CNC DrawBot using GRBL

[1] Kunal Kashikar, [2] Rashmi Bhagat, [3] Apurva Nachare, [4] Amesha Shigwan, [5] Mahalaxmi Palinje
[1, 2, 3, 4] Student, [5] Assistant Professor
[1]Department of Electronics and Telecommunication,
[1]Atharva College of Engineering, Mumbai, India

Abstract : In today's technological world ,automated systems have a rising demand as they provide better precision and accuracy and also eliminate the labor work .This paper proposes a three axis plotter which can be used for applications such as drawing ,writing ,etc. The system is based on the principles of CNC machine which makes use of g-code files for overall system operation. Suitable software are used to compile the mechanical and electrical counterparts to aim out results. This system is designed mainly to target the economical aspect and to reduce human labor, it mainly incorporates the use of a Personal Computer to program an ATMEGA 328 microcontroller embedded with the Arduino interface. The following system is capable of producing several types of outputs such as vector, raster, detailed drawings also offering a fastest way to produce efficient and precise output.

IndexTerms **- CNC, g-code, DrawBot, GRBL, Plotter, Drawing machine**

I. INTRODUCTION

CNC stands for Computer Numeric Control. It generally refers to machines which executes the task with a help of a computer by extracting commands and code written in the program. There are many applications based on principle of CNC machines such as, drilling, milling, engraving, etc. This paper proposes an idea of using the computer numeric controlled platform to build machine that could perform operations like a plotter. The plotter is the vector graphic device which gives the hard copy of the output. Different plotter designs are available in market depending upon the requirement [1]. Each plotter is capable of producing different outputs such as, drawing [2], writing, Pcb layout [3], etc. Such a system finds an important role in different sectors. These type of systems have wide range of applications in various fields one of them could be architectural and educational.

Carrying out successful implementation of such systems along with hardware, software plays an important role in achieving the result aimed. Different softwares are available for interfacing hardware of such kind. Similar such systems are developed using python software [3] which make it complex for rookies. Wherein some systems makes use of Visual MILL and Lab VIEW [5] and several others.

A thorough study of the system led to designing of a machine in such a way that it is capable of replicating the image or any text produced using software on surfaces like paper or anything with proper precision and accuracy. For signal generation simple open source hardware such as Arduino is used which also reflects the cost of the system. All the hardware selected to build the system are readily available and proper selection of software is a must to explore the interfacing world by other users. A ton of software were viewed and tested to match the machines requirements out of which a few were shortlisted for several operational steps.

The objectives of proposed plotter are as follows:

1) Developing a three axis system which is jitter free.
2) Hardware selections which is easy to interface and less complex.
3) Maximum automation with real time scaling and precision.
4) Develop a system which is inexpensive and has no hassle to relocate.

II. SYSTEM ANALYSIS

The illustrative block diagram depicts the overall architecture of the system is as shown in Fig 1.

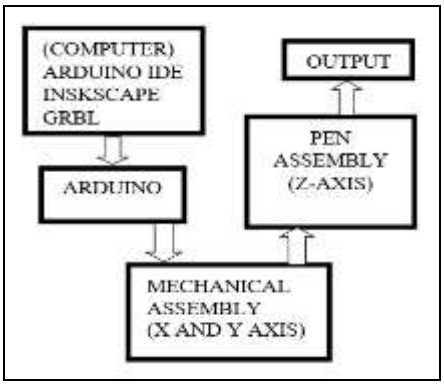

Fig.1. Block diagram of proposed system

Arduino Uno is a microcontroller board which incorporates the ATMega 328P and is interfaced to the computer onto which various codes are burned for different hardware used in the system. The CNC based systems run only onto g-codes, these g-codes contain the co-ordinates that drives the mechanical assembly which is interfaced with the electrical hardware. Parts required for the construction of mechanical and electrical assembly are listed in table 1.

Table 1: Mechanical & Electrical Hardware Contents

SR NO	Mechanical Hardware	Electrical Hardware
1	Smooth shaft	Arduino
2	LM8UU bearing	Power supply
3	608zz bearing	Stepper motor and servo motor
4	Stepper motor bracket	Motor drivers
5	Acrylic material	Discrete components

A. Structure Design

The overall design structure of the system is prototyped as shown in Fig 2.

