International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 3, May-Jun-2019, ISSN (Online): 2395-566X

An Automated CNC Machine

Supriya Firangi supriyafirangi@gmail.com
Megha B S Meghabs7801@gmail.com
Dept of Computer Science and Engineering
Poojya Doddappa Appa College of Engineering
Kalaburgi, Karnataka, India

Abstract- **With the advancement of technology, demand for computer numerical control(CNC) plotter machines in educational institutions and laboratories rapidly rising. The networking of objects which have the connectivity that enables them to communicate independently with one another via the internet. This project aims to develop the model of CNC plotter machine which is able to draw a circuit layout on PCB or any other solid surface using the electronic component. Initially the user needs to convert any image file or text file into G-code using inkscape software and then feed it to machine using processing software. Arduino Uno with an atmega328p microcontroller is used as the control device for this project. The microcontroller convert G-code into a set of machine language instruction to be sent to the motor driver of the CNC plotter. The main objective of project is to design and implement a CNC plotter machine which will be able to draw a PCB layout on a solid surface. A plotter is a 3D controlled 2D plotting machines which uses a pen to draw text or image on any given solid surface with complex line drawings. The machine will have three motors to implement the X,Y and Z axis. A servo motor will be used along the Z axis for positioning the pen which will go up and down. CNC technology has major contribution in industries. CNC machine are main platform in the contribution of good quality products in industries. The main aim of this project is to reduce time consumed for plotting and it r educes human involvement which eventually reduces rate of error and also increases the production.**

Keywords- **CNC, arduino controller, Gcode, internet of things, CD/DVD drivers.**

I. INTRODUCTION

In commercial enterprise it is not well organized or profitable to make everyday products by hand. On CNC machine it is possible to make hundreds or even thousands of the same items in a day. In industry, CNC machines can be extremely large. 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. 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.

CNC Plotter Machine is the automation of machines that are operated by precisely programmed commands. The function of this CNC Plotter is used for plotting various drawings. The CNC plotter is very similar to the 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. The application CNC machine and G codes are extended for Printed Circuit Board (PCB) drawing and drilling, Electrical Discharge Machining (EDM), metal removal and fabrication, lettering and logo engraving. The development of an automatic CNC machine for PCB drawing, drilling and a Lowcost CNC plotter using spare parts. CNC machine will give commands to all motors, controller, and accessories of machine to perform the necessary operations and does the machining work as designed by the programmer. Programming commands makes it very easy to perform complex operations. CNC machines used several programming languages, including G-code and M-code. The CNC programming languages are geometric code, referred to as G-code, controls when, where, and how the machine tools move.

Miscellaneous function code, referred to as M-code, controls the auxiliary functions of the machine, such as automating the unwanted and replacing of the machine cover at the start and end of production. In CNC, machines are operated via numerical control, wherein a software program is designated to control an object. The language behind CNC machining is alternately referred to as G-code, and it's written to control the various behaviours of a corresponding machine, such as the speed, feed rate and coordination. CNC machine will make possible to program the speed and control the

position of machine tool functions and run all with little involvement from human operators.

II. LITERATURE SURVEY

Venkata Krishna Pabolu et al. Nov 2010 [1] "Design & Implementation of a three Dimensional CNC Machine". It increases the demand for flexibility and cutting with respect to edge quality. It maintains the accuracy and reliability for complex shapes. In this system they used visual C# as a language on .NET platform. In this there are three main kinds of computerized numerical controllers: 1.Multiprocessor with ASIC, 2. PC front end, 3. Motion control card with PC. The design of this system is user-friendly one which give accurate results and also flexible to users. RTOS is very costlier and not user friendly and also with such system it is not possible to implement on any general PC, where user has to purchase the operating system.

Kajal J. Madekar, Kranti R. Nanaware, Pooja R. Phadtare, Vikas S. Mane Feb 2016 [2] "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-MukaddemAnsary, Abu ShafwanMondaol January 2017 [3] "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.

M. Anil Kumar, Dr.J. Krishna raj, R. Bhanu GowthamSai Reddy June 2017 [4] "Mini CNC 2D sketcher for accurate building drawing".It is easy to maintain and it is low-cost. The CNC machine controlled by PC interfaced with low cost embedded microcontroller and LABVIEW. It needs three axes movements for sketching unit. In this the G code which can be programmed manually. In this advantage is to draw accurate Image using the G code in A4 sheet. It created rough sketch can be further manipulated with due transformation, such as moving, rotating, scaling. Sometimes it works slowly.

