IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Volume 1, PP 12-17

Smart Axibot

Kunal Kashikar[1], Rashmi Bhagat[2], Apurva Nachare[3], Amesha Shigwan[4], Mahalaxmi Palinje[5]

[1, 2, 3, 4, 5] *(Department of Electronics and Telecommunication, Atharva College of Engineering, India)*

Abstract: *CNC based machines are widely used in industries in a variety of tasks such as engraving, drilling, cutting and much more. Making use of such machines will eliminate the labor work and also efficiency and accuracy will be increased. In this study, design and implementation of a multipurpose robot, based on computer numeric control (CNC) is emphasized. This created system can be used in two different ways. One as a DrawBot, for the activities such as drawing, writing, etc. and the other as laser an engraver which can be used for basic laser engraving applications. The system is designed to nurture the economic aspect of technology as it makes use of Arduino Uno as a signal generator. The correct and efficient arrangement of mechanical structure and proper use of the programs along with the circuitry makes this system works efficiently and accurately.*

Keywords - *Computer Numeric Controlled (CNC), Personal Computer (PC), GRBL, Laser, Plotter*

I. INTRODUCTION

There is a rising demand for CNC based applications in most of the sectors. In many industries, CNC machine tools have been proposed in order to make the task more effectively and efficiently as well. Educational institutions also started making use of such applications to do various tasks. The most common activity performed in today's technologically advanced world is writing, drawing etc. which is performed manually. Manual execution of such activities is time-consuming and also there is a chance that efficiency will not be up to the mark. As a solution to achieve immaculate performance with good efficiency machines known as plotters are developed. Similar such X-Y plotter designed and build which is capable of printing out designs and drawing exists [1][2][3]. The communication between a personal computer (PC) and CNC machine is done by using Software subsystem that gets a set of commands and fetches it to the mechanical subsystem in order to control the system. There are many software available which are suitable for the CNC machine operation, advancement is made making use of python programming for the 3 axis CNC plotter [4]. Laser engraver is a machine which runs on the CNC grounds and is basically nothing but the practice of using high power lasers for marking or engraving through several materials, this machine is similarly controlled using various software. Advantages of such a machine are the speed and the precision with which the cutting and engraving are carried out. Many systems are currently in use for such application. Using software namely GRBL and Inkscape are used to develop a laser cutting machine for basic engraving and cutting application [5]. For applications such as Laser engraving and cutting optical systems have been proposed and developed [6].Today there are many such systems available for fulfilling such applications, but there are very few multipurpose machines which incorporate with more than one feature because it is quite difficult task to fuse more than one feature within the system with leading to a hike an investment of such systems. Infusion of two listed machines i.e. plotter and laser engraver spiked the ideology and step towards implementation of Smart Axibot.

The complete paper is organized as follows:

Section II discusses a proposed methodology of the systems and elaborates each component of it. In Section III, the results in each stage of the bot have been discussed.

And Section IV discusses conclusion of the work.

II. SMART AXIBOT SYSTEM

CNC is a microprocessor based system that accepts set of program commands or machine codes (g-code) which processes and sends the control valued information to the electrical hardware and in return receives and analyzes the information from its sensors to perfectly ensure the proper operation, in this case, x and y-axis in terms of motion and process speed. Just like any CNC systems available in the market, this proposed machine behaves and operates the same mechatronics principle. Fig. 1 illustrates the architectural block diagram of Smart

Axibot. Here, the computer plays an integral part of the control system. The Arduino's programming language makes it easy to develop a program which defines the core parts digitally used in the machine. Multiple Power supply with different voltages are hosting three major parts of the system, GRBL software is used as a n interface for conversion of g-codes into digital pulses for the stepper drivers resulting in motion of motors and the axis assembly

.