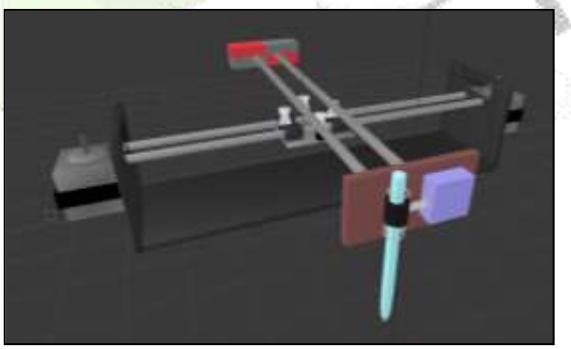

Fig.2. Design structure

The system consists of two axis i.e. X and Y axis operating orthogonally to each other, smooth shafts form these axis onto which linear bearings are put on. Two replicating pairs are mounted on one another forming a plus fashion. For sturdy and cost effective nature acrylic material is used for construction of the base and assembly mounts. Motor brackets are mounted on either side of the base which drives these two axis, digital drivers convert the g-code files into digital steps that drive the motors in steps. Attached to these motors is the timing belt which routes and holds the axis assembly. The overall movement of axis is completely dependent on motor movement which is in steps.

The third axis (Z axis) is designed for movement of the pen assembly i.e. to actuate the write head and is driven by servo motor shown in Fig.3. Clear acrylic assembly is built with nut and bolt provision for tightening and loosening the pen angles and pen. The special feature about the system is that the pen assembly can hold wide variety of pens i.e. from fine tip pens till the markers, ink pens, sketch pens, etc. This pen assembly has the capability to adjust the angle of pen with respect to the surface.

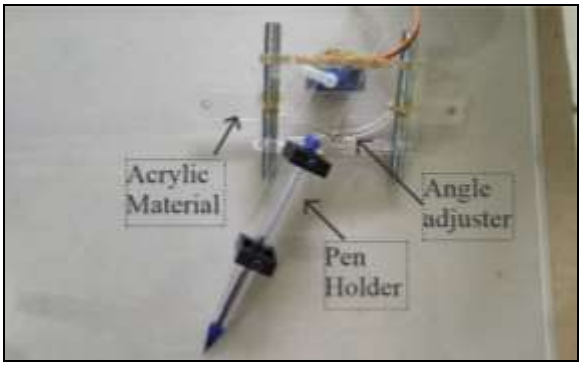

Fig.3. pen assembly structure

B. Software development

A code that defines all the major components such as laser module, servo motor along with dimensions for axis is uploaded onto the Arduino Uno board using Arduino IDE software employs the program to convert the executable code into a text file in hexadecimal coding that is then loaded into the Arduino board. For G-code generation Inkscape software which is an open source software is used, any image can be easily generated into the g-code by using this software. Another software is needed for the motion control of the axis, GRBL v 0.9 is selected to perform this task. GRBL converts the generated g-code into some specific commands shown in Fig. 4. which are usually co-ordinates/steps for the stepper motor that stepper driver decodes it into PWM signals which is sent to the stepper motor.

```
$20=0 (soft limits, bool)
$21=0 (hard limits, bool)
$22=0 (homing cycle, bool)
$23=0 (homing dir invert mask: 00000000)
$24=25.000 (homing feed, mm/min)
$25=500.000 (homing seek, mm/min)
$26=250 (homing debounce, msec)
$27=1.000 (homing pull-off, mm)
$100=314.960 (x, step/mm)
$101=314.960 (y, step/mm)
$102=78.740 (z, step/mm)
$110=800.000 (x max rate, mm/min)
$111=800.000 (y max rate, mm/min)
$112=350.000 (z max rate, mm/min)
$120=10.000 (x accel, mm/sec^2)
$121=10.000 (y accel, mm/sec^2)
$122=10.000 (z accel, mm/sec^2)
$130=200.000 (x max travel, mm)
$131=200.000 (y max travel, mm)
$132=200.000 (z max travel, mm)
```

Fig.4. Grbl command

The motion of the axis that includes parameters such as acceleration, delay, speed and the calibration is controlled by using Grbl software with help of various settings and configurations, '$$' input loads the settings interface which could be easily configured as per user requirement.

