

A
MINOR PROJECT REPORT
On
Writing machine using Arduino UNO R3

Submitted in partial fulfillment of the
Award of Degree
BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by:
Ashutosh Kumar Mishra
Ashutosh Kumar Singh

Under the guidance of:
Mr. Atul Vershney,
(Asst. Professor, ECE Department)



Department of Electronics and Communication Engineering
Faculty of Engineering and Technology, Gurukula Kangri University
Haridwar-249404, Uttarakhand

Acknowledgement

We would like to acknowledge the contribution of all those people who have been associated with us in this project. We would like to thank our guide **Mr. Atul Vershney**, Asst. Professor, Department of Electronics and Communication engineering, Faculty of Engineering and Technology, Gurukula Kangri Vishwavidyalaya, Haridwar. For his supervision, knowledge, support and persistent encouragement during our project work. He steered us through this journey with his invaluable advice, positive discussions and consistent encouragement.

We also express our deep sense of gratitude to other staff members of the department who have given us help and valuable advice time to time.

Candidate's Declaration

We hereby declare that the work, which is being presented in the minor project, and titled **“Writing machine using Arduino UNO R3”** in partial fulfilment of requirement for the award of degree of Bachelor of Technology in Electronics and Communication Engineering submitted in the department of Electronics and Communication Engineering, Faculty of Engineering and Technology, Gurukula Kangri University, Haridwar is an authentic record of our own work carried out during 15/09/2018 to 15/11/2018 under the supervision of **Mr. Atul Vershney, Asst. Prof. , Dept. of ECE.**

The matter embodied in this record has not been submitted by us for the award of any other degree or diploma.

Date:

Signature of candidate:

Ashutosh Kumar Mishra
Ashutosh Kumar Singh

This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

Internal Examiner

Mr. Atul Vershney
(Asst. Prof. , ECE)

External Examiner:

Table of Contents:

CERTIFICATE	2
ACKNOWLEDGMENT	III
Table of Figure	VI
ABSTRACT	VII
CHAPTER 1: INTRODUCTION	1
1.1 Introduction about Arduino Uno	2
1.4 Introduction about Mini Servo Motor	4
1.5 Introduction about Stepper Motors	4
1.6 Introduction about Preparatory Function	5
CHAPTER 2: Project planning.	6
Step 1: Disassembly DVD/CD Drives	6
Step 2: X and Y axis	6
Step 3: The Z axis	7
Step 4: Paper base	8
Step 5: The Circuit	9
Step 6: Testing X and Y axis movement	9
Step 7: Uploading the CNC code	9
Step 8: The GCTRL program	10
Step 9: Make your own G code file	10
CHAPTER 3 METHODOLOGY	11
3.1 DESIGN OF WRITING MACHINE	11
3.2 PROBLEM DEFINITION	11
3.3 WORKING	12
3.4 Main parts of CNC WRITING MACHINE.....	12
3.5 BLOCK DIAGRAM OF PROCESS	12
CHAPTER 4 : Inkscape 0.48.5	14
4.1 Creating G-Code File Using Inkscape	14
4.2 Processing	15
CHAPTER 5: Advantages, Disadvantages & Application	16
5.1 CNC WRITING Machine Advantages	16
5.2 CNC WRITING Machine Disadvantages	16
5.3 Application	17
Chapter 6 CODE	18

CONCLUSION	19
REFERENCES	21

ABSTRACT

In this project I will show you how to easily build your own low-cost Arduino Mini writing machine. For X and Y axis we will use stepper motors and rails from two DVD / CD ROMs! Printing area will be max 4x4cm. Because it works with serial communication you can also use a Bluetooth module (like HC-06) to print your stuff wirelessly through your computer Bluetooth connection! I have used the code from this site, so I need to thank the Maker blog for sharing this to us. With the advancement of technology, demand for Computer Numerical Control (CNC) plotter machines in Educational Institutions and Laboratories is rapidly rising. Low cost manufacture of Printed Circuit Board (PCB) has become a basic need in electronics laboratories, for mechanical engineering students and for electronics hobbyists. This paper will present an affordable model of a CNC plotter machine which is able to draw a circuit layout on PCB or any other solid surface using simple algorithm and available components. At first the user needs to convert any image file or text file into G code using Inkscape software and then feed it to the machine using Processing software. Arduino Uno with an ATmega328P microcontroller is used as the control device for this project. The microcontroller converts G-code into a set of machine language instruction to be sent to the motor driver of the CNC plotter. Key words Computer Numerical Control (CNC), Printed Circuit Board (PCB), G-code, Microcontroller Unit

