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Design and Manufacturing of Mini CNC Plotter Machine

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***Abstract:** This paper describes a low cost serial communication based mini CNC Plotter Machine based on open source software and hardware. Mini CNC Plotter Machine is an embedded system that works on the Principle on 'Computer Numeric Control (CNC)'. The system basically works with three stepper motors (two for X-axis & one for Y-axis) and micro-servo controller (for Z-axis). Wherein Arduino Circuit plots the input given from the computer through 'ENSCAPE Software' on the sheet which is placed on the drawing board using micro-controller. The plotter has four axis control (2 X-axis and 1 Y& Z axis resp.) and a micro-servo controller for movement of pen. This system reduces human effort and also reduces the chances of error. The efficient and correct mounting of all the parts and proper use of software and correct alignment of circuit makes the system more efficient.*

***Index Words:** CNC, Arduino, Plotter, Controllers, Axis, Efficient System.*

I. INTRODUCTION

In today's world the basic requirement of any industry is to produce large quantity and quality products with low production and installation cost having high surface finish and great dimensional accuracy. So this can be achieved by a machines which are controlled by Computer i.e. Computerized Operated Machines. They are basically known as CNC machines. By using a CNC machine the products are produced at a faster rate with high accuracy and less human interference. The CNC machines usually are of various types. The most common used CNC machines are two-axis CNC machine and three-axis CNC machine.

The CNC machine is a system. This system consists of three important parts viz. Mechanical design, Drive modules, and System software. The mechanical design consists the body of the system. The drive modules consists of the Microprocessor. And finally the System Software is used to generate the drawing on the sheet.

Mini CNC Plotter Machine is the automation of machines that are operated by precisely programmed commands. The main function of CNC Plotter is used for plotting various drawings of products. The working principle of CNC Plotter is very similar to CNC machine. 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 table. In this project we will show how to build your own low cost mini CNC Plotter. The printing area will be restricted to 400*400mm, because it works on serial communication.

II. LITERATURE REVIEW

Various authors have studied the development of such machines.'Fabrication of Low Cost 3-Axis CNC Router' by 'Dr.B.Jayachandraiah, O.Vamsi Krishna, P.Abdullah Khan, R.Ananda Reddy' have studied that rapid growth of technology increases the demand for CNC which are expensive. So they suggested the development of low cost CNC Router. They also stated that lower cost can be achieved by combining the features of standard PC interface with microcontroller based CNC system in an Arduino based embedded system. 'Low Cost CNC Using Open Source Software and Hardware' by 'Muhammad Yaqoob Javed, Syed Hussain Rizvi, M.Amer Saeed, Kamran Abid, Osama Bin Naeem, Adeel Ahmad, Kamal Shahid' presents a low cost serial communication based CNC machine based on open source software and hardware. In their research they have used Universal Serial Bus (USB) CNC controller with open source software (G Code & GRBL) and hardware (Arduino & GRBL shield) which are easily available and at low price as compared to other controllers.

III. EXPERIMENTAL SETUP

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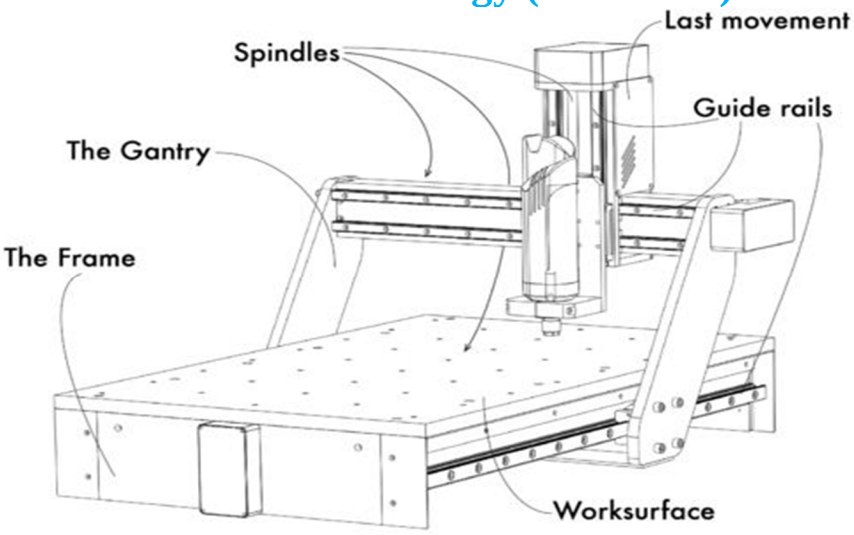


