

Mini CNC Plotter

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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. This research paper will present an affordable model of a CNC plotter machine which is able to draw a 2D diagrams images on to a small size paper very accurately and efficiently, using simple algorithms and available components. "CNC PLOTTER" is a work which is design to done a low cost three axis mini CNC plotter using stepper motor, Arduino micro controller and motor control software. At first the user needs to convert any image file or text file into G-code using Inkscape software and then feed it into the machine using processing software Arduino Uno is used as a control device for our project. This plots the required image on to the paper using some processing software and using mechanical arrangements. So, in our project, we are trying to create a low cost CNC plotter of small or medium size and an open structure.*

Keywords: Computer Numerical Control (CNC), Image File, G-Code, Micro-Controller Unit (MCU), Driver Motors, Plotting on the Paper

I. INTRODUCTION

Computer numerical control is an advanced form of soft automation developed to control the motion and operation of machine tools. Numerical control machine was invented around in 19th century to reduce work load, it is a method in which the manufacturing machine uses coded format, digits and letters. Its advantages include high efficiency, high flexibility, and high production rate, low cost of production. It includes three main steps that is receiving data, interpreting data and accordingly control action. Based on special characters letter codes and numbers a form of program called part program (a sequential instruction or coded commands that direct specific machine function) is used for automatically operation of a manufacturing machine to produce a specific part of specific dimension. The program is then converted into electrical signal to feed as input to motors that run the machine and do the tool movements.

A machine control unit (MCU) decides the tool depth of cut, cutting speed etc. Motion of tool is based on right hand coordinate system. Three axis of rotation X, Y, Z for the three dimensional motion of tool plus an axis of rotation. The z-axis is one of the three which allows the movement of router in up and down direction. This axis is very important because it controls the depth.

The y-axis functions as motor mount to move z-axis in addition with slide mechanism, x-axis uses two pieces one for front and one for back which serves as height stands.

1.1 Objectives

The objectives of our project is to design and implement a CNC plotter machine which will be able to draw any plan, elevation, side views of buildings and also to draw required images on the paper. Also, to develop a low cost automatic mini CNC plotter machine for any drawing with reduce in cost of mechanism along with the increase in flexibility.

1.2 Methodology

We have supply the current in Arduino with USB DATA cable to transfer data from Computer to Arduino Board. Here we have Used 3 stepper Drivers to supply the G codes in sequence to the stepper motors. Arduino will be mounted on CNC shield. CNC shield will be distributing the Current in the command of Arduino. CNC shield will be converting the command of G codes in digital pulse by Stepper motor. In X- direction stepper motor will be move left and Right, Y- direction stepper motor will be move in front and back direction, Z- direction stepper motor will be move in up and down. We have made many difficult design via using this machine. The accuracy of these machines results is very high. So we



have used in industry to reduce the cost of design printing and maintain accuracy level. Drafting and Scaling of CNC Plotter machine is very precious.

II. SOFTWARE

It consists of

1. Inkscape (version 0.47)
2. Arduino IDE
3. Processing 3.3

2.1 Inkscape (Version 0.47)

There are two basic types of graphic images: bitmap (or raster) images and vector images. In the first case, the image is defined in terms of rows and columns of individual pixels, each with its own color. In the second case, the image is defined in terms of lines, both straight and curved. A single straight line is described in terms of its two end points.

A. Inkscape Window

Start by opening Inkscape. This window contains several major areas, many containing clickable icons or pull-down menus. The following figure shows this window and labels key parts. As Inkscape has grown more complex, the area required to include icons and entry boxes for all the various items has also grown leading to problems when Inkscape is used on small screens. The Command Bar, Snap Bar, Tool Controls, and Tool Box have variable widths or heights. If there are too many items to be shown in the width (height) of the Inkscape window, a small down arrow will appear on the right side or bottom of the bars. Clicking on this arrow will open a drop-down menu with access to the missing items.

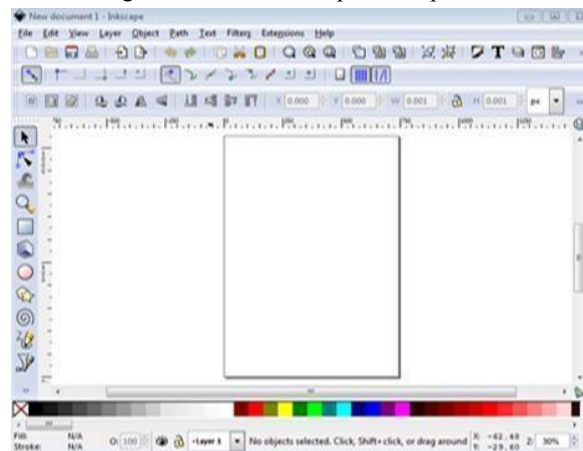


Figure 1: Inkscape Window

2.2 Arduino IDE

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a “sketch”. The Arduino IDE supports the languages C and C++ using special rules to organize code. The Arduino IDE supplies a software library called Wiring from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consists of two functions that are compiled and linked with a program stub `main ()` into an executable cyclic executive program

- **Setup ():** A function that runs once at the start of a program and that can initialize settings.
- **loop ():** A function called repeatedly until the board powers off. After compiling and linking with the GNU tool chain, also included with the IDE distribution, the Arduino IDE employs the program argued to convert the

executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

2.3 Processing 3.3

Processing is a simple programming environment that was created to make it easier to develop visually oriented applications with an emphasis on animation and providing users with instant feedback through interaction. The developers wanted a means to “sketch” ideas in code. As its capabilities have expanded over the past decade, Processing has come to be used for more advanced production-level work in addition to its sketching role. Originally built as a domain-specific extension to Java targeted towards artists and designers, Processing has evolved into a full-blown design and prototyping tool used for large-scale installation work, motion graphics, and complex data visualization.

