



International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 5, May 2019

Arduino Based Mini Sketching CNC Machine

Uday Shankar singh¹, Shubham Singh², Abhijeet Mitra³, Dhaneshwari Verma⁴, Prof. Seema Mishra⁵

B.E. Scholar, Dept. of EEE, RSR-Rungta collage of Engg. & Tech., Bhilai, CG, India^{1,2,3,4}

HoD, Dept. of EEE, RSR-Rungta collage of Engg. & Tech., Bhilai, CG, India⁵

ABSTRACT: With the advancement of technology, demand for Computer Numerical Control (CNC) plotter machines in Educational Institutions and Laboratories is rapidly rising. Low cost manufacture of Printed Circuit Board (PCB) has become a basic need in electronics laboratories, for electronics engineering students and for electronics hobbyists. This paper will present an affordable model of a CNC plotter machine which is able to draw a circuit layout on PCB or any other solid surface using simple algorithm and available components. At first the user needs to convert any image file or text file into G code using Inkspace software and then feed it to the machine using Processing software. Arduino uno with an ATmega328P microcontroller is used as the control device for this project. The microcontroller converts G-code into a set of machine language instruction to be sent to the motor driver of the CNC plotter.

KEYWORDS: Computer Numerical Control (CNC), Printed Circuit Board (PCB), G-code, Microcontroller Unit (MCU), Plotter.

I. INTRODUCTION

A Plotter is a special type of printer that uses a pen to draw images on solid surfaces. In Computer Numeric Control (CNC), microprocessor is used which is capable of processing logical instructions interfaced with a computer. The logical instructions are provided by using a computer in the form of code or text or image which is then transformed into a machine language by microprocessor to be executed by the machine.

A CNC plotter machine is a 3D controlled 2D plotting machines which uses a pen to draw text or image on any given solid surface. It can be used for the purposes such as PCB Design, logo design, etc. This project is based on CNC plotter machine. With the increasing demand for the use of CNC plotters in universities and laboratories, a cheap and less complex design is an absolute need. The parts used for the plotter in our project are easily available at a very low price and spare parts are also used. The construction is very simple and robust.

II. METHODOLOGY

A CNC plotter is able to draw complex line drawings. The coordinates are uploaded to the machine controller by a separate program. The image file is transformed into a G-code via Software. Then the code is transferred to the microcontroller by which the motor mechanism is instructed to draw the image. In this project, we are going to present a simple design for a CNC plotter. Our idea is an Arduino based design using ATMEGA 328P microcontroller.

The machine will have three motors to implement the X, Y, and Z axis. A servo motor will be used along the Z axis for positioning the pen which will go up for logic 0 and down for logic 1. Drawing will be done on the X-Y plane where the positioning will be controlled by stepper motors.