Shani Ranjan, Mani Rani, ShwetaRanjan, Dr.Manmohan Singh May 2018 [5] "Design And Implementation of low cost 2d plotter Computer Numeric Control(CNC) Machine". It reduce the cost and complexity of machine Plotter are used to make 2D plotters which is digitally controlled. In this they used microcontroller and L293D motor driver for designing the plotter. The Inkscape software allows to convert any images into graphics code usually known as G code. GTCRL processing program is used to send G code file from user interface to CNC plotter. It requires highly skilled operator for maintaining the CNC plotter. It takes a time to find the right location on plotter. It take more space than regular printers.

Lakshmi pathi Yerra, K. Chinnamaddaiah and Subramanyam B, P. Ravi kanth Raju June 2017 [6] "Development Of An Open Type CNC System For A 3-Axis Micro CNC Machine". That evaluate the performance of the whole system that are integrated functions could run as real-time parallel processes. The stepper motor is integrated 0 with the arduino where the GRBL is uploaded to the chip which causes matrices of X, Y, Z.The high spindle speed reduces the chip load which reduces the forces between the tool and material.It takes more time to locate and it is not feasible for the implementation.

Dr M Shiva kumar, Stafford Michahail, Ankitha Tantry H, Bhawana C K, Kavana H, Kavya V Rao, April 2014 [7] "Robotic 2D Plotter". The main objective is Robotic 2D plotter which is basically a selective compliance articulated Robot Aim (SCARA) has been implemented. In this they have need the ATmega 8 microcontroller and supported win a full suite of program and system development tool. AT mega 8 includes 8kbytes of in system programmable flash memory and 12 byte EEPROM. The codes thus loaded controls the servo motors based on pulse width modulation (PWM). The arm will be moved and the corresponding output is viewed on the drawing board. It is useful for the field of graphics. The arm couldn't control remote place by the web browser.

SundarPandian 2014 [8] "develop low cost 3 axis CNC machine". It is low cost and it is used currently in the laboratory. Stepper motors with drivers, Arduino open source, microcontroller and open source motor control

software. Author used ready to assemble kit from Zen Tool works, USA. Kit provided stepper motor, lead screw, guide rod, anti-backlash falans and spring. He made the Body with high density PVC. The machine has fix gantry and mobile bed so there is restriction in working area. The model provides more scope for hands-on learning by the students and therefore better learning outcomes. It is developed for only educational purpose.

Paulo Augusto Sherring da Rocha Junior et al. 2010 [9]studied a design of CNC prototype machine with three cartesian axis with 600mm of length both X and Y axis and 100mm of length Z axis. Three stepper motors with holding torque of 10 kgf-cm, 8W of power per phase, 1.8° step angle and positioning precision higher than 95% were used to control the motion of spindle in X, Y and Z axis. As end effector, a universal DC machine with nominal speed of 35000 rpm was used. The software to control and load the program into the machine was designed in the LabVIEW integrated development environment (IDE). The transfer of instructions from the software to the machine was by using Universal Serial Bus (USB) based on a PIC18F2550 microcontroller. The simulation in MATLAB showed the good results of voltage regulation using digital chopper. On the basis of above statements, they concluded that the machine works well with wood, acrylic, copper clad, and even with fluctuating power supply.

Sherring da Rocha Jr., P.A., Souza, R.D.S. and Emilia de Lima Tostes, M 2012 [10] this work represent the portable CNC plotter to plot any unexceptionable design by CD/DVD driver that should be easily available to make CNC plotter/3D printer .Computer numerical control (CNC) can be used to describe many types of device like Plotter, 3D printer, Milling machines, Vinyl cutter and others. CNC basically means that the physical movement of the machine that must be controlled by any type of controller (like Arduino UNO). The controller must be conducted by any computing device. This whole plotter/printer system is working based on G-Codes. G-Codes are used to give commends or instructions. Computer numerical control is use in any machine that moves in different direction like X-axis and Y-axis and code will instruct it exactly where to go and Z-axis control the depth. The movement in the direction of X, Y will be manipulated by stepper motor of CD/DVD driver and Z-direction will be control by a 3D Pen conducted with a servo motor.

III. HARDWARE COMPONENTS DECSRIPTION

The required hardware components of the CNC plotter machine are listed below:

- Motor driver module (2 pieces)
- Servo motor
- Arduino uno
- Pen
- PCB

1. Motor driver module

The sketching pen in the CNC sketching unit requires a movements along for the X and Y axes we will use two motors from DVD/CD drives.

