

Design and Implementation of low-cost 2D plotter Computer Numeric Control (CNC) Machine

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Abstract- This paper represents an Arduino Uno and Motor driver ICs based automatic technique for implementation of any text or image to its 2D plotted text or image by 2D plotter CNC machine. In this era the technology based on CNC machine increases. The fabrication of low cost CNC machine is used to reduce cost and complexity of machine. The idea behind the project is how to make 2D plotter CNC machine faster and relatively lower cost than others.

Keywords—2D plot ; G-code ; Inkscape; CNC;

I. INTRODUCTION

The use of technology in education has become indispensable. However the cost associated with the advanced technologies is very high. Computers, softer and the interface which is available between the hardware and software has taken education a step ahead of the old days were visualization, verification was so very difficult [1-3]. Low-cost robots serve a lot of purpose in education [4-5]. Plotters are generally used to make 2D plots which is digitally controlled. This 2D plots CNC machine can be replaced by higher specific laser sources which can be used for cutting of different materials of different strength in 3D plots. The 2D plotter is designed to recording and plotting two dimensional data on a rectangular coordinate system [6-11]. In computer numeric control Arduino Uno microcontroller and L293D motor driver is used which is capable of processing logical instruction interfaces with computer. A CNC plotter machine is a 3D controlled 2D plotting machine which uses a pen to draw text or image on any given solid surface. The coding for the CNC system which is G-code programming. G-code is a function to tell the machine to move to various point at the desired speed, control the spindle speed and turn on and off at various positions [12-14]. Meanwhile, low cost and easily controlled function of the Arduino system contributed on simplifying the building circuitry of microcontroller in the 2D potter [15-16].

II. MODELLING

The idea was conceived and the 3D model of the low-cost pen plotter was modelled using commercially available CAD software. The 3D model of the general 2D plotter is shown in figure 1.

The plotter has 3degrees of freedom. The pen can move up and down in the Z axis and the pen is free to move along 2D plane (X-Y axis). The pen is gripped by servo motor for upward and downward movement. The setup has base to enclose the circuitry. Above the base mechanism to move the plotter in X and Y direction and ahead which carries the pen is assembled on the base. Two bi-directional motors are used in which one motor is used for X axis and another for Y axis.

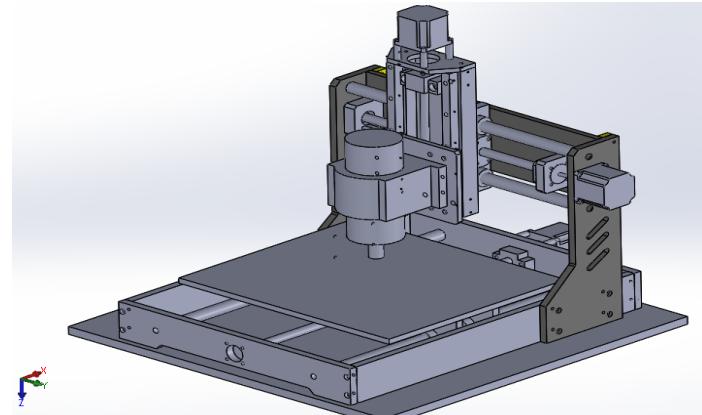


Figure 1. 3D model of 2D plotter CNC machine

III. METHODOLOGY

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 image. In this paper, we are going to present a simple design for 2D plotter. Our idea is an Arduino based on Arduino Uno and L293D motor driver.

The machine will have three motors to implement 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' [17]. Drawing will be done on the X-Y plane where the positioning will be controlled by stepper motors. System overview is provided in figure 2.

The X axis is attached to two plastic parts and it was cut it to fit the construction. Ensure to put the Y axis straight to 2D plotter base and the X axis vertically in this. On that surface the servo motor (Z axis) will be attached to the pen base. Pen must be able to move up and down with the aid of servo motor. Now it will have to attach a hard surface on Y axis.

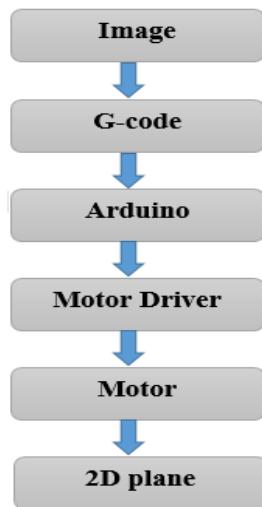


Figure 2: Block Diagram of 2D CNC Plotter

On this, it will put the paper piece to print the text or image that we programmed. The area of printing is 4cm x 4cm. Schematic circuit diagram of 2D CNC plotter as shown in figure 3.

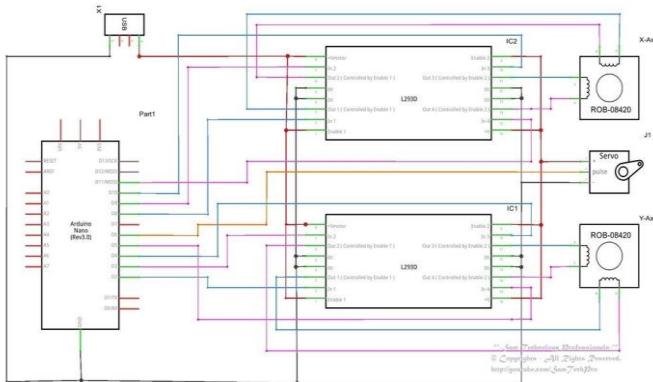


Figure 3: Circuit Diagram of CNC machine

To complete the entire project three software is used-

- Arduino IDE
- Inkscape
- Processing

A. Arduino IDE

The Arduino Integrated Development Environment (Arduino IDE) contains a text editor for writing code, a message area, a text console, a tool bar with buttons for common function and series menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them [18]. Figure 4 shows the Arduino software to program the Arduino Uno.

