ARDUINO-BASED CNC XY PLOTTER

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Abstract : In this paper, we present a novel technique that utilizes Arduino Uno and Motor driver ICs to automate the process of transforming any text or image into a 2D plotted text or image using a 2D plotter CNC machine. With the increasing demand for CNC machines in various fields, developing low-cost alternatives has become necessary. Our approach aims to reduce both the cost and complexity of CNC machines while maintaining high speed and accuracy. The primary objective of this project is to provide a faster and more affordable 2D plotter CNC machine compared to existing solutions.

Index Terms – CNC, Arduino, Stepper Motor, Servo Motor, Inscape Software, G-Code file.

I. INTRODUCTION

The technology used in the educational sector has become essential, but the high costs of cutting-edge technology present a significant challenge. The availability of computers, software, and the interface between hardware and software has revolutionized education and made visualization and verification much more accessible than in the past. Low-cost robots have proven to be extremely useful in education. Plotters are commonly used for creating 2D plots that are digitally controlled. The 2D plotter CNC machine can be replaced by higher-specificity laser sources capable of cutting materials of varying strengths for 3D plots. The 2D plotter is designed to record and plot two-dimensional data on a rectangular coordinate system. In computer numeric control, an Arduino Uno microcontroller and an L293D motor driver are used to process logical instruction interfaces with the computer. A CNC plotter machine is a 3D-controlled 2D plotting machine that uses a pen to draw text or an image on any solid surface. The coding for the CNC system is G-code programming, which instructs the machine to move to various points at the desired speed, control the spindle speed, and turn on and off at various positions. Additionally, the low cost and easily controlled functionality of the Arduino system simplifies the building circuitry of the microcontroller in the 2D plotter.

II. THE OBJECTIVE OF THE SYSTEM

- Precision Drawing: The primary objective of the Arduino-based CNC 2D plotter is to achieve precise and accurate drawing capabilities
- Cost-effectiveness: The plotter aims to provide a cost-effective solution for drawing and plotting
- Versatility: The plotter is designed to be versatile, allowing users to create a wide range of designs and patterns. Whether it's intricate artwork, technical drawings, or PCB prototypes, the plotter aims to be adaptable to various applications and provide a platform for creative expression
- User-friendly Interface: The plotter aims to provide a user-friendly interface for ease of use. This includes developing or utilizing software applications that simplify the process of converting digital designs into motor movements

III. METHODOLOGY

In order to control the pen plotter, the coordinates are first uploaded to the machine controller through a separate program. The image file is then converted to G-code using software and transferred to the microcontroller. In this paper, we propose a simple design for a 2D plotter that uses an Arduino Uno and L293D motor driver. The machine will have three motors, one for each of the X, Y, and Z axes. A servo motor will be used to control the pen's position along the Z axis, with the pen moving up for logic '0' and down for logic '1'. Drawing will be done on the X-Y plane, with positioning controlled by stepper motors. An overview of the system is provided in Figure 2. To construct the plotter, the X-axis is attached to two plastic parts that have been cut to fit the design. The Y axis is attached straight to the base of the 2D plotter, with the X axis attached vertically to it. The servo motor (Z axis) is then attached to the pen base on that surface. The pen must be able to move up and down with the help of the servo motor. Finally, a hard surface is attached to the Y-axis for drawing. The project requires the use of three software programs: Arduino IDE, Inkscape, and Processing. Inkscape is used for designing the image or text that will be plotted, while Processing is used for converting the design into G-code. Arduino IDE is used to program the microcontroller that controls the motor mechanism of the plotter. The circuit diagram of the 2D CNC plotter is shown in Figure 3. The plotter has an area of printing of 4cm x 4cm and is designed to be attached to a hard surface on the Y axis.