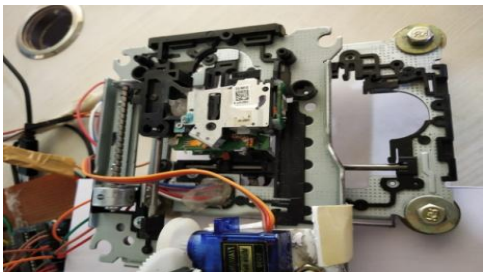


Fig. 1 Motor drive

2. Servo motor

A Servo motor is used for the movement of the sketching pen in up and down in a Z direction. Servo motor is paired with some types of encoder to provide the position and give the feedback of speed to the control board.

Fig. 2 Servo motor

3. Arduino uno

Arduino UNO is an open-source micro controlling electronics platform. Arduino UNO board able to control many electronics components. It have different output voltage points (5v, 3.3v) to give maximum efficiency. It has 14 digital input/output pins.

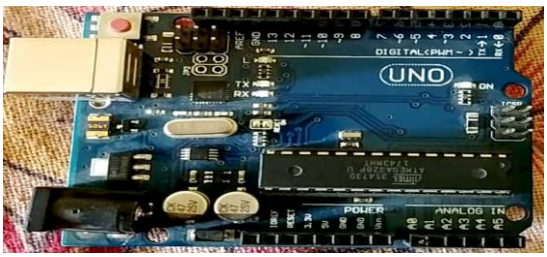


Fig. 3 Arduino uno.

4. Pen

Pen plotters use drawing pens that provide infinite resolution, because the lines are actually drawn. All other printing devices print dots.

Fig. 4 pen

5. PCB

PCB is an printed circuit board. It is a board that has lines that connect various points together. there are some traces that electrically connect the various connectors and components to each other.

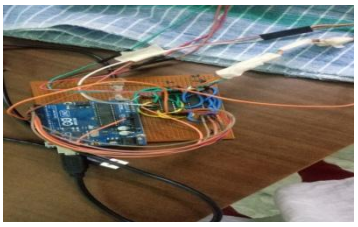


Fig 5 PCB.

IV. COMPLETE CNC PLOTTER

The fabrication of this project finally ended up with a finished product. After organizing all those motors with the design mechanism unit and axis with each other and also implementation become completed. The accuracy and speed can be maintained by using high-speed motors with high-end drivers to drive the motor at an accurate speed. Some issues like precision and execution time for a print can be considered in due course of time which can be further improved with high powered motors and large printing span area.

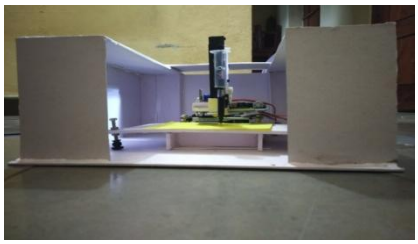


Fig 6 CNC plotter.

V. SOFTWARE IMPLEMENTATION

The G-code from computer is interface with Arduino by using program as a USB-to-serial converter. The output of ATMEGA328 is given to two motor drivers.

1. Fritzing - It is friendly open source circuit software which is mainly used for PCB design. Creating PCB Layout Using Fritzing. Using "Breadboard" option any circuit can be built easily by simply dragging and dropping down different components. Schematic circuit diagram and PCB layout will be generated automatically.

In PCB layout we need to choose the positions of the components, their layers and connections. After that we need Export for PCB option is selected and choose "G-code". The file is automatically loaded in Inkscape software. Inkscape 0.48.5: To make G-code files that are compatible with this CNC machine user have to use the Inkscape. It is quality vector graphics software which runs on Windows, Mac OS X and Linux. For creating a wide variety of graphics such as icons, logos, diagrams, maps and web graphics.

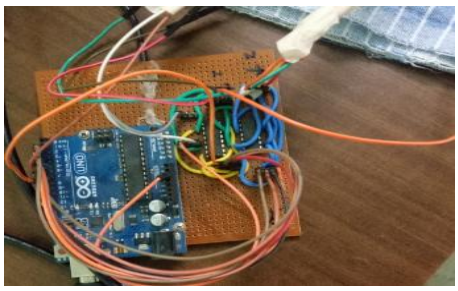


Fig.7 PCB layout connections.