Fig 3:- Setup of mini CNC machine plotter

The Mini CNC Plotter System consists of three subsystems
Mechanical System
Electronic System
Computer for software

The main components of the system are explained below

A. Arduino Mega 2560:

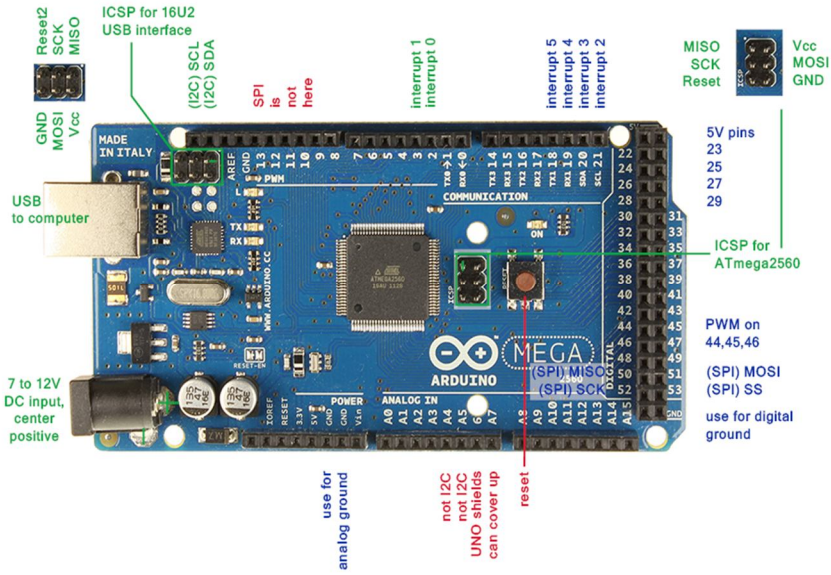


Fig 3.1:- Arduino Mega 2560 Circuit

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable. The Mega 2560 board can be programmed with the Arduino Software. The ATmega2560 on the Mega 2560 comes preprogrammed with a boot loader that allows you to upload new code to it without the use of an external hardware programmer

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B. Stepper Motor



Fig 3.2:- Stepper Motor

A stepper motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor, as long as the motor is carefully sized to the application in respect to torque and speed. Switched reluctance motors are very large stepping motors with a reduced pole count, and generally are closed-loop commutated.

C. Stepper Motor Driver (L293D)

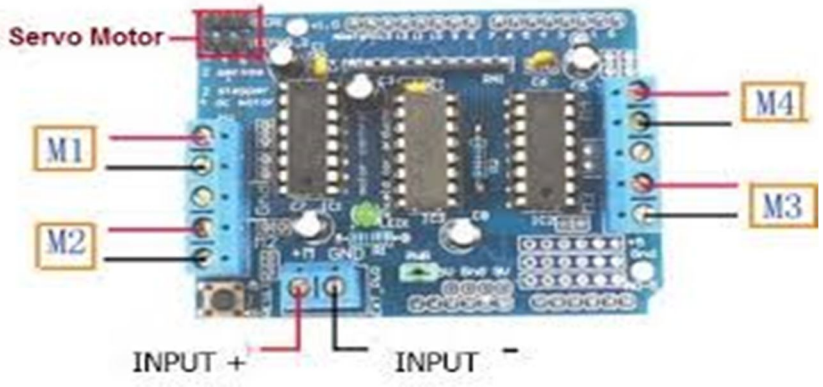


Fig 3.3:- Stepper Motor Driver (L293D)

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D.

D. Ball Bearings

A ball bearing is a type of rolling element that uses ball to maintain the separation between the bearing races. The purpose of ball bearing is to reduce the rotational friction and support radial and axial loads.

E. Lead Screw

A lead screw is a mechanical device which is used to transmit rotational motion into linear motion with some amount of friction. A threaded rod provides a helical raceway for ball bearings which acts as a precision screw. Also they can withstand high thrust load with minimum friction.

F. Software

The computer system consists of the software. The software used for plotting is “ENSCAPE Software”. This software converts the diagram into G-codes and M-codes and then stored the data in the Arduino circuit. Then the input from Arduino circuit plots the drawing on the sheet.

