

A Review : Implementation of Low Cost CNC Plotter Using Arduino

Prof. Neha Chourasia¹, Pradeep Wasnik², Rohit Tembhurne³, Shivam Londhe⁴, Roshani Sahare⁵,
Vaibhav Mundafale⁶

Department of Electronics & Telecommunication, RTMNU University, Nagpur, Maharashtra, India

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 Ink space software and then feed it to the machine using Processing software. Arduino uno with an ATmega328P micro-controller is used as the control device for this project. The micro-controller 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, Micro-controller Unit (MCU), Plotter, Arduino board.

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 part sare also used. The construction is very simple and robust.

II. OBJECTIVES

The objectives of this project is to design and implement a CNC plotter machine (Drawing surface area 20cm x 20cm) which will be able to draw a PCB layout (or any image) on a solid surface.

III. 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[1]. Drawing will be done on the X-Y plane where the positioning will be controlled by stepper motors. System overview is provided in Figure 1.

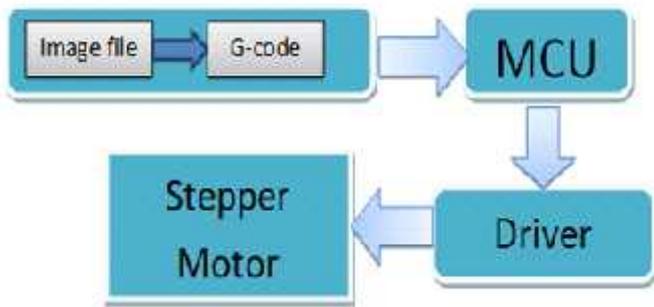


Figure 1.

Mini CNC Plotter Machine is worked on input as a G codes of Design and Converting it via use of Arduino, Stepper Drivers,CNC Shield, Stepper Motor in to a Rotation of Lead screw. We have work on to maintain lowest cost of our project. We have design a simple construction of our project. This is easier way to use stepper motor with lead screw, CNC shield, Stepper drivers, Arduino based atmega328 Board, etc. The Setup of machine is flexible that's why it will be easily Transported and Maintenance time is short.

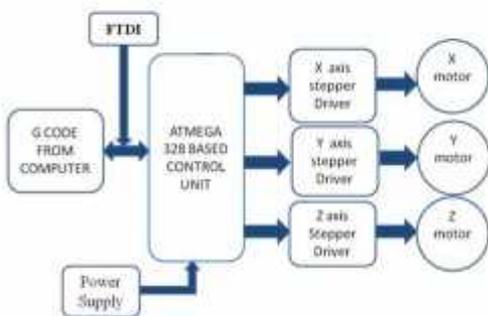


Figure 2. block diagram mini CNC plotter machine

IV. SCHEMATIC ARRANGEMENT

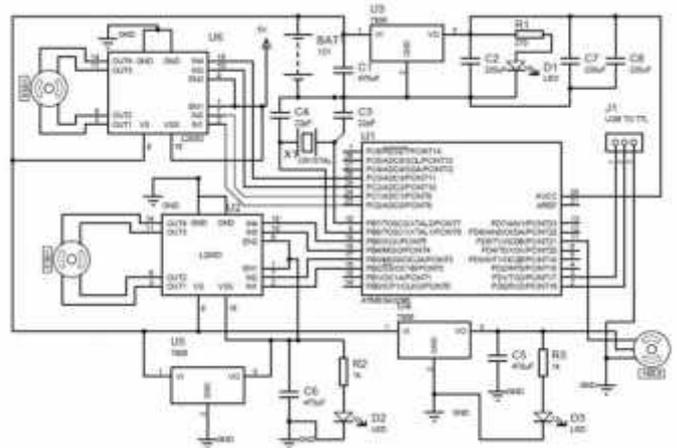


Figure 3. Schematic diagram

V. WORKING OF PROJECT

Main blocks of this system consists of power supply, FTDI module, ATMEGA328, 3 Easy drivers each connected to stepper motors X, Y, Z. From power supply we get two voltages i.e. +5volt and +12 volt. 5volt which is required to ATMEGA328, Easy drivers whereas +12volt supply is required to stepper motors. RESET is connected to 5v supply through 10k ohms resistors to pull up the voltage thus it act as a pull up resistors. We have used here 16MHz crystal oscillator connected to ATMEGA with two capacitors of 22pF. The GRBL code from computer is interface with controller using FTDI 232 module i.e. serial to USB converter. The output of FTDI is given to pin no.2 and 3 i.e. RXD and TXD pins of ATMEGA328. The output of ATMEGA328 is given to three Easy Drivers. Easy Driver consists of 16 pins from which we are using in our project only 9 pins. Four pins are used for two stepper motor coil i.e. coil A and coil B. Two pins for input 5volt supply i.e. VCC and GND. Three pins are used for STEP, DIR; GND. STEP is used for micro stepping. DIR is direction input pin which will move stepper motor according to the given dimensions. Third pin is directly grounded.

Spindle motor is connected to pin no. 16 of ATMEGA328. It is used for drilling purpose. According to the given dimensions Easy drivers or

drilling machine will move. When working of motors is completed the dimensions on pc will roll of to again its initial value i.e zero.

VI. FEATURE

- 1.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.
2. It consumes low power and works with high accuracy due to precise controlling of stepper motors.
- 3.This is a low cost project as compared to other CNC product. It is made with easily available components and spare parts.
4. 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.
- 5.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 userfriendly .
- 6.The existing CNC machines are of high cost, difficult to maintain and requires highly skilled operators. Our CNC plotter overcomes these problems.
- 7.It is of low cost and easy to control and there is no need of highly skilled operators. It can be used for long hours at a stretch which is not possible in existing ones. It is hoped to extend this work for future development.

VII. APPLICATION

- 1.Metal Removal Industries The proposed CNC 2D sketcher can also be modified to use in metal removing industries so as to remove the unwanted metals from the raw materials to get the desired small size automotive parts and industrial components.
2. Metal Fabricating Industries In fabrication industry, the machining operations can be performed on metal bars / plates with the help of CNC lathe or milling machine. Similar application like CNC milling

in manufacturing of turbine blades are widely employed in recent times.

3. Electrical Discharge Machining (EDM) Industry The proposed CNC 2D sketcher can also be modified as an electrical discharge machine which removes the metal by burning of metal and as a electron beam melting machine.

4. Other Industries There are other industries which use CNC machines widely. Industries like the wood working which includes various operations like routing, drilling, lettering and engraving operations.

VIII. FUTURE SCOPE

- 1.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.
- 2.The pen can also be replaced with a powerful drill so that it can be used for both milling and drilling purposes.
- 3.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.

IX. 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 consume slow 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.

X. REFERENCES

- [1]. Madekar, kajal j., et al. "automatic mini cnc machine for pcb drawing and drilling." (2016).
- [2]. Linggarjati, jimmy, and rindahedwig. "Manuallyinterchangeable 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]. Industrial supplie online net/crafts man-cnc-router
- [7]. Geocities ws/industrial mark et place/ cnc-machines
- [8]. Arduino. cc/en/Main/Arduino Board Unit
- [9]. En.wikipedia.org/wiki/ATmega328
- [10]. Dual full-bridge driver. multiwatt15. Ordering numbers: l298n (multiwatt vert.) l298hn
- [11]. Sg909g 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)
- [14]. W. bosshart, printed circuit boards. newdelhi: 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,"*teknikelektro, sekolahtek ni kelektrod an in for matika, institutteknologibandung, bandung, 2014.*