Ink scape uses the W3C open standard SVG (Scalable Vector Graphics) and is free and open-source software. 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, user need to select "object to path" command to create the G-code file of the selected image.

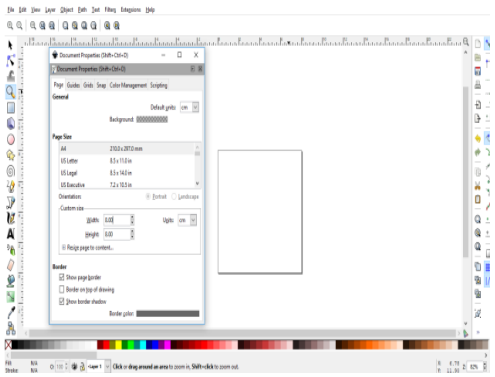


Fig. 8 creating new document for Inkscape

By using inkscape software we can generate g code for specified image or text given by the user. In this select file say new select default then select document properties in that select default units as cm and also units as cm and change the height and width size to 8.00cm as shown in fig.

International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 3, May-Jun-2019, ISSN (Online): 2395-566X

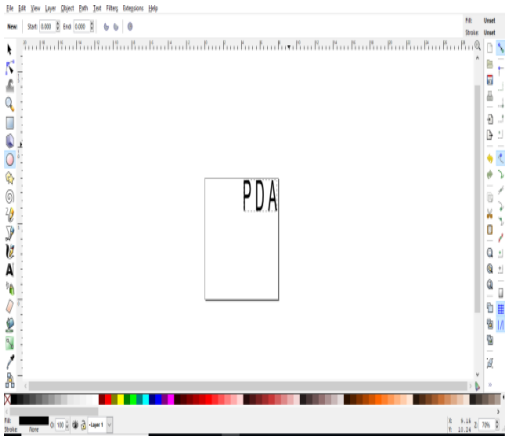


Fig.9 creating text for generation of Gcode.

In the above fig shows the create, select and edit the objects tool where we can add a text and select edit paths by nodes so that the outline of the text can be easily detected so the text can be easily print on the sheet. After this select path and the select object to path so that edges can be easily seen. After this save the file with the filename with G-code extension.

2. Processing- It is open source programming language software which is used for electronic drawings. The port of Arduino UNO is selected after running GCTRL program followed by uploading the desired G-code.Press p on the keyboard. The system will ask you to choose a port. So select the port on which your Arduino board is connected. Now press g and browse to the folder where you saved your G-CODE.

Select the right G-CODE and press enter. If everything was connected right, you should see you device starting to plot on the paper. Immediately CNC machine will start sketching selected G-code file, sketching can be stopper by pressing 'X' button and both the axis can be moved to their home locations i.e. coordinates '0' by pressing 'H' button in a fig After this select a file to process which can able to draw on pallet as shown in fig.

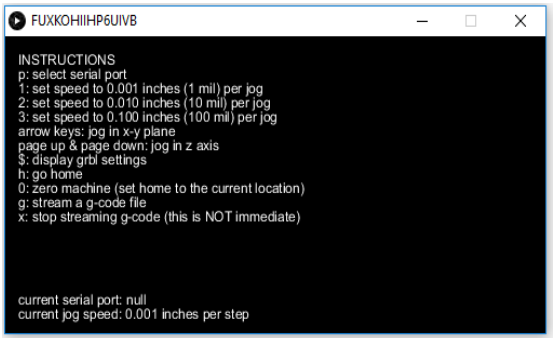


Fig.10 After generation of Gcode through processing

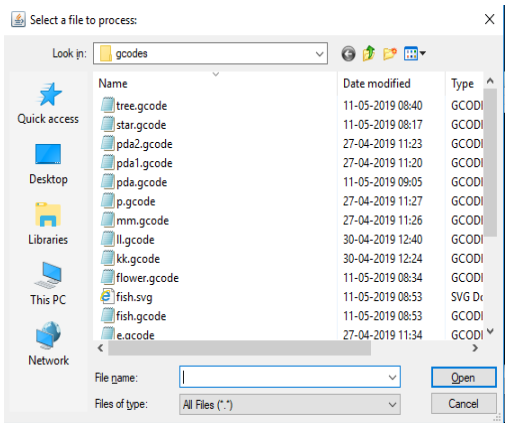


Fig.11 Select a file for process.

Change the file type to "MakerBotUnicon G-Code" as shown in below pic. This will only appear if the Add-on installation was successful. Finally click on save and click ok on the pop-up window.