IV. CONCLUSION

With the increasing demand for small scale high precision parts in various industries, the market for small scale machine tools has grown substantially. Using small machine tools to fabricate small scale parts can provide both flexibility and efficiency in

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manufacturing approaches and reduce capital cost, which is beneficial for small business owners. In this thesis, a small scale three axis CNC plotter machine is designed and analyzed under very limited budget.

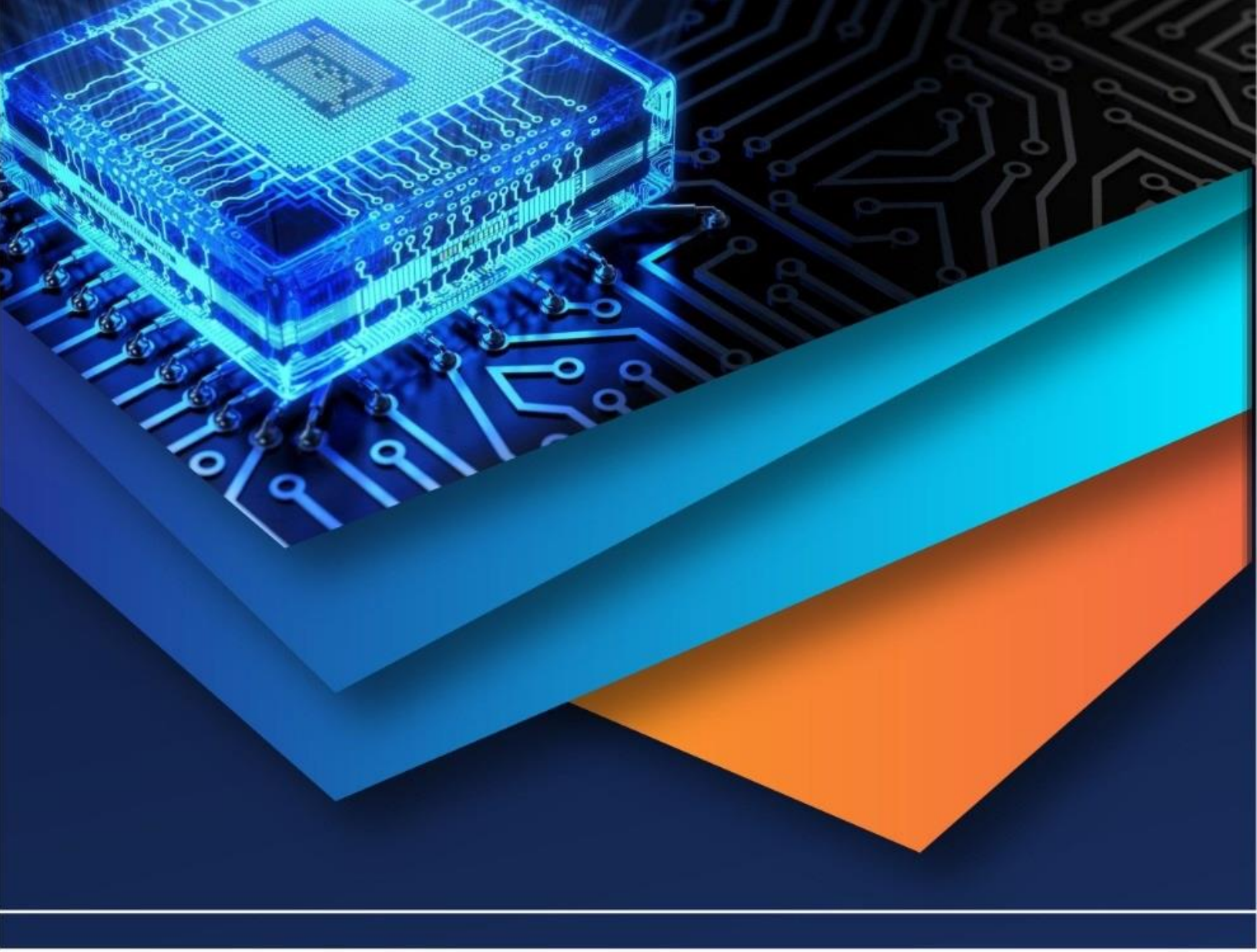
V. ACKNOWLEDGEMENT

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