CHAPTER 1: INTRODUCTION

Cost of the project and increase Reliability and Flexibility. In we have replace pen with mechanical tools drilling, grinding, machining etc. This will be used for soft material cutting or machining, laser cutting machine tool is also worked on this setup. We have reduced the cost, in the setup of mini cnc Writing machine. Mini CNC writing 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

1.1 Introduction about Arduino Uno

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 [2]. It is open source platform based on easy to use hardware and software. T have digital and analog input/output pins which can interface into various expansion board and other circuits and microcontroller with complementary components that helps in programming and incorporation into other circuits[3]. Current supplied 5 volts with USB cable..

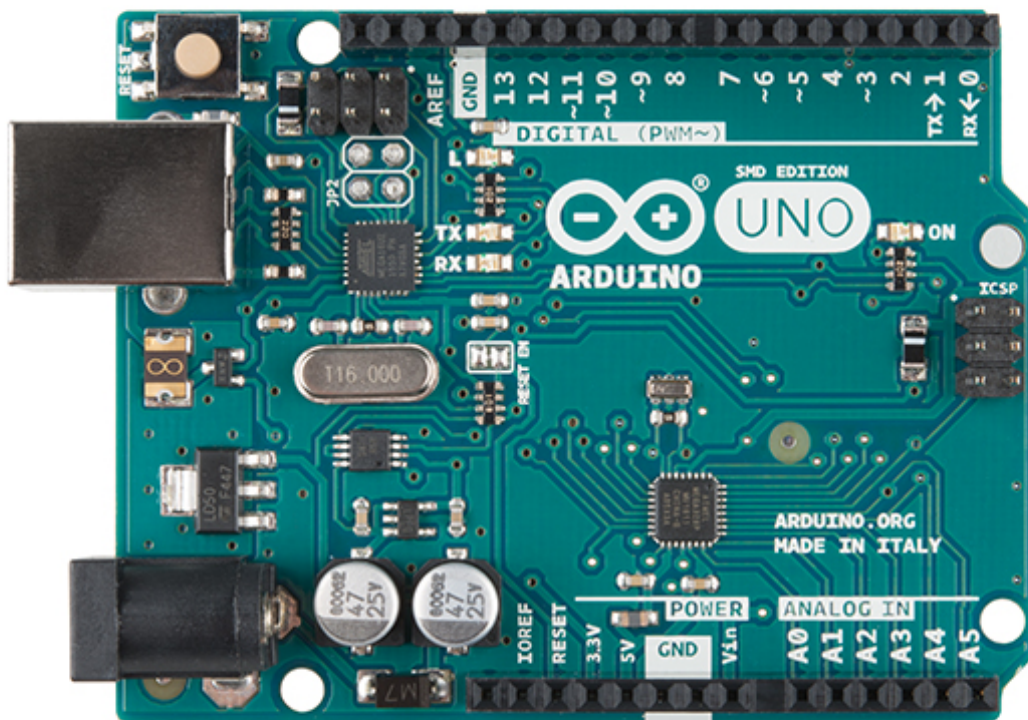


Figure 3: Arduino UNO

L293D motor driver

L293D is a typical motor driver or motor driver LC which allow DC motor to drive on either direction L293D is a 16-pin LC which can control a set of two DC motor simultareous inn any direction .it means that you can control two DC motor with a single L293D