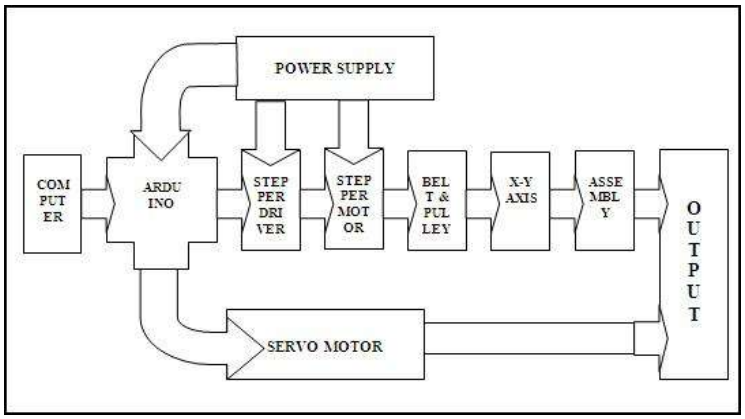
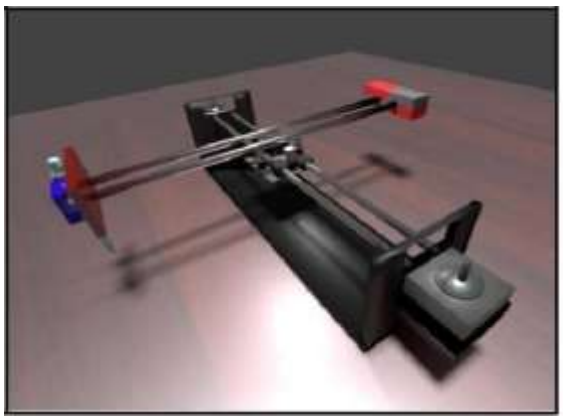


Fig. 1. Block diagram representation of proposed system

The approach started with splitting the machine building between two majors, Mechanical structure build, and Electronics.

2.1 Mechanical Build

The conceptual prototype of the system was built using Blender software (see Fig. 2). As per proposed block diagram the x-y axis is designed which is four hardened rods for smooth sliding action, both the axis are held together with a four-way sliding assembly through which the timing belt is routed and fixed at one end. The red line illustrates the timing belt in Fig. 3 with 'M' as stepper motors fixed on either side of a solid structure built using acrylic.



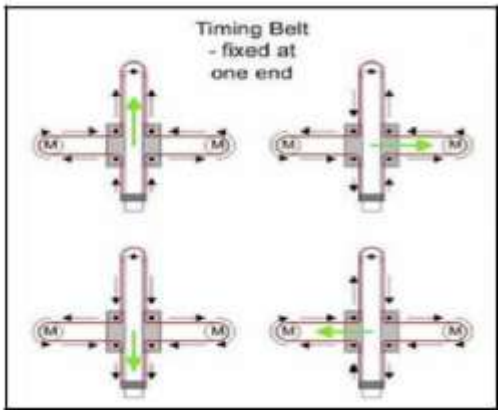


Fig. 2. Conceptual prototype Fig. 3. Four way sliding assembly and timing belt route

For the assembly to have motion, bearings are used along with custom laser cut stands. Fig. 4 depicts the real-time structure of sliding assembly.

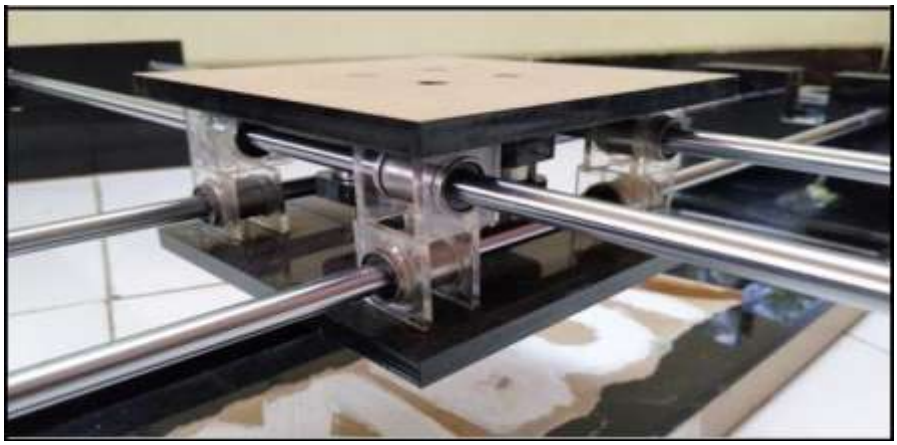


Fig. 4. Sliding assembly structure

Here the y-axis front end is custom build for Smart Axibot's application. The DrawBot applications will be carried out using the pen assembly (see Fig. 5) and Laserbot applications via a 2500mv with custom brackets designed for it. (See Fig. 6). Also, the back end of the y-axis will be carrying the replicate weight of the front end.

