



# Eco Friendly CNC Plotter Using Recycled Parts from CD/DVD Drives

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**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 project will present an eco-friendly 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.

The project will use parts from CD/DVD to create an eco-friendly project which helps in reducing e-waste in a global scale. 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 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.

## I. INTRODUCTION

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, an eco-friendly and less complex design is an absolute need.

In this system instead of plotting the drawing of product by hand, it is plotted by a computer-controlled pen. It produces a high-quality work as compared with the human work. Automation and precision are the main advantages of CNC Plotter.

## II. RELATED WORK

### Details of Hardware & Software:

#### Hardware:

Mechanical Design of CNC Plotter Machine

The two-dimensional mechanical design of the body of CNC plotter is shown below

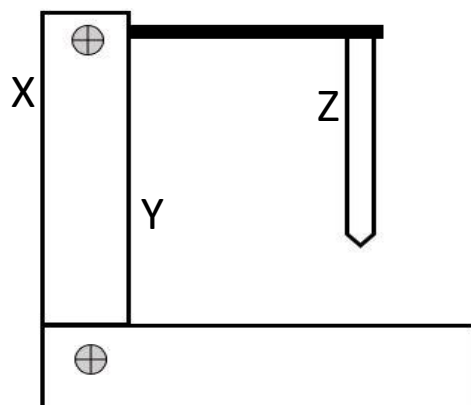


Fig 1: Hardware



Requirements:

- Arduino Uno
- L293D Motor shield
- Mini Servo Motor
- 2x DVD/CD Drives or cartridge carriers
- 5V 1Amp power adapter
- Jumper wires for connections

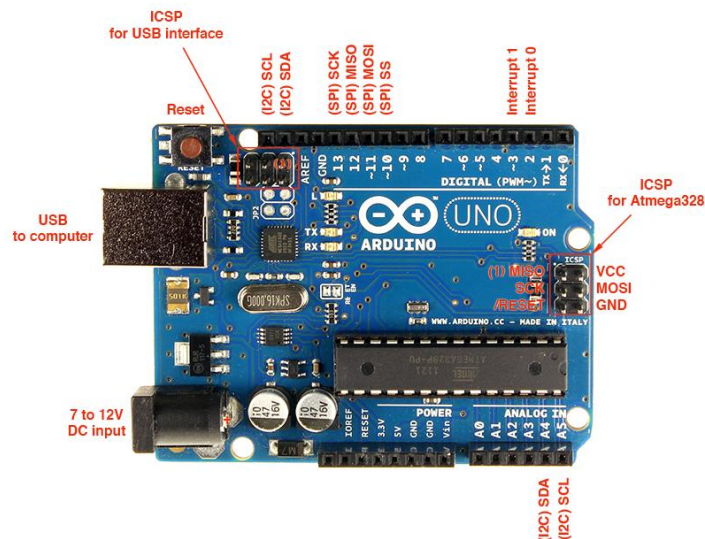


Fig 2: Arduino Uno

Software:

To complete the task of entire project three software's are used:

- **Inkscape Version 0.48.5:**

Inkscape is a free and open-source vector graphics editor. This software can be used to create or edit vector graphics such as illustrations, diagrams, line arts, charts, logos, business cards, book covers, icons, CD/DVD covers, and complex paintings. Inkscape's primary vector graphics format is Scalable Vector Graphics (SVG); however, many other formats can be imported and exported.

- **Processing IDE version 3.1.1:**

Processing is open source programming language software which is used for electronic drawings. GTCRL processing program is used to send G-code file from user interface to CNC plotter.

Processing is an open-source graphical library and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context.

- **Arduino IDE version 1.6.6:**

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

**Framework:**

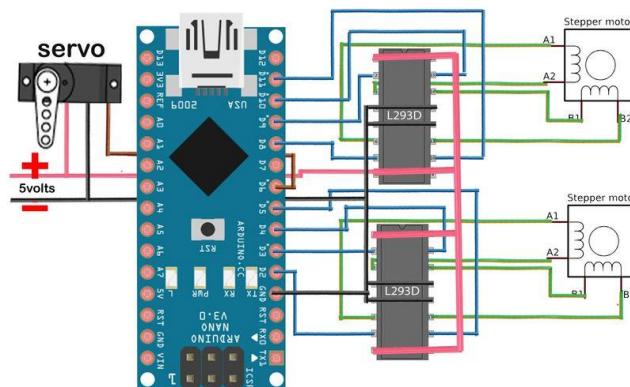


Fig 3: Schematic circuit diagram of CNC plotter

**Machine Assembly:**

➤ **Mechanical Body Description:**

First step to start building this CNC machine is to disassemble the DVD drives and take off them the stepper motors. Use the screwdriver to open and take off them the rails.

