE INK PREPARATION

9. CONDUCTIVE INK:

In this project, The Printed Circuit Board Plotter, we use a pen that carries conductive ink instead of normal ink, to draw conductive traces on an insulating material. Such inks can be used in a variety of ways.

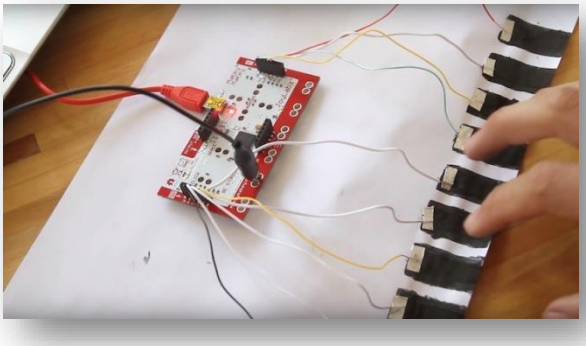
Different methods can be used, where the main component is a conductive material like graphite, charcoal, silver nanoparticles. Some of the methods can be:

Method 1:

Mix 75.5% of Indium and 24.5% of Gallium, add deionized water and mix it well. heat it to 50 degrees Celsius. The result will be a silver colored metallic ink.

Method 2:

Take activated carbon and mix it with vinegar using a blender or a mixer. Once mixed well, add some liquid glue to thicken up the mixture. Charcoal can also be used instead of activated carbon.



Method 3:

Mix graphite and acetone. add cigarette filters to combine all the components together. liquid transparent glue can also be used instead of cigarette filters. The solution starts conducting once it has dried on paper.

CHAPTER: 10

FUTURE WORK

10.FUTURE WORK

Printed Circuit Board Plotter is a foundation stone towards revolutionizing the way circuits are made on a PCB. The future work mainly centers on the enhancement of the application i.e. user front end and the user transmission side.

As a future improvement a number of applications and techniques can be introduced due to versatility and flexibility in its design.

- A drill machine can be introduced in the place of a pen, which can drill precisely in places where components are to be placed in a circuit
- Resolution can be increased thus making fabrication of complex circuits possible
- Implementation on multi-layered PCBs can also be introduced

CHAPTER: 10
APPENDIX

APPENDIX A

CIRCUIT BOARD PLOTTER

SYNOPSIS

Extended Title: Printed Circuit Board Plotter

Brief Description of the Project / Thesis with Salient Specifications:

The main aim of this project is to design and develop hardware which would draw the proteus design on a sheet of an insulating material made of fiberglass or plastic. It will use a conductive to draw the circuit hence making the path conductive. This will make the PCB designing easy, fast and reliable.

Scope of Work:

It can have wide scope of applications in

- Industries where electronics are invariably based on PCBs.
- In labs where experimenting on new systems and designs are done.
- Educational sector.

Academic Objectives:

- Understanding the use of GBRL Software.
- Learning the use of Arduino based programming.
- Understanding the underlying concept of PCB designing.
- Utilization of Universal serial G code sender Program.

Application / End Goal Objectives:

- It will make PCB designing, a difficult task when done by hand, easy and accurate.
- No printing of the circuit design on the PCB is required.
- Can also be used for general 2D printing.

Previous Work Done on The Subject:

"MR PEN" carried out by SGT Bassit Ali, SGT ECA Umer Naveed Malik and GC Zat Ul Akmam Abassi under the supervision of Dr. Ahmad Muqeem Sheri.

Material Resources Required:

- 2 Nema 17 steppers (*)
- 48mm smooth rods (two 400mm-long and two 320mm-long)
- 8 LM8UU
- 2 20-tooth GT2 pulleys
- 10 F623ZZ bearings
- 1 micro servo SG90 (plus a 250mm cable extender)
- 1 Arduino UNO
- 1 CNC Shield
- 2 Palolu step sticks
- 1 GT2 belt (1.4 meters long)
- 2 M10 threaded rods (400mm-long each)
- 8 M10 nuts
- 8 30mm M3 screws with nuts
- 8 6mm M3 screws
- 4 16mm M3 screws with nuts
- 4 M3 washers
- 2 4mm OD, 100mm-long carbon fiber tubes
- 2 15mm M3 screws
- 1 12V 2A power supply
- 1 USB cable
- 1 conducting pen

No of Students Required:

Group Members:

- NC Muhammad Ibrahim
- NC Sana Fayyaz
- NC Arham Tasleem
- NC Muhammad Haris

Special Skills Required:

- This project uses a special flavor of GBRL firmware.
- Universal serial G code sender Program.
- Inscape for creating files G-Code files.

APPENDIX B

COMPONENTS USED

Arduino UNO	
CNC Shield	
Nema-17	
SG90	
Conductive pen	

CHAPTER: 11

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