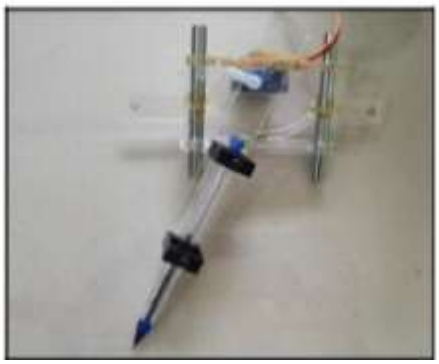


Fig. 5. Pen Assembly

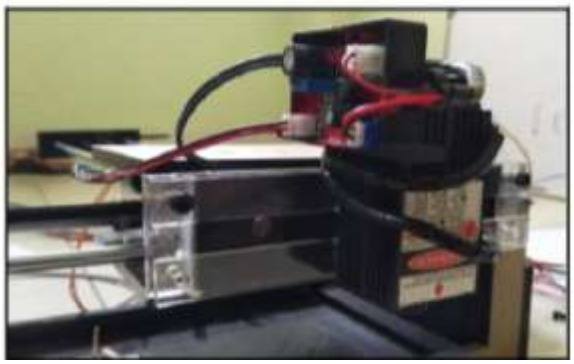


Fig. 6. Laser Assembly

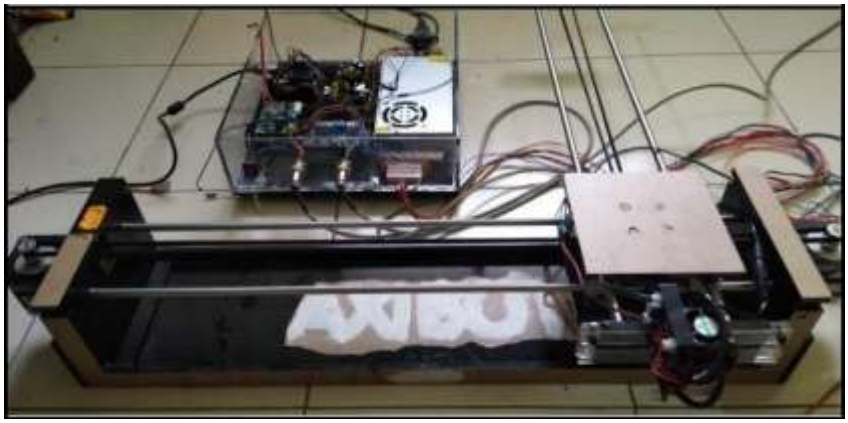


Fig. 7. Depicts the overall mechanical structure

2.2 Electrical Build

The connections are made as per the circuit diagram is shown in Fig. 8. The very first step comprises of loading the code in the Arduino board, this code segregates the signals going separately to each component. The Arduino is powered by a USB cable and simultaneously receives signals from the Personal Computer. The stepper motor drivers along with stepper motors are powered by a 24v power supply. Stepper motor used comprises of two phases which are connected to the phase connectors of DM320c motor driver, this controls the

phase electricity winding supplied to the motors. The movement of both x and y-axis is henceforth controlled using the motor directions. For DrawBot the main primary component used is the servo motor connected to the digital pins of Arduino and similarly, for LaserBot the servo is replaced by the TTL logic of Laser. Supplementary connections are made internally depicted in Fig. 9.

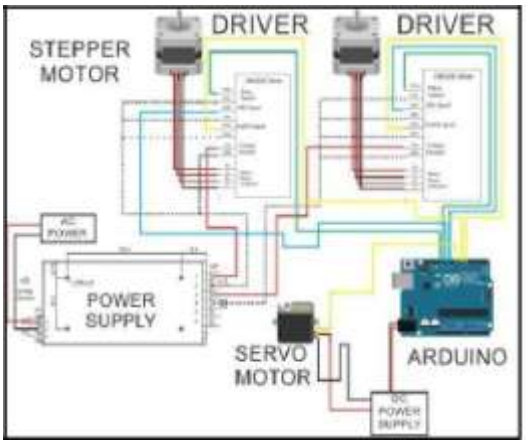


Fig. 8. Smart AxiBot Circuit Diagram Fig. 9. Supplementary connections

III. PWM (PULSE WIDTH MODULATION)

Smart AxiBot is designed incorporating pulse width modulation technology, it is basically used to control the power delivery to electrical devices, which in this case is servo motor and laser module for their specific applications. All of this controlling is totally relying on the power delivery and duty cycle (See Fig. 10), which is nothing but the proportion of on time to the regular interval or cycle period and is simply defined in percentage.