IV. BLOCK DIAGRAM

The block diagram of an Arduino-based CNC XY plotter consists of an Arduino board as the central control unit, motor drivers for precise motor control, stepper motors for movement, a pen or tool holder, a power supply an interface for communication with a computer or input device.
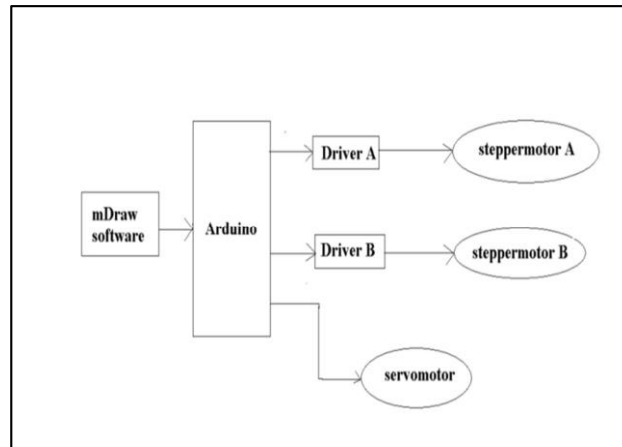

fig 1. block diagram

Arduino Board:

The Arduino board acts as the brain of the plotter. It is a microcontroller board that executes the program instructions to control the movement of the plotter. The Arduino board receives commands from a computer or other input devices and translates them into appropriate signals to drive the motors.

Stepper Motors:

Stepper motors are used in the plotter to provide precise control over the movement of the pen or tool. The stepper motor for the X-axis controls the horizontal movement, while the stepper motor for the Y-axis controls the vertical movement. These motors move in discrete steps, allowing for accurate positioning of the pen.

Pen or Tool Holder:

The pen or tool holder is the component that holds the drawing instrument, such as a pen, pencil, or marker. It is usually attached to the moving platform driven by the stepper motors. The plotter can be designed to lift or lower the pen to create lines or shapes of different thicknesses.

Power Supply:

The plotter requires a power supply to provide electrical power to the Arduino board, motor drivers, and other components. The power supply should have sufficient voltage and current capacity to meet the requirements of the motors and other electronic components.

Servo Motor:

The servo motor is used to control the vertical movement of the drawing tool (pen holder). It receives commands from the Arduino to position the drawing tool at specific heights, allowing it to lift or lower the pen during the drawing process.

V. SOFTWARE REQUIREMENT

1) *ARDUINO IDE-*

The Arduino Integrated Development Environment (Arduino IDE) is a software tool that includes a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It is used to upload programs and communicate with the Arduino and Genuino hardware. Figure 4 displays the Arduino IDE software used for programming the Arduino Uno.
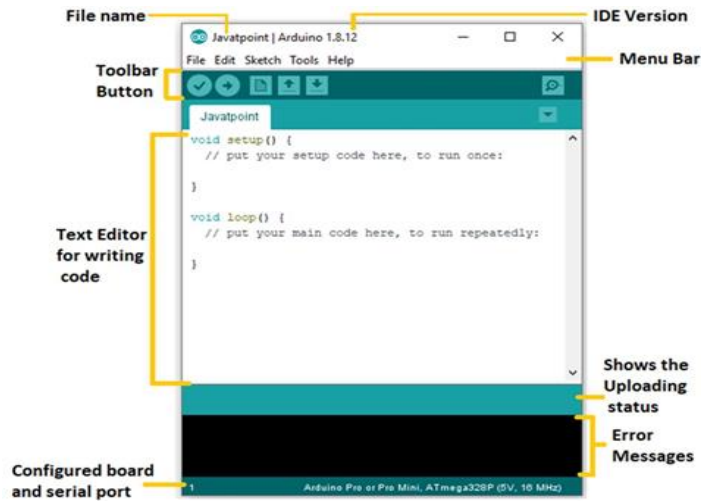
fig 2 arduino ide

Here's a detailed Explanation of the Arduino IDE

1) Code Editor: The Arduino IDE features a code editor where you can write and edit your Arduino sketches (programs). The editor provides syntax highlighting, auto-completion, and basic code formatting to help you write code more efficiently.

2)Code Libraries: Libraries can be added to Arduino sketches to simplify complex tasks, such as working with sensors, displays, communication protocols, and more. The Arduino IDE comes with a set of standard libraries, and you can also download and install additional libraries from the Arduino Library Manager or import custom libraries.