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 5, May 2019

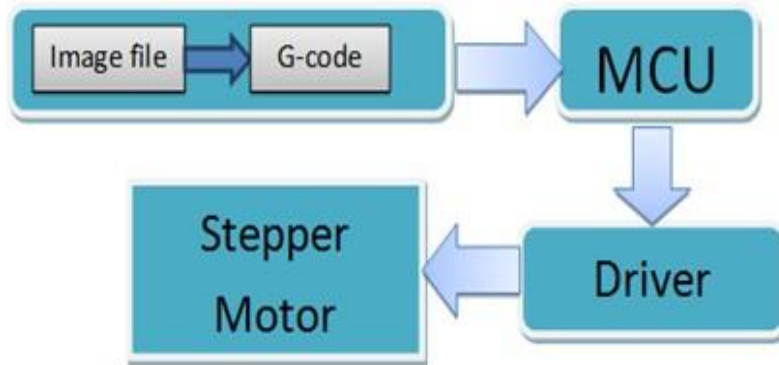


Fig. 1 Block diagram of CNC Plotter

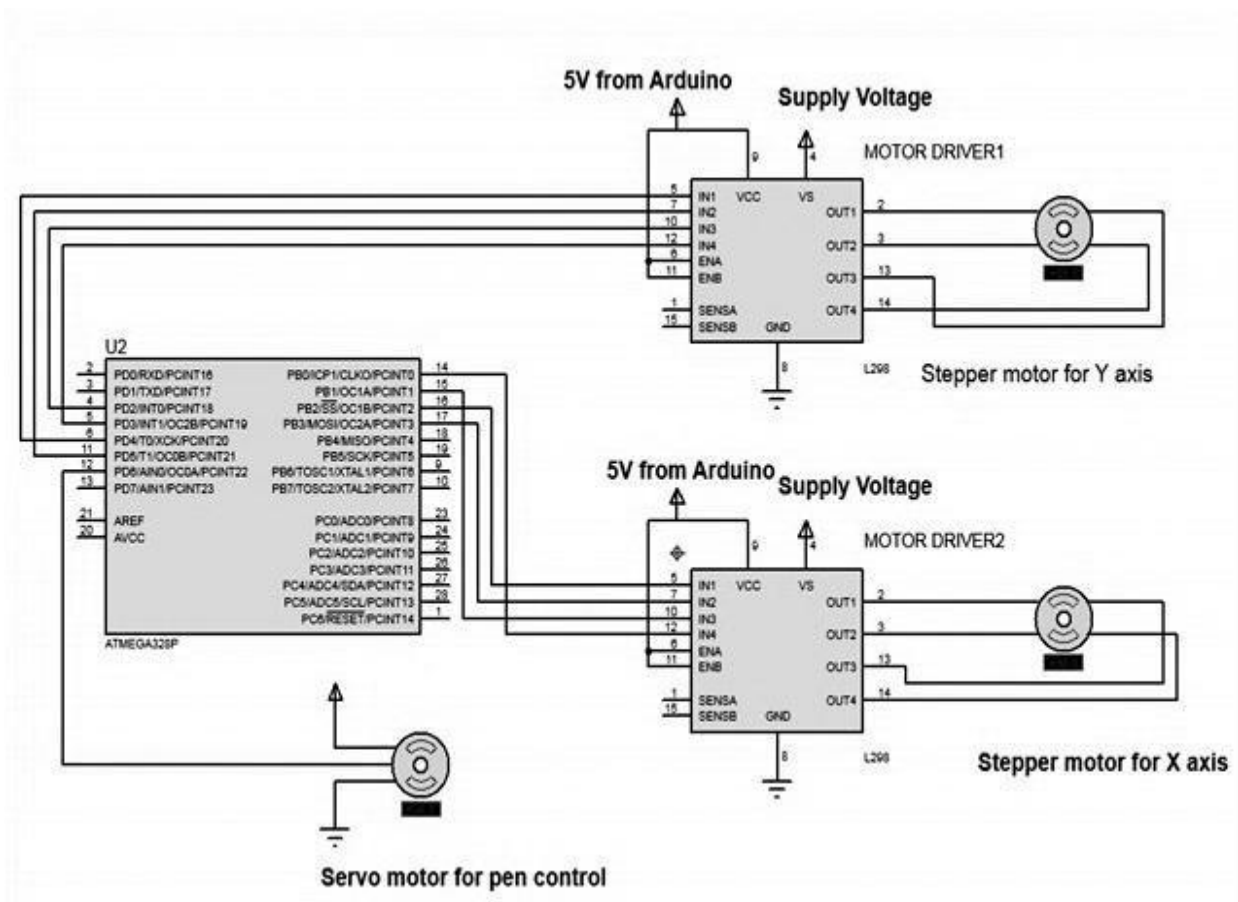


Fig 2: Schematic circuit diagram of CNC plotter

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 5, May 2019

III.SOFTWARE AND CODING

To complete the task of entire project three software is used-

- Inkscape
- Fritzing.
- Processing

Inkscape 0.48.5

Inkscape is used to design the plotted diagram or text. In this project by using this software G-code file of a selected image or text is created. G-code is a commonly used numerical control programming language which includes X, Y, Z coordinates.

Creating G-Code File Using Inkscape

The CNC plotter of our project will work within 20cm×20cm area.