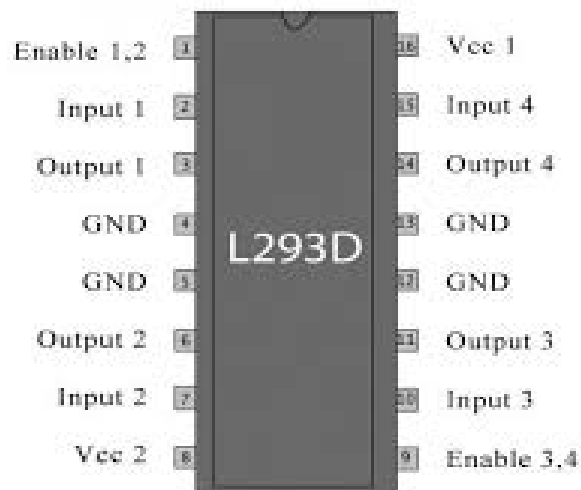


Figure 4: L293D motor drive

1.4 Introduction about Mini Servo Motor

A servo motor is an entirely different story the function of the servo is to receive a control signal that represents a desired output position of the servo shift and apply power to its Dc motor until its shaft turns to that position

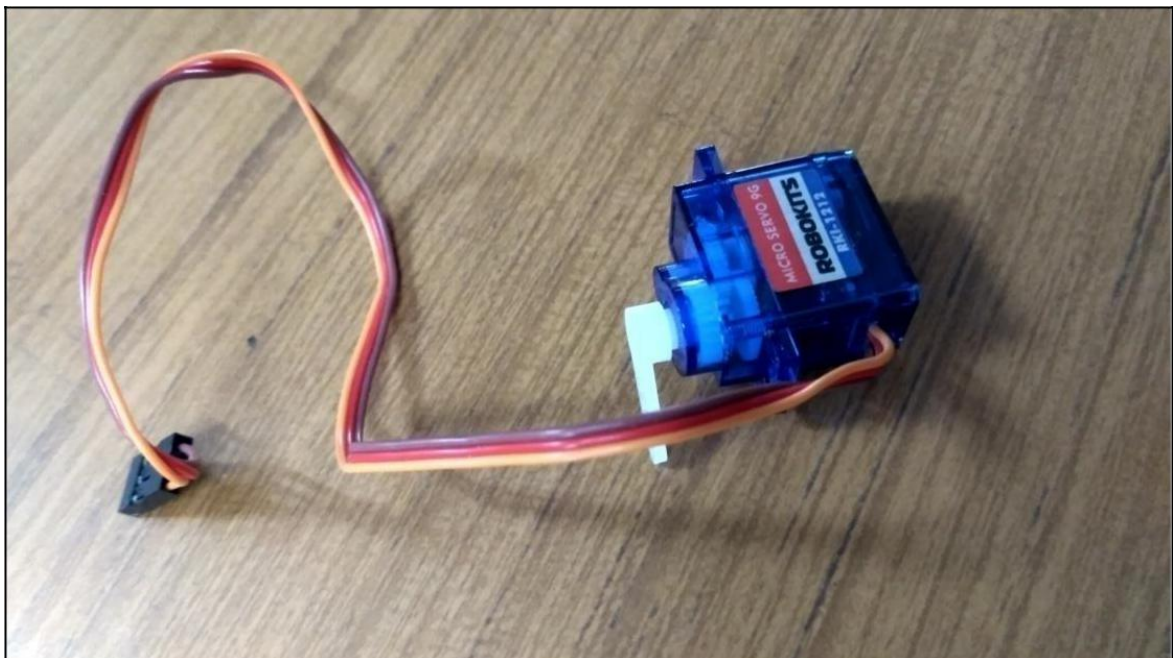


Figure 5 Servo Motor

1.5 Introduction about Stepper Motors

Stepper can be converted digital pulse in to a movement of pen with respect to axis X, Y, Z direction. A stepper motor is a brushless motor that divides a full rotation into a number of equal steps, 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. We have used 3 stepper motors with lead screw. Motor output will be in the form of rotation of lead screw



Figure 6 stepper motor

1.6 Introduction about Preparatory Function

This is presented by “G”. G codes are pre-defining Function associated with the Movement of Machine Axis [2]. It has Two Digits, Ex- G00, G81, and G90. It is possible to include more than one G address in one block. Provided these Functions are not mutually Exclusive [3]. Ex- G02 and G03 are together in one block are not Permissible. G function are define the path to be followed a complete design. ExG00-positioning.

G01- Linear interpolation

G02- Clockwise Circular Interpolation

G03- Counter clockwise Circular Interpolation

G04- Dwell

Problem definition

The available Arduino controlled CNC machines are having only 2 axis movement. The structure is weak and can machine foam only

CHAPTER 2: Project planning.