3)Compilation: Once you've written your code, the IDE compiles it into a binary file that can be understood by the Arduino board. During compilation, the code is checked for errors and converted into machine-readable instructions.

4)Serial Motor: The Arduino IDE includes a built-in serial monitor tool that allows you to communicate with your Arduino board over the serial interface. You can use the serial monitor to send and receive data between your Arduino board and the computer, which is useful for debugging and monitoring the behavior of your sketches.

5)Board Manager: The Arduino IDE supports a wide range of Arduino boards. The "Board Manager" feature allows you to install and manage board definitions for different Arduino variants, such as Arduino Uno, Arduino Mega, Arduino Nano,and more. You can select the appropriate board type from the Tools menu in the IDE.
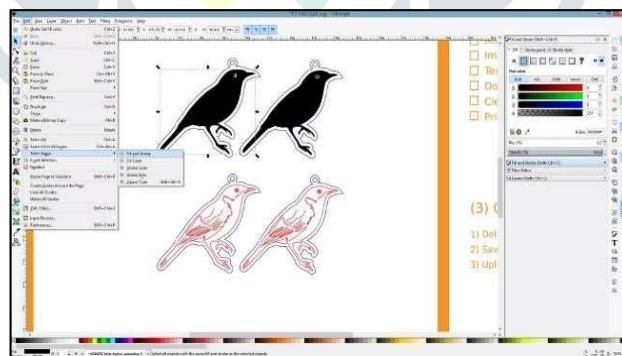
2) INKSCAPE-

fig 3 inkscape

Inkscape is a software tool used for converting images into a graphics code, commonly referred to as G-code. This is achieved by integrating Inkscape with necessary extension files. The G-code tools extension is an open-source tool used with Inkscape to export G-code for use with the CNC machine this programming is written in Python Language. Inkscape extensions work with the standard Unix IO model by taking SVG on standard input and outputting transformed SVG on standard output. The figure is a representation of the Inkscape software used to convert an image to its G-codeAs a GNU/Linux, Windows, and macOS, Inkscape is a free and open-source vector graphics editor. It has a wide range of features and is frequently used for cartoons, clip art, logos, typography, diagramming, and flowcharting as well as other artistic and technical illustrations. Because vector graphics are not constrained by a set number of pixels like raster graphics, they enable sharp printouts and renderings at any resolution. The Scalable Vector Graphics (SVG) file format, which is widely supported by other software including web browsers, is used by, PDF, PS, and PNG are just a few of the additional file formats that it can Export and import. G-code generator, allowing users to draw and trace their image before converting it into a G-code file. The G-code file is then attached to the processing software, which runs in the Java language. Users can specify the speed of the stepper, set the (0, 0) location set the home location, and abandon plotting using the processing language. After loading the G-code, the command is sent automatically. The original image and its 2D plotted image by the CNC plotter are shown in the figure.
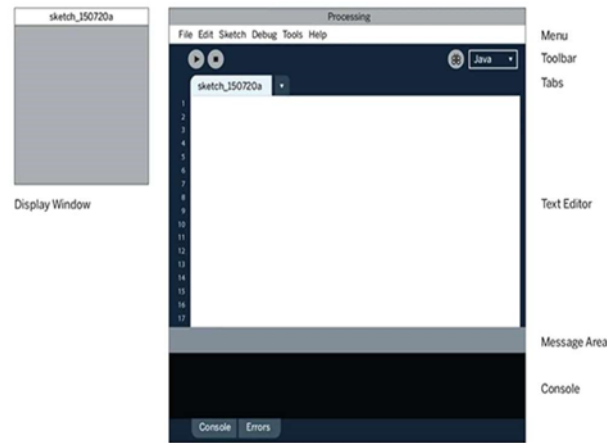
3) *PROCESSING P3 SOFTWARE*

fig 4. *processing p3 software*

Processing is a software programming language that is open source and used for electronic drawings. The GTCRL processing program is used to transfer the G-code file from the user interface to the CNC plotter. By pressing the "P" button on the keyboard, the port of the Arduino Uno is selected, and the "G" button is used to connect to the Arduino. The full CNC code is uploaded to the Arduino, and then the Arduino waits for the G-code file from the processing software. When the processing software sends the command to the Arduino, it starts plotting the G-code on the 2D plane. Figure 4 displays the Processing software that uploads the GTCRL code to the CNC machine.

