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Design and Fabrication of CNC Plotter Machine

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ABSTRACT

In this project we will show you how to easily build your own arduino CNC plotter machine based on the open source hardware and software . The Arduino plotter machine has been dependent on the principle of Computer Numerical Control with limited area o the motion of X, Y and Z axis. for X and Y axis we will used stepper motor(nema 17), GT2 time belt pulley and guided rail (4-8mm SS rod shaft) and for Z axis we will used servo motor for up and down motion. These three axis stepper motors are controlled by CNC Shield for movement (X, Y and z axis) . This machine's movement on the X axis is 300 mm and Y axis is 500 mm. Length of travel means the linear movement of stepper motors that control for X, Y and Z axes from point to another point. The left and right movement controlled by X axis stepper motor, front- back movement controlled by Y axis stepper motor and the pen is up-down that is controlled by Z axis servo motor.

This paper present cnc plotter machine which is able to draw 2d diagrams or isometric views of mechanical machine parts or circuit layout on PCB using simple algorithms .At first the user needs to converts any image file into g-code using inkspace software then feed it to the universal G-code sender . arduino uno microcontroller is used to as the control device for this project . the microcontroller coverts g-code into set of machine language instruction to be sent to the motor driver of the cnc plotter machine .

INTRODUCTION

Mini CNC plotter machine is described as it is based on Arduino controller and CNC shield. CNC is computer numerical control machine. G codes are preparatory Function. G codes are pre-defining Function Associated with the movement on machine axes. In CNC Plotter Machine only G codes are used. G codes are giving the Direction to move the pen in X, Y, Z directions. Pen can be changed by tools of drilling, laser cutting tool, milling it can be worked, if it is made in large size. The aim of over is to make a mini CNC plotter machine which is capable to draw difficult design in paper or surface of metal, To cut it with a great accuracy. We have used 3 stepper motors with lead screw in Cartesian coordinate X, Y, Z directions. Stepper motor is convert digital pulse into lead screw rotations. Stepper drivers are used to give command to the system. The main aim is to fabricate a MINI CNC plotter Machine to draw an object with using G codes. We also work on to reduced.

LITERATURE SURVEY

Kajal J. Madekar, Kranti R. Nanaware, Pooja R. Phadtare, Vikas S. Mane Feb 2016

"Automatic mini CNC Machine for PCB drawing". To develop low-cost automatic mini CNC machine for PCB drawing. This system reduces the cost of machine and increases the flexibility. In this G code is interfaced with ATMEGA

328. CNC based controller by FTDI module which is used to convert the code in convenient controller the code

I.e. serial to USB converter, x moves to left , Y moves to right and z moves to up and down. It gives better accuracy and reduces the work load. G code mark easy to find the information of locations of all stepper motor moving. In the GRBL support 3 axis of motion X, Y and Z but dose not support rotation axes(X, Y).

Mohammad kamruzzaman Khan Prince, Muhsi-AL- Mukaddem Ansary, Abu ShafwanMondaol January 2017

"Implementation of a low-cost CNC Plotter using spare parts". It can able to draw PCB layout on a solid surface. In this Arduinobased design using ATMEGA 328P microcontroller. It can draw complex line drawings. In this they use the fritzing software for open source circuit simulator software which is mainly used for PCB design . GTCRL is GUI program for use with GRBL. It control for sending the G code. In this Bresenham‟s Line Algorithm is used. It consumes low power and works with high accuracy due to precise controlling of stepper motors. It is designed for private manufacturing and small scale. This machine runs in a slow pace and generates excess heat which causes the heat sink to be heated quickly. The Z-axis is not very rigid so it causes slight vibration.

III. Hardware component and their Descriptions

I. Stepper motor

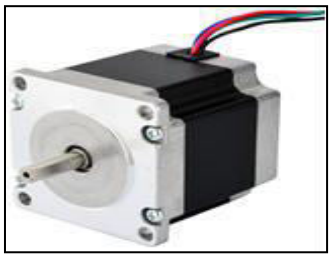
II. Servo motor

III. Ardino UNO and cnc shield

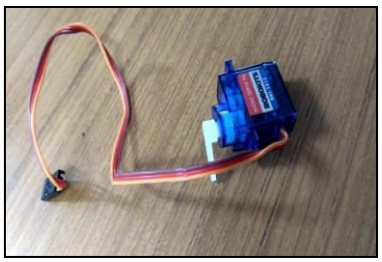
IV. 3d printed bracket

V. Guiding Rail

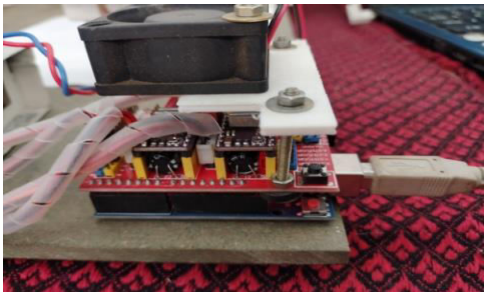
1. **Stepper motor** : Stepper can be converted digital pulse in to a movement of pen with respect to axis X, Y, Z direction, the stepper motor is known by its property to convert a number of impulses into a defined increment in the shaft position. Each pulses move the shaft through a fixed angle.