Step 1: Disassembly DVD/CD Drives

First step to start building this CNC machine is to disassemble two DVD/CD drives and take off them the stepper motors. Use the screwdriver to open them and take off them the rails. Next step is to choose our base for this CNC machine. I used one surface from remaining DVD garbage' stuff. Finally we will need to find something to attach the one of the stepper-rails vertically to our construction. (you will understand what I mean in our next step) Watch the above image.

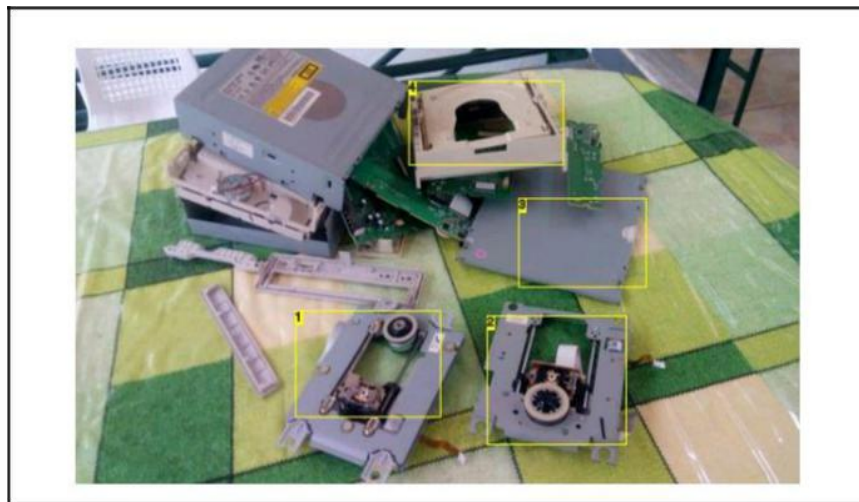


Figure 7 disassembly

Image Notes 1.

1. 1st Stepper motor with rails
2. 2nd stepper motor with rails
3. This metal will be our CNC "base"
4. We will cut this plastic to attach on it later one of the stepper-rails

Step 2: X and Y axis

In first image above you will see the Y axis of our CNC machine. Attach it on your surface, in this part you will need some screws and nuts in second image you will see the X and Y axis. The X axis is attached to two plastic parts that I took from remaining 'garbage' stuff. I cut it to fit the construction. This is an easy procedure. Just make sure to put the Y axis straight to CNC base and the X axis vertically in this (90 degrees)

Step 3: The Z axis

That's the most difficult part of our construction. You will need something to attach it on X axis, a flat surface. On that surface you will attach the servo motor (Z axis) and the pen base. Pen (or pencil) must be able to move up and down with the help of servo motor. Watch the above image to understand what you need to do to build Z axis Image Notes 1. Servo motor must be able to move up and down the pen.

Step 4: Paper base

Now you will have to attach a wood (or plastic) surface on Y axis (5x5cm will be fine). On this you will put the paper piece to print your texts or images Remember, printing area is 4x4cm

Step 5: The Circuit

Now that we have our construction ready, it's time to build the circuit and test stepper motors (X and Y axis). Watch the above image with breadboard circuit schematic. Steppers motors wiring is something that need patient. On next step you will find a 'testing' code for x and y axis. If yours steppers doesn't work properly you must find correct working combination by changing the cables between them and the L293D IC On mine CNC , X axis motor connection are: L293 A: Pins 1 and 3 & B: 2 and 4, but on Y axis motor connection are A: 1 and 2 & B: 3 and 4

Step 6: Testing X and Y axis movement

Here is the X and Y axis testing code embedded using code bender For X axis: For Y axis: If you see any movement here that means that the stepper motors wiring is correct! if you don't, try to change the cables..