VI. RESULT AND DISCUSSION

The pen holder is mounted onto the CNC machine, which is controlled by the motor to move in the X and Y directions The DC motor is controlled by two L293D motor driver ICs. Inkscape is used as the G-code generator, allowing users to draw and trace their image before converting it into a G-code file. The G-code file is then attached to the processing software, which runs in the Java language. Users can specify the speed of the stepper, set the (0, 0) location set the home location, and abandon plotting using the processing language. After loading the G-code, the command is sent automatically.

- The utilization of technology in the field of education become imperative. However, the high expenses associated with advanced technology pose a significant challenge and due to this challenge, it isn't affordable for many industries and institutes. The availability of computers, software, and the interface between hardware and software has revolutionized education and made visualization and verification much more accessible than in the past.
- Imperative. However, the high expenses associated with advanced technology pose a significant challenge. The availability of computers, software, and the interface between hardware and software has revolutionized education and made verification much more accessible than in the past.
- Low-cost robots have proven to be extremely useful in education. Plotters are commonly used to create digitally controlled 2D plots. A 2D plotter can be replaced as Higher-specificity laser sources that can cut materials with varying strengths for 3D plots can take the place of CNC machines. A rectangular coordinate system is what the 2D plotter uses to record and plot two-dimensional data.
- An Arduino Uno microcontroller and an L293D motor driver are used in computer numeric control to process logical instruction interfaces with the computer. A CNC plotter machine is a 3D-controlled 2D plotting machine that draws text or images on any solid surface with a pen.
- G-code programming is used for the CNC system, which instructs the machine to move to various points at the desired speed, control the spindle speed, and turn on and off at various positions. Furthermore, the Arduino system's low cost and easily controlled functionality simplify the circuitry of the microcontroller in the 2D plotter.
- The utilization of technology in the field of education has become imperative. However, The high expenses associated with advanced technology pose a significant challenge. The availability of computers, software, and the interface between hardware and software has revolutionized education and made visualization and verification much more accessible than in the past.
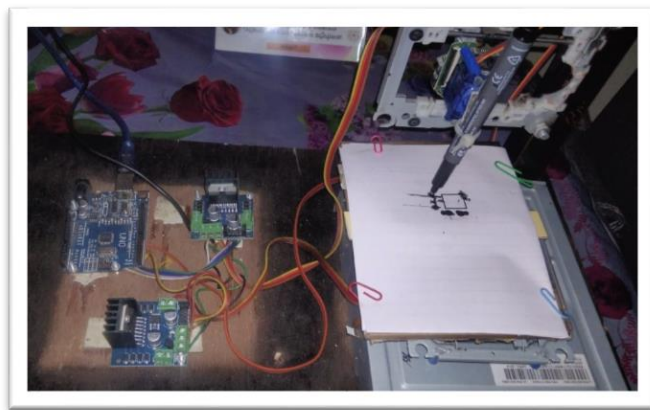- The result of the project is shown in Figure 5

fig 5. arduino based cnc xy plotter

VII. CONCLUSION

The Arduino-based CNC XY plotter is a versatile and cost-effective solution for creating two-dimensional drawings, designs, and patterns. using Arduino boards, stepper motors servo motors, belts, and pulleys, we can create an automated system capable of precise movements and accurate drawings.

Additionally, the Arduino-based CNC XY plotter is relatively affordable compared to commercial CNC machines. By building it yourself and sourcing the components independently, you can save a significant amount of money while still achieving satisfactory results innovative and adaptable Arduino-based CNC XY plotter combines the CNC power of computer numerical control with the ease of use and accessibility of the Arduino platform Through the use of a computer-controlled mechanism, this The project enables individuals to produce exact and intricate drawings, designs, and artwork.

VIII. ACKNOWLEDGMENT

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