A Processing program is called a sketch. The idea is to make Java-style programming feel more like scripting, and adopt the process of scripting to quickly write code. Sketches are stored in the sketchbook, a folder that's used as the default location for saving all of your projects. Sketches that are stored in the sketchbook can be accessed from File Sketchbook. Alternatively, File Open... can be used to open a sketch from elsewhere on the system. Advanced programmers need not use the PDE, and may instead choose to use its libraries with the Java environment of choice. However, for a beginner, it's recommended to use the PDE to gain familiarity with the way things are done.

III. HARDWARE DESCRIPTION

3.1 Arduino Uno

Arduino Uno is a surface mount breadboard embedded version with integrated USB it is a complete and breadboard friendly it has everything that has electrically with more analog input pins and onboard +5v jumper. physically it is missing power jack the Uno is automatically sense and switch to the higher potential source of power there is no need for the power select jumper.

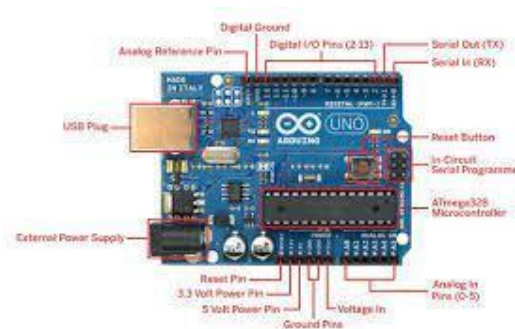


Figure 3: Arduino IDE

3.2 L293D Motor Shield

L293D IC is a motor driver integrated circuit shown in fig. it is used to control the Stepper and servo motor rotations in clockwise and anticlockwise directions. This change in rotations help the sketcher to move in the required three direction say, X, Y and Z axis directions corresponding to left and right movement, front and back movement and up and down movement.



Figure 4: L293D Motor shield

3.3 Servo Motor

A servo motor shown in fig. Is used for the movement of sketching pen in up and down in Z direction. This will help the CNC 2D sketcher to point the pen in A4 sheet and withdrawing in front the sheet to stop drawing.



Figure 5: Servo Motor

3.4 Stepper Motor

A stepper motor is a type of DC motor which has a full rotation divided in an equal number of steps. It is a type of actuator highly compatible with numerical control means, as it is essentially an electromechanical converter of digital impulses into proportional movement of its shaft, providing precise speed, position and direction control in an open-loop fashion, without requiring encoders, end-of-line switches or other types of sensors as conventional electric motors require. The steps of a stepper motor represent discrete angular movements, that take place in a successive fashion and are equal in displacement, when functioning correctly the number of steps performed must be equal to the control impulses applied to the phases of the motor. The final position of the rotor is given by the total angular displacement resulting from the number of steps performed. This position is kept until a new impulse, or sequence of impulses, is applied.



Figure 6: Stepper Motor

IV. BLOCK DIAGRAM

Mini CNC plotter machine is worked on input as a G-codes of design and converting it via 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 on our project this is easier way to use Stepper motor with lead screw, CNC Shield, Stepper Drivers, arduino board,etc. The setup of machine is flexible that's why it will be easily transported and maintenance time is short. The basic diagram of CNC Plotter machine is Shown in figure.



Figure 7: Block Diagram of Plotter

V. FINAL SETUP

All sections i.e. two CD drives for X and Y-axis using two stepper motor, Z-axis using one servo motors ,all the connections on zero PCB according to circuit, so these all basic parts are fixed and mounted on the PVC sheet and they are all integrated together to get a good output.

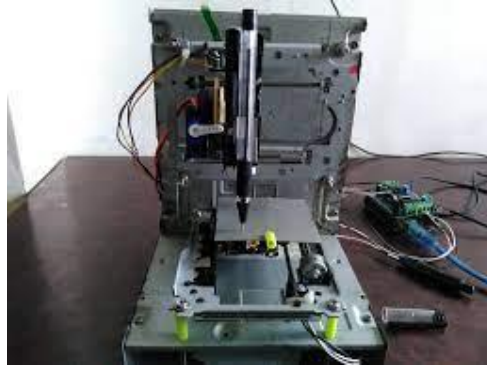


Figure 8: Final Setup

VI. FUTURE SCOPE

The pen of the machine can be replaced by a laser to make it work like a laser 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 drilling and milling purposes the servo can be replaced with a stepper motor and pen with a 3D pen to make it a 3D 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. Further the applications of proposed CNC 2D sketcher can also be extended in the field of printed circuit board PCB drawing and drilling electrical discharge machining (EDM), metal removal and fabrication lettering and logo designs or engraving as well.

VII. CONCLUSION

Even though more number of CAD/CAM software are available for building as well as production drawing, printing and plotting of plan, elevation and other views, the CNC 2D sketcher can do different building drawings as required by the customers. This requires some modification in drawing can be obtained by making changes in G-code manually or by generating through Inscap software the proposed CNC 2D sketcher gives instant priming or sketching of building drawing in an A4 sheet further the application of proposed CNC 2D sketcher can also be extended in the field of printed circuit board (PCB) drawing and drilling, Electrical discharge machining (EDM), metal removal and fabrication, lettering and logo designs or engraving as well.

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