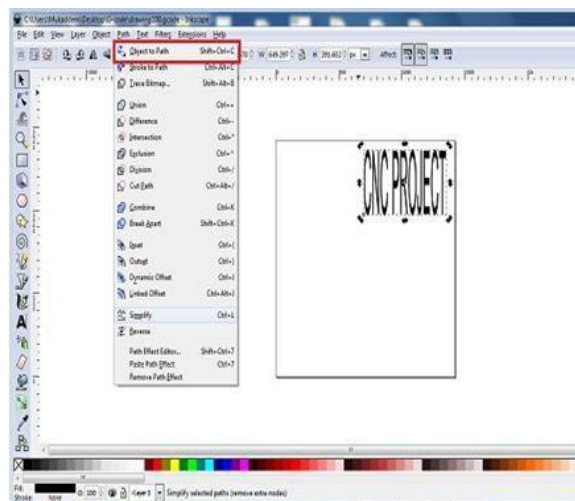


Fig. 3 Conversion of text to G-code

So we choose the document properties of the Inkscape 40cmx40cm (Width×Height) which is four times the working area of the plotter because the plotter can draw only in the first quadrant. So we have initially kept the axes at the nearest end of the motors which is considered as origin to easily modify the design. In Fig. 3 the working area of CNC plotter is shown with the text written in the pre-defined area. The text is selected using cursor and then select “object to path” from the drop down window to save the G- code form of the selected text.

To create G-code of an image, the file must have a transparent background. The image should be dragged into the selected area then select “trace bitmap” from drop down window to create a transparent image. Scans are selected as 8 and “Edge detection” is selected to create black & white image. After adding this transparent image in the predefined area we’ve used “object to path” command to create the G-code file of the selected image by following the steps described earlier.

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijirccce.com

Vol. 7, Issue 5, May 2019

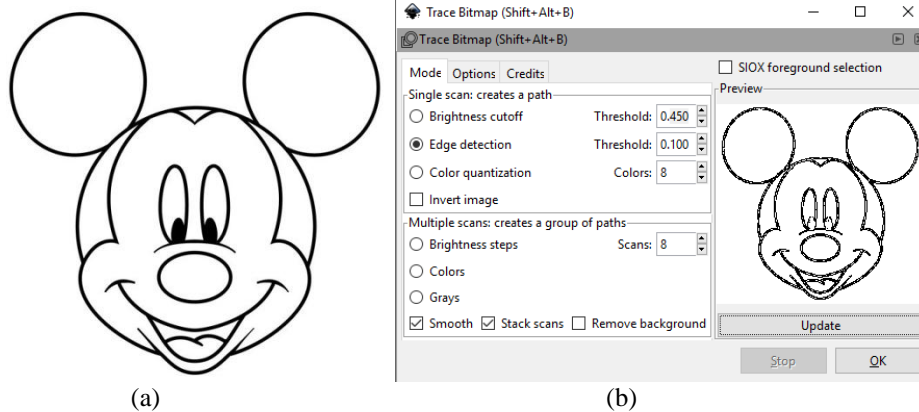


Fig. 4 Creating transparent image (a) original image (b) transparent image.

Upload our desired G-code file. Immediately CNC machine will start sketching selected G-code file. Sketching can be stopped by pressing X button.

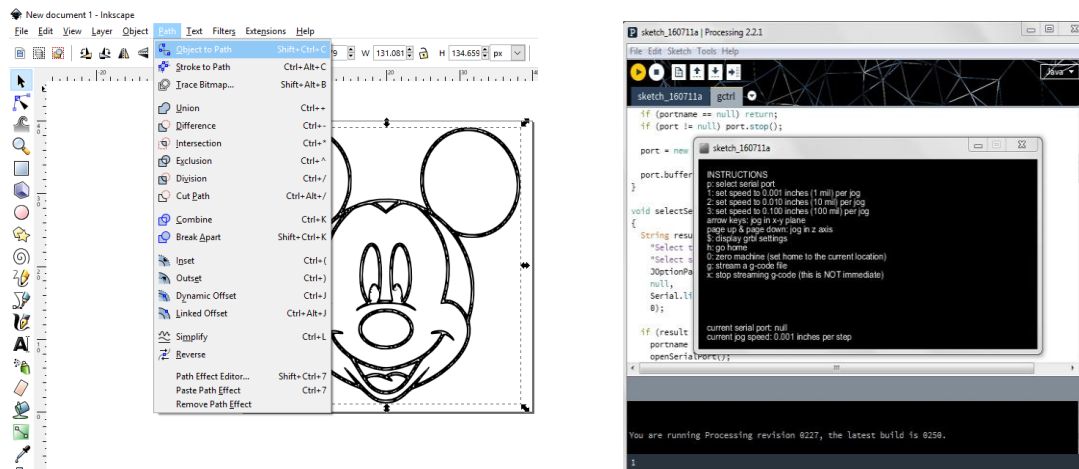


Fig. 5 Conversion of transparent image to G-code

Fritzing

It is friendly open source circuit simulator software which is mainly used for PCB design.