2. **Servo motor ;** The servo motor is closed loop mechanism that incorporates positional feedback in order to control the rotational or linera speed and position it is control by ardino or cnc shield , which determines the amount of movement which represent the final command position for the shaft.. in our machine this motor is used to up & down movement of Z-axis.



3. **Ardino UNO or CNC Shield:** Arduino will be define as, it is received the command or data from the computer and with the help of USB cable. It is mounted on CNC shield, it will be transfer data from Arduino to CNC shield with using stepper driver. Arduino UNO is a microcontroller board, it contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable and a power source. It controls the position of stepper motor with help of a program



4. **3d printed bracket**: In this mahine some 3d printed bracket are used for mounting or support stepper motor . it is a plastic material and lighter in weight .

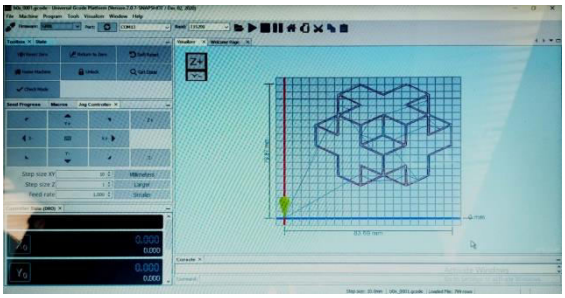
5. **Guiding Rail** : this is a 8 mm SS rod Shaft(u) wihich is also mounted in 3D printed brackets. In this machineit is used to purpose of sliding movement of X-axis or Y-axis . for sliding lineir bearing (LM 8 uu)is used.

IV. Software used with description

i. **Inkspace**

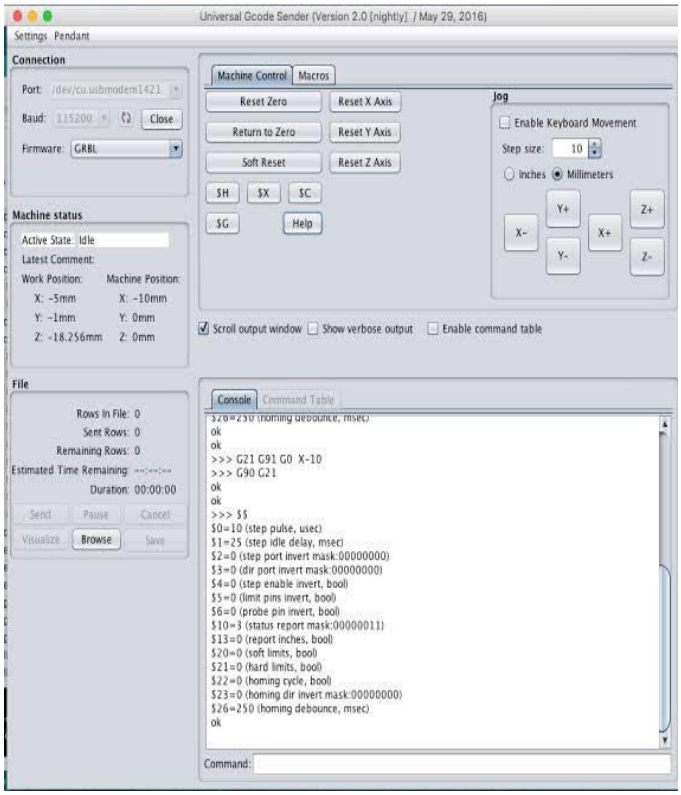
ii. **Universal G-code Sender**

1. **Inkspace SO-11.0**:



Inkspace is a free and open source vector graphics editor used to create vector images primarily in scalable vector graphics format. Inkspace can render primitive vector shapes (e.g. rectangles , ellipses , polygons , arcs , spirals and 3D boxes) and text. Created Shapes can be further manipulated with transformations, such as moving rotating, scaling and skewing. . In this project by using this software G-code file of a selected image or text is created G-code is a commonly used numerical control programming language which includes X, Y, Z coordinates.

2.**Universal G-code sender** : Universal G- code sender is a java – based tool that can enable user to send the G-code to machine supported by CNC.It is a full featured G-code platform used for interfacing with advanced CNC controller like GRBL, TinyG, G2core and smothieware. Universal g-code sender is a sief-contaed java application which includes all external dependencies and can be used on most computer running windows, MacOSX or Linux. It is a application used to send command from your computer to your machine.