III. RESULT AND DISCUSSION

The proposed system was tested with different tests to determine its accuracy in different modes .The system is capable duplicating the image or any text pattern designed using Inkscape. Fig 4-6shows the end product of different designs produce by the system.

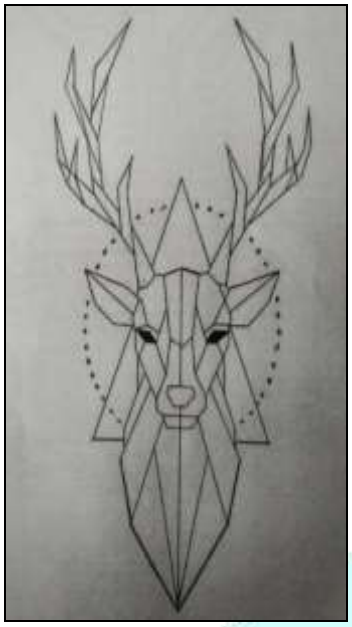

Fig.5. Vector Image Result

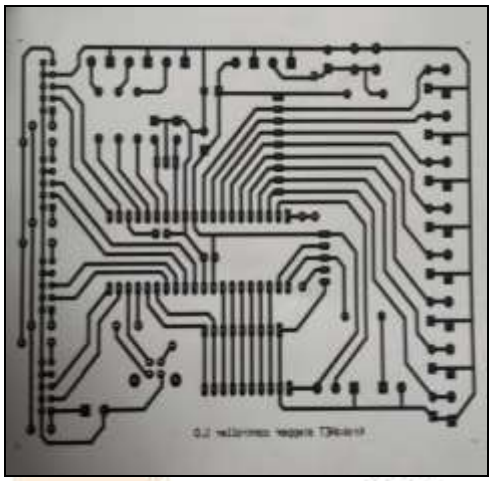

Fig.6. Detail image test

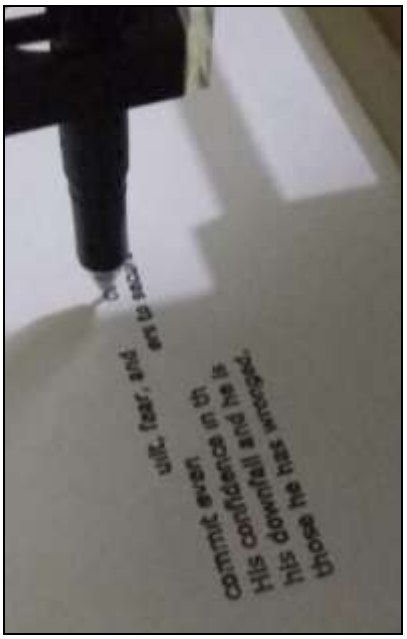

Fig.7. Text Result

High speed of operation is achieved to reduce time required to complete the task, also speed of operation can be varied depending upon the accuracy needed. For detailed results speed the Drawbot speed is set considerably slow, this is done to avoid jitter on the axis resulting in distorted details. The Drawbot considerably gives greater precision with minimum accuracy errors. Hence the cost efficient, high speed, easy to interface, flexible system is achieved.

IV. CONCLUSION

Due to rising demand for an automated system in industries, the retail for three axis CNC based systems has been increased. In this work such a system is proposed which can be used for writing and drawing purpose. The different pen changing capability makes the system more efficient to fulfill requirements and makes it capable for the endless variety of applications. The system is made from selecting open source hardware and software thus satisfying the cost effective agenda, which could be a profit to any scale industries. The complete system functionality has been tested through various changes in software. Thus, the design of proposed system has succeeded to achieve the objectives of this project in precisely and repeatability goal.

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