Creating PCB Layout Using Fritzing

Using “Breadboard” option any circuit can be built easily by simply dragging and dropping down different components. Schematic circuit diagram and PCB layout will be generated automatically.

In PCB layout we need to choose positions of the components, their layers and establish connections. Then „Export for PCB” option is selected and choose “Etchable SVG” (Scalable Vector Graphics). From the saved folder the top layer mirror file is loaded. The file is automatically loaded in Inkscape software and from there G-code will be generated as described earlier.

Processing

Processing is open source programming language software which is used for electronic drawings. GTCRL processing



International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 5, May 2019

program is used to send G-code file from user interface to CNC plotter. The Fig. 6 shows the user interface of processing 2.2.1 software after running GTCRL program. The port of Arduino Uno is selected by pressing "P" button on keyboard hence "G" button is used to Bresenham's Line Algorithm is used for plotting in the CNC plotter. A part of this algorithm is shown below-

```
void line(int x0, int y0, int x1, int y1)
{
    int dx = abs(x1-x0), sx = x0<x1 ? 1 : -1; int dy = abs(y1-y0), sy = y0<y1 ? 1 : -1; int err = (dx>dy
    ? dx : -dy)/2, e2; for(;;){
        setPixel(x0,y0);
        if(x0==x1 && y0==y1) break; e2 = err;
        if(e2 > -dx) { err -= dy; x0 += sx; } if(e2 < dy) { err += dx; y0 += sy; }
    }
}
```

Two stepper motor is used to control X and Y axis, and a servo motor is used to control the Z axis. The test code of Y axis stepper motor is shown below-

```
#include <Stepper.h>
const int stepsPerRevolution = 20;
// Connection pins:
Stepper myStepperY(stepsPerRevolution, 2,3,4,5); void setup() {
// Set speed: myStepperY.setSpeed(100);
// max 250 steps for dvd/cd stepper motor myStepperY.step(160);
delay(100);
}
void loop() {
}
```

The code for X axis stepper motor is also same except the pin numbers. The Z axis is represented by a servo motor controlled by the PWM pin of the arduino. The full CNC code is uploaded in the arduino then the arduino will wait for G-code file from processing software. When the processing software send command to arduino it will start plotting the G-code.

G-code

To draw a text file or design a circuit layout by the CNC plotter firstly the files need to be converted into G-Code. G-Code is a set of instruction that contains number of X, Y, Z, coordinates depending on the file. G-Code instructs X axis of the machine to travel from X1 to X2 points with a specific speed and same is true for Y axis, but for Z axis the coordinates are fixed because only vertically up & down movements are involved.