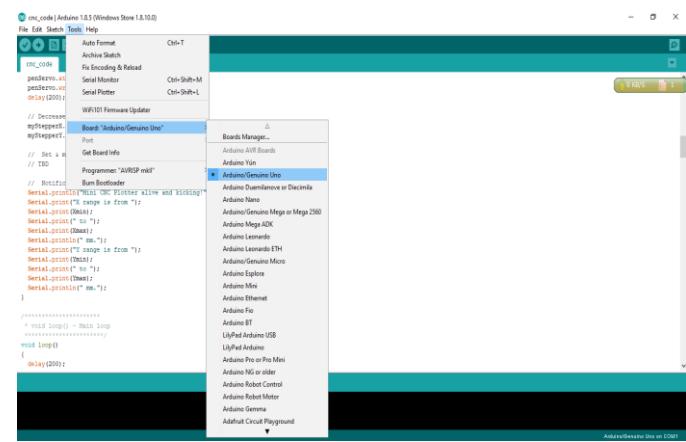


Figure 4: Arduino Uno Software

B. Inkscape

The use of Inkscape is to convert any image into graphics code usually known as G-code. G-code formats are generated by integrating Inkscape with necessary extension files [19].

G-code tools is an open source Inkscape extension, to export G-code for use with the CNC machine, written in the Python programming language. Inkscape extensions work in standard Unix IO model, taking SVG on standards input, and output transformed SVG on standard output [20]. Figure 5 shows the Inkscape software which is used to convert an image to its G-code.

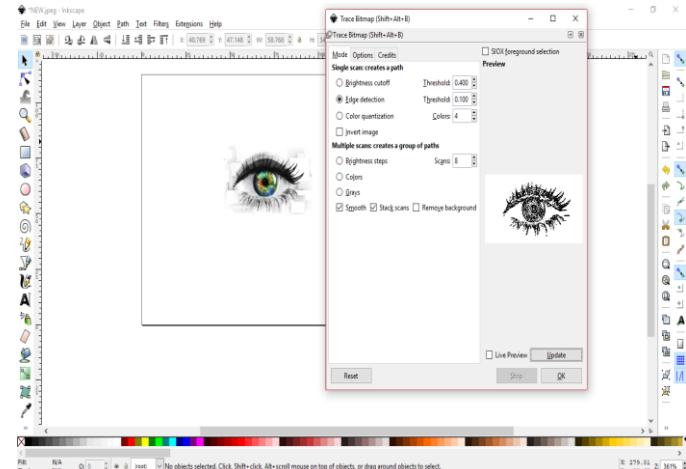


Figure 5: Inkscape Software

C. Processing

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. The port of Arduino Uno is selected by pressing 'P' button on keyboard hence 'G' button is used to 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 sent command to Arduino it will start plotting the G-code on 2D plane [21]. Figure 6 shows the Processing software which uploaded GTCRL code to CNC machine.

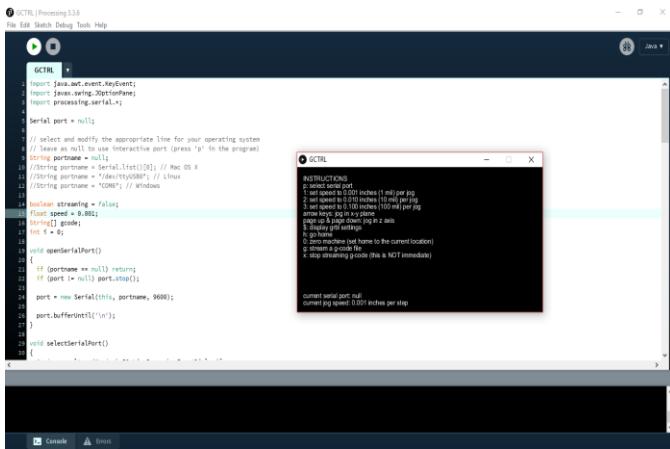


Figure 6: Processing P3 software

IV. RESULT AND DISCUSSION

The pen holder is mounted on the CNC machine. The plotter movement in X and Y direction is controlled using motor coupled gear to move the position left and right and forwards and backwards. We use two L293D motor driver ICs to control the DC motor. The overall assembly of the X-Y plotter fabrication is by using DVD drives. This CNC machine is used to fabricate PCB. The use of Inkscape as the G-code generator enables the users to draw and trace their image before converting into G-code file. The file is then attached to processing software, run in Java language. The processing language enables user to specify the speed of the stepper, setting the (0, 0) location, go home setting, and to abandon plotting. The command is sent automatically after the G-code is loaded. The figure shows the original image and its 2D plotted image by the CNC plotter. The original Image and CNC plotter plotted image are shown in figure 7a & 7b.

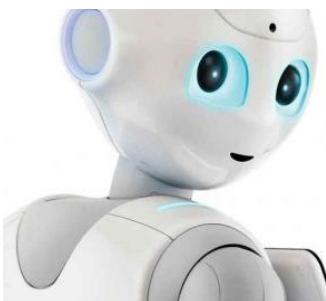


Fig. 7a: Original Image



Figure 7b: Plotted Image

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