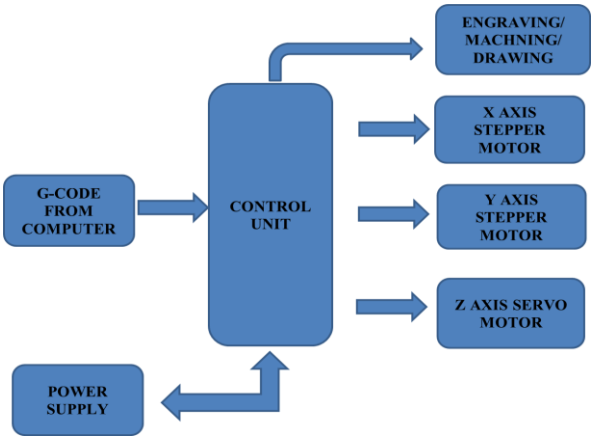


UGS with coding

V. Working

Firstly, we have supply current in ardino through data cable. Here we are used power supply 12V or 10A (SMPS) with USB data cable to transfer data to computer to ardino board. Here we have used 3 Stepper Drivers and 1 servo motor 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 servo motor will be move in Up and down[2]. We have make 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.

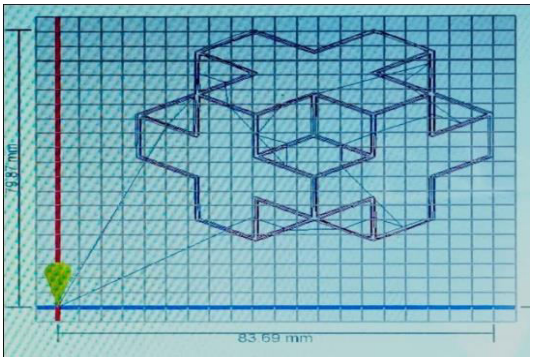
VI. Block Diagram



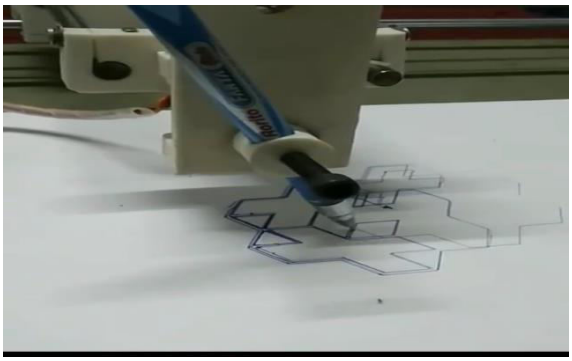
VII. Image file

Fig shows a image file that has been converted into a sketch through Inkspace or universal G-code Sender and then plotted via CNC plotter machine.

1. Isometric view in software



1. Draw image by CNC plotter machine



VIII. TABLE

Sr.no	Detail specification of CNC plotter Machine	
1	**Writing size**	A4 sze 210 x297mm
2	**Control software**	Inkspace SO -11.0
3	**Pen travel speed**	3000 – 5000 mm/min
4	**Pen Draw speed**	800 – 1500 mm/min
5	**Continous working time**	8 Hours
6	**Pen type**	Pencil marker , fountain pen cd drive pen etc.
7	**Supported material**	Paper cardboard , floor , Notebook etc
8	**Stepper motor**	Nema 17
9	**Sliding**	Lineer bearing LM 8UU
10	**System support**	Window XP, window 7 , 8 ,10
11	**Power input**	AC 100-240 V
12	**Working voltage**	DC 12v

IX. Result and discussion

A plotter machine was ready to operate. The plotter machine is implemented and manufactured as planned, therefore it can plot and write, this plotter machine starts to collect data from programming that is derived from computer aided design (CAD) and computer aided manufacturing (CAM). The programs produce the computer file and will then extract the command to run the device. The program will be transferred via Arduino and then loaded into the plotter machine to start machining. After completing its zero position settings and testing, the plotter machine was fully functional ready to work.

X. conclusion

In this paper, we used the concept of a low-cost plotter machine, which is easily controlled by the computer and suddenly stopped and paused by clicking on the computer. This small machine can be easily transported and assembled everywhere as required. The board size of this device is 40X40 cm. Stepper Motor will run on this standard for board size. If we have an increase in the size or length of the lead coil, it will be free to make the large size of the design on paper

Acknowledgement

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XI. future scope

Actual industrial CNC milling: It is planned to scale up the prototype. CNC machine in terms of size, use more powerful motors, strengthen the frame and worktable with material like aluminum and cast iron, and augment the CNC control software with software for simulation ahead of actual run. The Implementation of 3D technology to the same hardware abstract is going for printing of 3D models.

XII. References

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