Step 7: Uploading the CNC code

Here is the main CNC code embedded using code bender In this part you will see your pen goes up. If don't, change pen Up and pen Down variables that controlling the servo motor. Press the "Run on Arduino" button and program your board from your browser! Figure 12-circuit MINI CNC PLOTTER 2018 [10]

Step 8: The GCTRL program

Now we are ready to print our first image! To do this we will use the gctrl.pde processing program. This program sends 'G code' images to the CNC plotter. What is G code? G code is a file with X,Y and Z coordinates. Header of this file is set to: M300 S30.00 (Servo down) G1 X10.00 Y10.00 F2500.00 G1 X20.00 Y10.00 F2500.00 M300 S50.00 (Servo up) Download

Processing from here, now download and open GCTRL.pde application. Click the "play" icon/button to start the program. ~Watch the above image~ Now press 'p' and select your Arduino serial port. Press 'g' and select the 'drawing g code' file

Step 9: Make your own G code file

To make g code files that are compatible with this CNC machine you have to use the Inkscape. Inkscape is professional quality vector graphics software which runs on Windows, Mac OS X and Linux. It is used by design professionals and hobbyists worldwide, for creating a wide variety of graphics such as illustrations, icons, logos, diagrams, maps and web graphics. Inkscape uses the W3C open standard SVG (Scalable Vector Graphics) as its native format, and is free and open-source software. Download and install Inkscape from here (Important: download 0.48.5 version) Now you need to install an Add-on that enables the export images to g code files. This add on can be found here with installation notes.

Setup Inkscape for first use

Open the Inkscape, go to File menu and click "Document Properties". See the 1st image above and make the changes, make sure to change first to "cm". Now close this window. We will use the area within 4 to 8 cm. See the 2nd image above. How to print texts Put text, change font to Times New Roman and size to 22. Now click on cursor icon and center the text like the 3rd image above. Select Path from menu and "Object to Path". How to print images This is more difficult than texts. Images must have a transparent background. Drag and drop the arduino logo image (download it from files) in Inkscape. Click ok to the next window. Now you have to re-size the image to fit our printing area, see the 4th image above. Click Path from menu and "Trace Bitmap". Make changes as the 5th image above. Click ok and close the window. Now, move the gray scale image, and delete the color one behind it. Move the grey image to the correct place again and click from Path menu "Object to path". The 6th image above show how to delete image outline.

Export as g-code

Final, go to file menu, click save as and select g code. Click ok on next window. That's it! Ready to go! Use the getrl.pde app to print the g code file on your new Arduino CNC Plott

CHAPTER 3 METHODOLOGY

We have supply the current in Arduino with USB DATA cable to transfer Data from Computer to Arduino Board [1], 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[2]. We have made much difficult design via using this machine. The accuracy of this machines result 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.

3.1 DESIGN OF CNC MACHINE

There are 3 movements of using 3 CD ROMs. The horizontal movement(X) i.e. forward & backward movement is provided by the lower CD Rom. The 2nd CD Rom is mounted between the 2 columns which provide side movements(Y) i.e. left and right hand side movements. The spindle which is mounted on the 3rd CD Rom provides vertical movement (Z) for feed of tool.

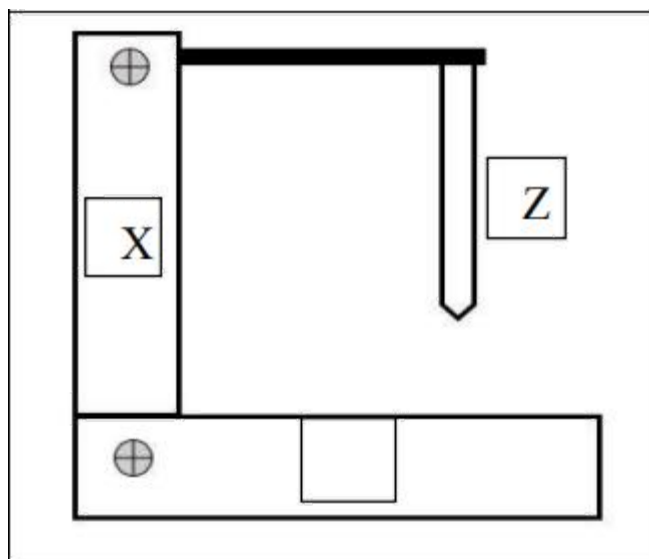


Figure 13:DESIGN OF CNC CACHINE

3.2 PROBLEM DEFINITION

The available Arduino controlled CNC machines are having only 2 axis movement. The structure is weak and can machine foam only.

3.3 WORKING

We have supply the current in Arduino with USB DATA cable to transfer Data from Computer to Arduino Board [1], 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[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.