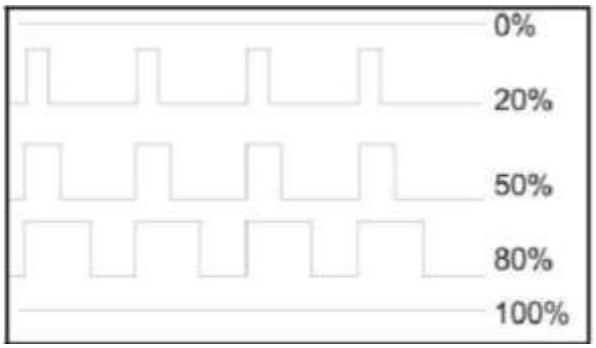


Fig. 10. Duty Cycle

As duty cycle increases, the amount of power delivery also increases. The whole Smart Axibot ecosystem is working the command of G-code generation that tells the motors where to move, how fast to move and which path to follow which is done by following the coordinates generated inside the g-code file. These G-codes has some pre-defined actions such as rapid movement, controlled feed, set tool information, switch co-ordinates etc. Here, specific codes were programmed to define the electrical devices which are the servo motor and laser module. Two important commands are used to define the on-off action using PWM signals i.e. M03 (Laser on, servo angle down), M05 (Laser off, servo angle up) similar other commands have been programmed to control the machine.

These commands are fed to GRBL software to control the machine.

Fig. 11. GRBL commands

Fig. 12. Extension Tool

After setting the suitable values for your data the tool and Inkscape will generate a G-code file which would consist all the above set parameter in the form of codes, this G-code file is sent to the GRBL for machine control, as per the values and co-ordinates the microcontroller uses PWM signals to detect the coordinates and arranges the power delivery which is finally sent to the motor drivers for motor and axis control. Note M03 and M05 commands are now by default incorporated in the G-code file.

IV. RESULT AND DISCUSSION

The proposed system is tested with different configurations to determine its accuracy and output in different modes. The system is capable duplicating the image or any text pattern designed using the G -code generated by Inkscape. Fig. 13, 14 depicts the different outputs produced using DrawBot, the angle for servo motor is calibrated for every different surface.

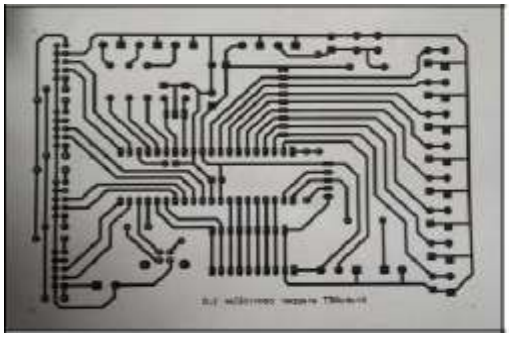


Fig. 13. Vector Image Output

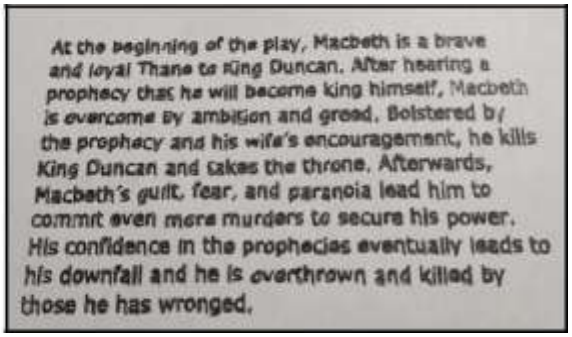


Fig. 14. Layouts and Fonts

The LaserBot has mainly two work profiles i.e. Laser Engraving and Laser Cutting. The Laser module uses similar work base such as Vector and Raster used in DrawBot but requires different configurations to control the laser power in the extension tool. This system makes complete use of PWM pulses to get a refined output. Following are the calculated and suitable Laser power for different applicable outputs.