**For X axis:**

Place one stepper motor (with rails) on an outer case of DVD drives and mark it with a pen in order to open the 4 holes for the screws. Make sure that is perfectly align! (use a triangle ruler). Open the holes with the help of an electric drill and mount the motor with nut screws.

Place on one side of it the four mounting angles and then mark it with a pen in order to open the holes required for the screws. Make sure that the distance between them is 5mm.

**For Y axis:**

Place the other stepper motor on the other DVD case and mark them with a pen in order to open the holes for the screws. Again, make sure that the motor is perfectly align.

Place the case on the X axis and mark them with a pen in order to open the holes required to fit on the mounting angles. Mounting angles is done in such a way that both the cases are aligned at a perfect 90degree angle.

**For Z axis:**

That's the most difficult part of our construction.

We will need something to attach it on Y axis, a flat surface. On that surface you will attach the servo motor (Z axis) and the pen base. Pen (or pencil) must be able to move up and down with the help of servo motor.

**Complete CNC Plotter:**

After all those mounting of motors with the sliding mechanism unit and axis with each other also with basement implementation become completed.

The Figure 4 shows complete CNC plotter.

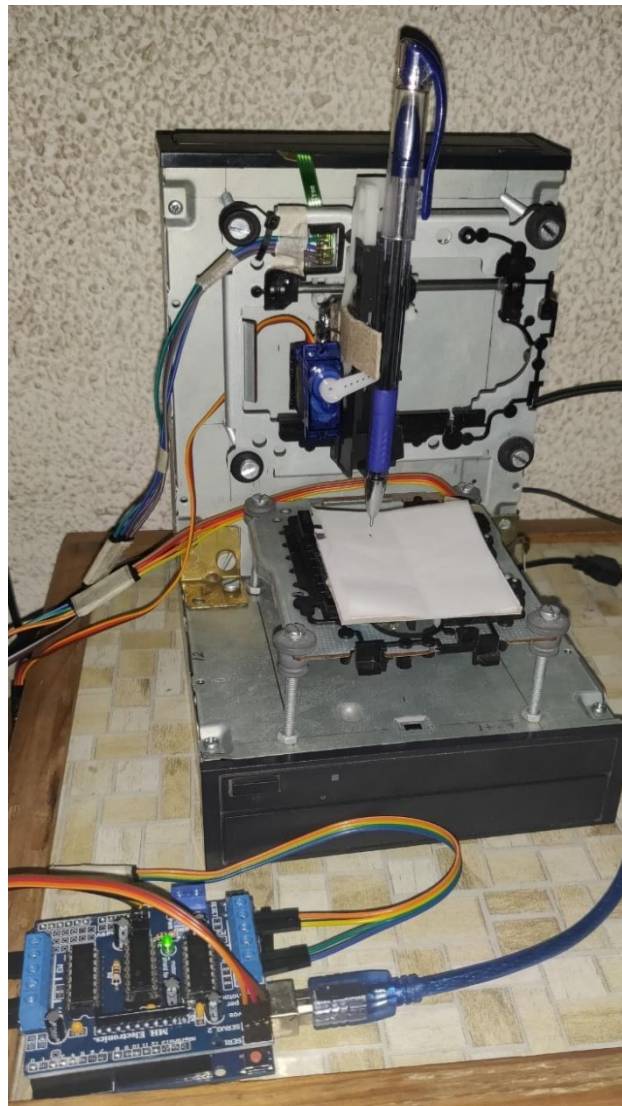


Fig 4: CNC plotter

### III. PROPOSED ALGORITHM

- We are using Arduino UNO as a brain of CNC machine, as we know there is stepper motors used in CNC machine.
- Stepper motors are not easy to control so here we are using a L293D motor shield to control our stepper motors and one servo motor is used for pen up down movement.
- Before we start wiring, first we need to know the correct wire of stepper motor.