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 5, May 2019

IV.RESULTS AND DISCUSSION

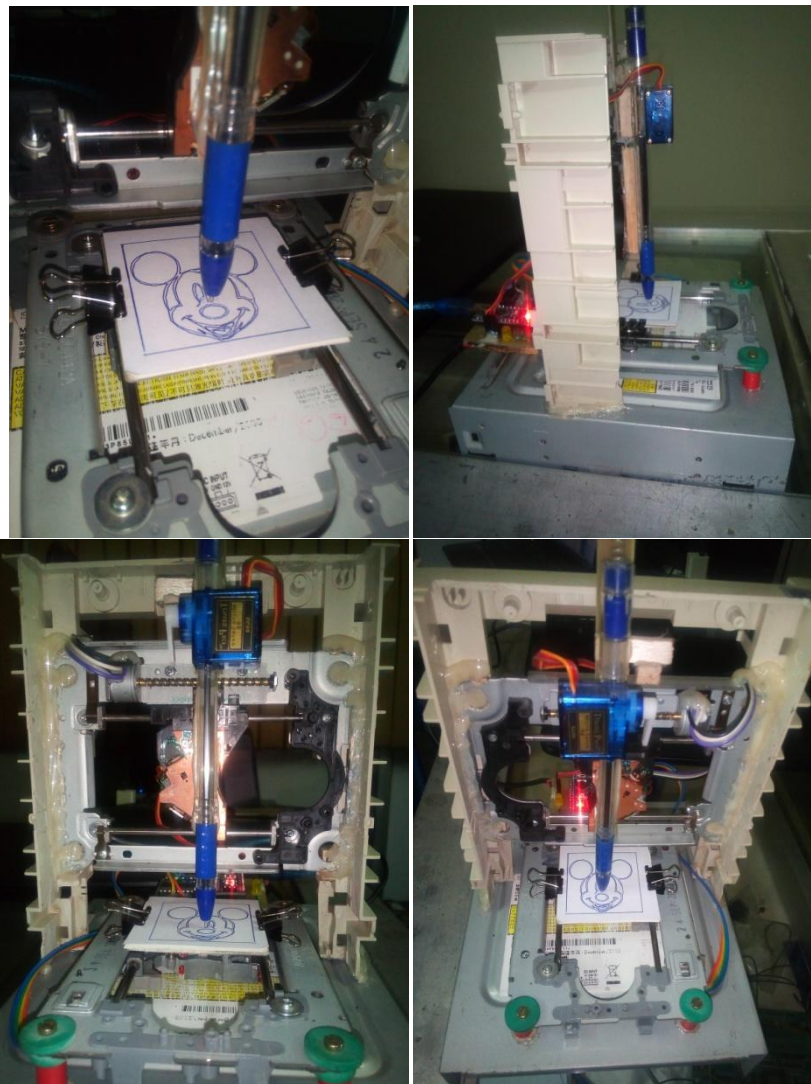


Fig. 6 Final CNC Sketching

V.FUTURE SCOPE

The pen of the machine can be replaced by a laser to make it work like a laser engraving or cutting machine. Engraving machine can be used on wood. The pen can also be replaced with a powerful drill so that it can be used for both milling and drilling purposes. The servo can be replaced with a stepper motor and the pen with a 3-D pen to make it a 3-D printer which can print objects with dimensions. By extrapolation of the axes, the working area of the machine can be extended keeping the algorithm unaltered.

VI.CONCLUSION

This project is about building a mechanical prototype of a CNC plotter machine which is able to draw a PCB layout of 20cm by 20cm (or any image/text) on a given solid surface. It consumes



International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijirce.com

Vol. 7, Issue 5, May 2019

low power and works with high accuracy due to precise controlling of stepper motors. This is a low cost project as compared to other CNC product. It is made with easily available components and spare parts. It is designed for private manufacturing and small scale applications in educational institutes. The machine is designed with a very simple construction scheme and can be carried anywhere without much effort. The algorithm used is simple. The pen can be replaced with a pinhead or laser head or any other tool for different purpose of use. Software that has been used is open source and user- friendly.

REFERENCES

1. Madekar, kaja j., et al. "automatic mini cnc machine for pcb drawing and drilling." (2016).
2. Linggarjati, jimmy, and rinda hedwig. "manually interchangeable heads of homemade computer numerical control (cnc) machine." *internetworking indonesia journal* 1.1 (2013).
3. M.R. Wright, d.e. platts, d.b. french, g. traicoff, m.a. dupont, and g.a. head, "cnc control system patents," us patent 545393, sep 26, 1995.
4. Torjus spilling "self-improving cnc milling machine" university of oslo (2014)
5. neje 200mw mini diy laser engraving machine cnc laser printer
6. Industrialsuppliesonline.net/craftsman-cnc-router
7. geocities.ws/industrialmarketplace/cnc-machines
8. arduino.cc/en/Main/ArduinoBoardUno
9. en.wikipedia.org/wiki/ATmega328
10. Dual full-bridge driver. multiwatt15. ordering numbers: l298n (multiwatt vert.) l298hn
11. sg90 9 g micro servo. tiny and lightweight with high output power.
12. Stepper Motor sth-39d1126-06 1.8deg/step 2 phase hybrid stepping motor electric motor step motor cnc
13. [en.wikipedia.org/wiki/Power_supply_unit_\(computer\)](http://en.wikipedia.org/wiki/Power_supply_unit_(computer))
14. W. Bosshart, printed circuit boards. new delhi: tata mcgrawhill, 1983.
15. D. Christian and f. i. hariadi, "speed control of spindle motor in the designing control module of computer numerical control (cnc) pcb milling machines," *teknik elektro, sekolah teknik elektro dan informatika, institut teknologi bandung, bandung*, 2014.