Laser power being set from a range of 0-255, for vector image laser engraving power of 240 along with medium speed settings is set to achieve the following result shown in Fig. 15. For Raster image engraving a considerably slower speed is set out to get a precise result and setting laser power to maximum to get a darker result as Fig. 16.

Fig. 15. Vector Laser Engraving

Fig. 16. Raster Laser Engraving

Fig. 17. Material cutting

Using LaserBot variety of material cutouts can be obtained by setting proper Laser power and machine speed. Fig.17 depicts cutting of materials such as corrugated cardboard, chart paper, gsm paper.

V. CONCLUSION

In this proposed implementation, the Servo Motor and Laser Module both make use of PWM techniques to provide efficient and effective method to control the power deliveries and outputs. The AxiBot considerably gives greater precision with minimum accuracy errors, with greater cost optimization and a considerable easy user interface with good access to configure and obtain a precise output with swift speed. With open source hardware and software, there are no limits and boundaries to program Smart Axibot and test its limits. The main advantage would be the easy to use nature with open source hardware with possibilities of using many materials for LaserBot applications while pen changing capability to obtain various results. The Smart AxiBot could be a big game changer in technology industries for making PCB and directly etching electrical tracks onto boards.

REFERENCES

[1]. Dominic Tighe,Computer-controlled xy-plotter , *Electronic Systems News Summer* 1987.

[2]. Kajal J.Madekar, Kranti R. Nanaware, Pooja R. Phadtare, Vikas S. Mane, Automatic mini CNC machine for PCB drawing and drilling, *International Research Journal of Engineering and Technology, VOL. 03, Issue 02,* 2016. *[e-ISSN: 2395 -0056] [p-ISSN: 2395-0072]*

[3]. Bassam Shaer, Teresa Frigon, Adam Ferguson, Darius Bethel, Application of Embedded Systems with a Universal Plotter, *Proceedings of the IEEE SoutheastCon 2015,* April 9 - 12, 2015 - Fort Lauderdale, Florida. *[15/$93718.-010-4 6©732-0713050 I-E5/E1E5 /$31.00 ©2015 1IE.0E0E ©2015]*

[4]. Tekumatla Shivakumar, Manne Sai Sravan, K Selvajyothi, Python based 3-Axis CNC Plotter, [*978-1-5090-2547-3/16/$31.00 ©2016 IEEE]*

[5]. Rashid Khalid Hilal Al Habsi and G. R. Rameshkumar, Design and Fabrication of 3-Axis Computer Numerical Control (CNC) Laser Cutter ,*International Journal of Multidisciplinary Sciences and Engineering, VOL. 7, NO. 5. [ISSN: 2045-7057JUNE 2016]*

[6]. L. C. Hernández, 1 J. Cabrera, 1 B. Lambert, T. Flores, 1 R. Sis, M. Arronte, L. Ponce. MEP, Optical System Assembly for Cutting and Engraving, *MEP* 2006, 7-11 November 2006, Guanajuato, Guanajuato, México. *[1-4244-0628-5/06/$20.00*©2006 *IEEE]*

[7]. Prabhanjay Gadhe, Vikas Jangir , Mayur Yede , Wasim-Ul-Haq, Design and Implementation of PCB Using CNC, *International Research Journal of Engineering and Technology (IRJET), Vol. 04, Issue 02,* Feb -2017. *[e-ISSN: 2395 -0056] [p- ISSN: 2395-0072]*

[8]. Zsolt Illyefalvi-Vitdz and Jhnos Pinkola, Application of Laser Engraving for the Fabrication of Fine Resolution Printed Wiring Laminates for MCM-Ls, *Electronic Components and Technology Conference,* 1997

[9]. Mr. Sachin Patel, Asst.Prof.Sandip.B.Patel , Asst.Prof.Anup.B.Patel, A Review on Laser Engraving Process, *International Journal for Scientific Research & Development, Vol. 3, Issue 01,* 2015. *[ISSN (online): 2321-0613]*

[10]. Dr.B.Jayachandraiah, O.Vamsi Krishna, P.Abdullah Khan, R.Ananda Reddy, Fabrication of Low Cost 3-Axis Cnc Router, *International Journal of Engineering Science Invention, Vol.0 3 Issue 06,* June 2014. *[ISSN (Online): 2319 – 6734]*

.