3.4 Main parts of CNC plotter

Mini CNC Plotter Machine is worked on input as a G codes of Design and Converting it via use of 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 of 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.

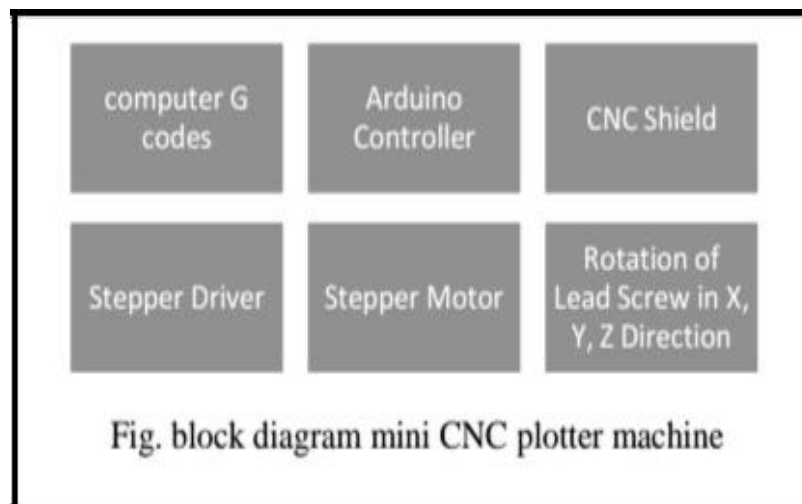


Figure 14:main parts of CNC plotter

3.5 BLOCK DIAGRAM OF PROCESS

In this idea of project, Arduino microcontroller platform with ATMEGA 328 core is used. It can be easily interfaced with PC using FTDI module whereas also with the easy drivers and stepper motors to. The basic block diagram is as shown in FIG.1 The explanation is given as follows

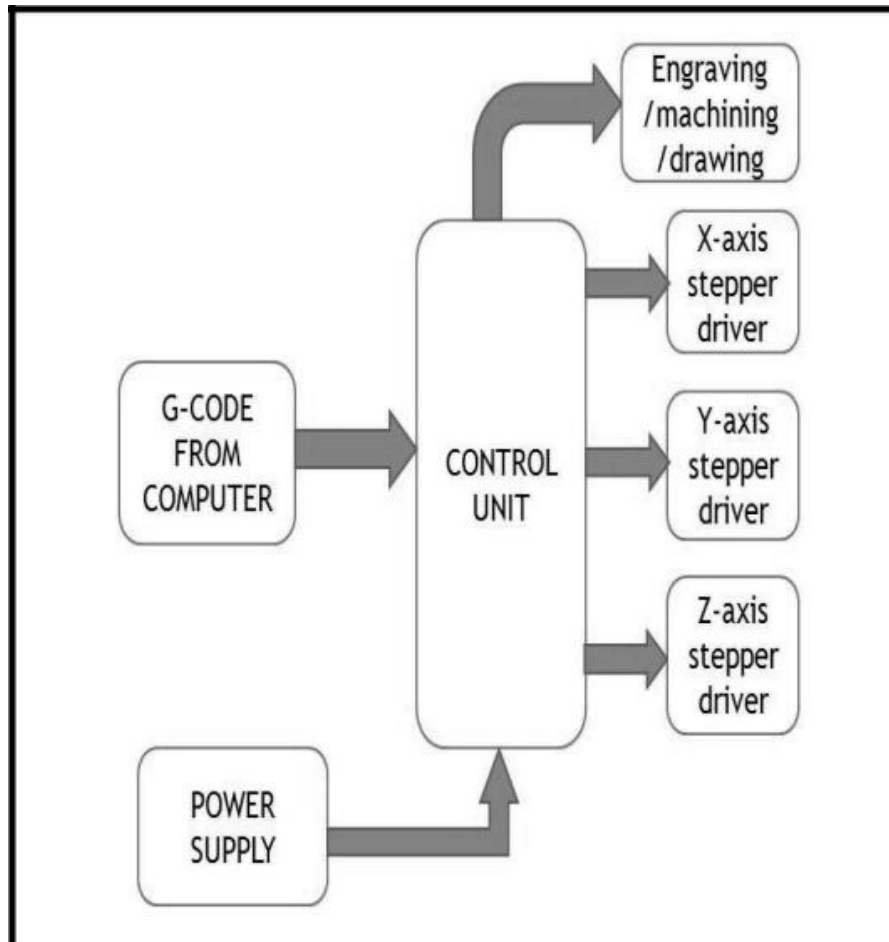


Figure 15:BLOCK DIAGRAM

CHAPTER 4 : Inkscape 0.48.5

Inkscape is used to design the plotted diagram or text. 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.