- Our stepper motor has 4 wires and each stepper motor has two coils means a set of two wires forms one coil.
- So, we need to find out which two wires are from one coil, so here I am using a multimeter keeping the multimeter on continuity test.
- I connect the multimeter probe to the wires one by one, if I get continuity between any two wires means that both wires belong to a single coil and the rest two are from another coil.
- Don't forget to remove that yellow jumper, and connect the stepper motor wires as shown in the figure and also connect the servo motor at the servo 1 terminal of the L293D Motor shield.

### Calibration:

After finishing the complete build-up of the machine, it is necessary to calibrate the movement of the axes. Test code for stepper motor is used where stepper motor's steps per revolution was 20 and 160 steps were allowed for the motor to travel. On running the code, it is found that the motor has travelled 26.5 mm which indicates that the motor takes 6 steps to cover 1mm. this is how calibration is done for both X and Y axis.

### 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. System overview is provided in figure

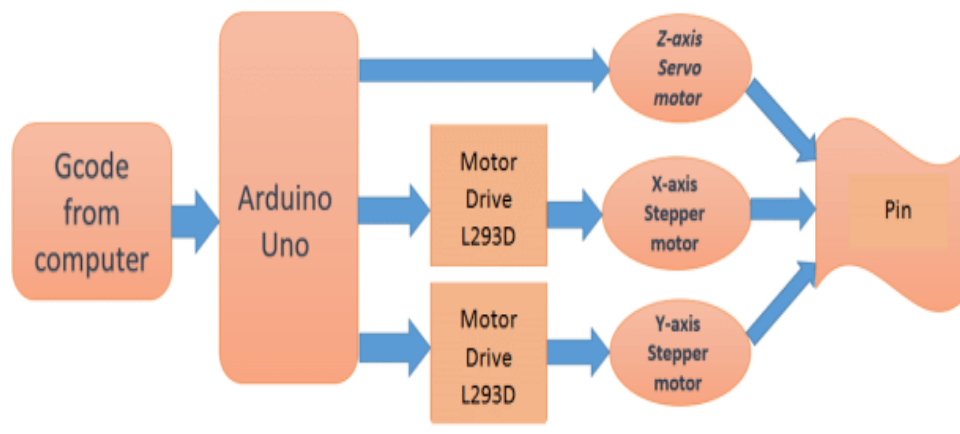


Fig 5: Block diagram of CNC Plotter

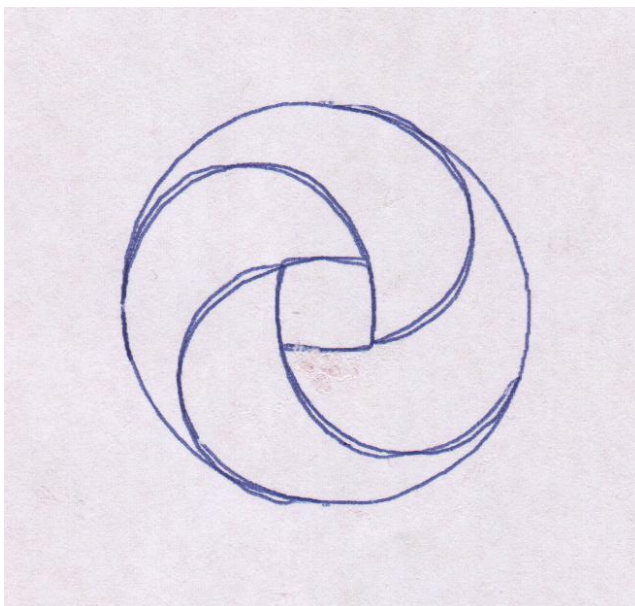
## IV.RESULTS

### 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.

## V.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 low power and works with high accuracy due to precise controlling of stepper motors. This is a low - cost eco-friendly project as compared to other CNC product. Proper use of recycled parts can reduce e-waste on a global scale. It is designed for private manufacturing and small - scale applications in educational institutes. Software that has been used is open source and user- friendly.



#### REFERENCES

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