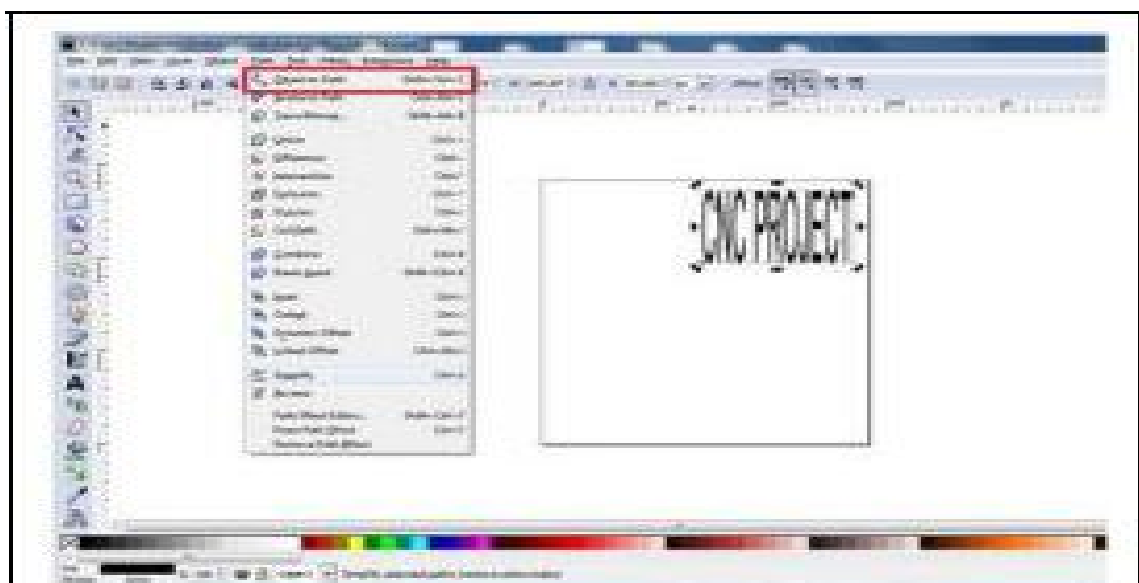


Figure 16:inkscape

4.1 Creating G-Code File Using Inkscape

The CNC plotter of our project will work within 20cm×20cm area So we choose the document properties of the Inkscape 40cmx40cm (Width × Height) which is four times the working area of the plotter because the plotter can draw only in the first quadrant. So we have initially kept the axes at the nearest end of the motors which is considered as origin to easily modify the design. In Fig. 3 the working area of CNC plotter is shown with the text written in the pre-defined area. The text is selected using cursor and then select “object to path” from the drop down window to save the G code form of the selected text. To create G-code of an image, the file must have a transparent background. The image should be dragged into the selected area then select “trace bitmap” from drop down window to create a transparent image. Scans are selected as 8 and “Edge detection” is selected to create black & white image. After adding this transparent image in the predefined area we’ve used “object to path” command to create the G-code file of the selected image by following the steps described earlier

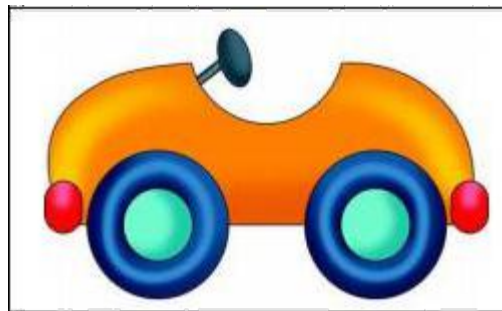


Figure 17: drawing of car

4.2 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 Fig. 6 shows the user interface of processing 2.2.1 software after running GTCRL program. The port of Arduino Uno is selected by pressing „P“ button on keyboard hence G button is used to upload our desired G-code file.

Immediately CNC machine will start sketching selected G-code file. Sketching can be stopped by pressing X button

CHAPTER 5: Advantages, Disadvantages & Applications

5.1 CNC Writing Machine Advantages

- 1.CNC machines can be used continuously 24×7 throughout the year and only need to be switched off for occasional maintenance.
- 2.CNC machines are programmed with a design which can then be manufactured hundreds or even thousands of times. Each manufactured product will be exactly the same.
- 3.Less skilled/trained people can operate CNC machines unlike manual lathes /milling machines etc. which need skilled engineers.
- 4.CNC machines can be updated by improving the software used to drive the machines
- 5.Training for correct use of CNC machines is available through the use of ‘virtual software’. This software is like a computer game that allows the operator to practice using the CNC machine on the screen of a computer.
- 6.Modern design software allows the designer to simulate the manufacture of his/her idea. There is no need to make a prototype or a model. This saves time and money.
- 7.One person can supervise many CNC machines as once they are programmed they can usually be left to work by themselves. Only the cutting tools need replacement occasionally.

5.2 Its Disadvantages

The machine runs in a slow pace and generates excess heat which causes the heat sink to be heated quickly. A slight error may remain on the image file after it has been plotted due to one side of the Y-axis fixed to the moving mechanism and the other end is free to move. The Z-axis is not very rigid so it causes slight vibration.

5.3 Application

1. Compact CNC/3D Printer by Brijesh Sondarva
2. Mini CNC Foam Cutter by Jonahmarrs
3. Mini Arduino CNC by me_zain
4. CD/DVD Bipolar Motor Driver W/o Microcontroller by Samiran

5. CNC Stomp PadProject | CNCProgramming |G-CodeProgramming |CNC
PlasmaCutting byivanirons
6. L293D driver board for CNC by Brijesh Sondarva

Chapter 6 CODE

```
/*
Into Robotics
*/

#include <Servo.h> //add '<' and '>' before and after servo.h

int servoPin = 8;

Servo servo;

int servoAngle = 0; // servo position in degrees

void setup()
{
  Serial.begin(9600);
  servo.attach(servoPin);
}

void loop()
{
  //control the servo's direction and the position of the motor

  servo.write(45); // Turn SG90 servo Left to 45 degrees
  delay(1000);    // Wait 1 second
  servo.write(90); // Turn SG90 servo back to 90 degrees (center position)
  delay(1000);    // Wait 1 second
  servo.write(135); // Turn SG90 servo Right to 135 degrees
  delay(1000);    // Wait 1 second
  servo.write(90); // Turn SG90 servo back to 90 degrees (center position)
  delay(1000);

  //end control the servo's direction and the position of the motor

  //control the servo's speed

  //if you change the delay value (from example change 50 to 10), the speed of the servo
  changes
  for(servoAngle = 0; servoAngle < 180; servoAngle++) //move the micro servo from 0
  degrees to 180 degrees
  {
    servo.write(servoAngle);
    delay(50);
  }
}
```

```
    for(servoAngle = 180; servoAngle > 0; servoAngle--) //now move back the micro servo
    from 0 degrees to 180 degrees
    {
        servo.write(servoAngle);
        delay(10);
    }
    //end control the servo's speed
}
```

CONCLUSION

In this paper we have presented the concept of a low cost three-axis mini CNC plotter writing machine. The existing CNC machines are of high cost, difficult to maintain and requires highly skilled operators. Our CNC plotter overcomes these problems. It is of low cost and easy to control and

there is no need of highly skilled operators. It can be used for long hours at a stretch

which is not possible in existing ones. It is hoped to extend this work for future development.

FUTURE SCOPE

The pen of the machine can be replaced by a laser to make it work like a laser engraving or 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 milling and drilling purposes. The servo can be replaced with a stepper motor and the pen with a 3-D pen to make it a 3-D 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

REFERENCES

- 1.Video on youtube by tapendra mandal
<https://www.youtube.com/watch?v=2VFOU-WUQIY&t=69s>
- 2.Video on youtube by techboyabhi