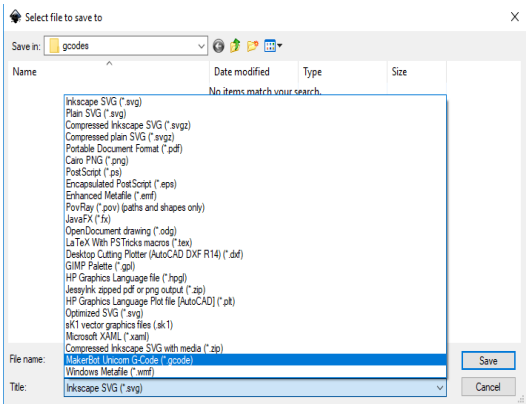


Fig.12 Select a file to save to.

VI. DESGIN DESCRIPTION

- CNC Machine is a process used in the manufacturing field. It contains the use of computers to control machinery tools.
- From this CNC technology and revolutionary change in the world of digital electronics & Microcontroller, here is an idea of CNC pen plotter.
- The idea behind this project is to make a CNC machine which can draw images on surface. It uses two stepper motors and one servo motors as linear actuators on each axis X, Y & Z.
- While drawing, the proper synchronization of this entire three axis is most tough task.

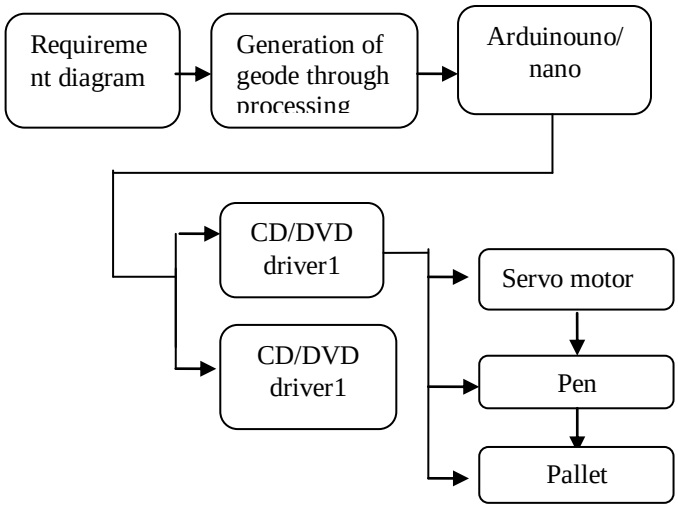


Fig.13 Block Diagram Cnc Plotter.

1. CD/DVD Writer-The sketching pen in the CNC sketching unit requires a movements along for the X and Y axes we will use two motors from DVD/CD drives.

2. Servo Motor: A Servo motor is used for the movement of the sketching pen in up and down in a Z direction. Servo motor is paired with some types of encoder to provide the position and give the feedback of speed to the control board.

3. L293d IC And Motor Driver- L293D IC is a motor driver integrated circuit it is used to control the stepper and servo motor rotations in clockwise and anticlockwise directions. This change in rotations help the sketcher to move in the required three directions say, X, Y and Z axis directions corresponding to left and right movement, front and back movement and up and down movement.

4.Arduino UNO/NANO- Arduino UNO is an open-source micro controlling electronics platform. Arduino UNO board able to control many electronics components. It have different output voltage points (5v, 3.3v) to give maximum efficiency. It has 14 digital input/output pins.

5.G-code through Processing: Processing is open source programming language software which is used for electronic drawings. The port of Arduino UNO is selected after running GCTRL program followed by uploading the desired G-code. Immediately CNC machine will start sketching selected G-code file, sketching can be stopper by pressing 'X' button and both the axis can be moved to their home locations i.e. coordinates '0' by pressing 'H' button.

VII. RESULTS AND DISCUSSION

A fully functional CNC Printer that could work efficiently according to programmer's commands as demonstrated. The biggest advantage behind making this model is being the cost-effective ness, one can ask why there is the need for making this CNC printer when there are other printers available in the market. The fact is one can have printers but can't have it at this much affordable price. This factor makes this machine somewhat unique from all other printers.

This project is designed with a very simple construction scheme and can be carried anywhere without many efforts. A very simple algorithm is implemented which can handle any type of modifications made within the machine without rewriting it. Though the circuit is very complicated to handle so, it is preferred to create a compact one i.e. by minimizing the jumper wires, can easily be stick to the back of the machine. It consumes low power and works with precision which could be altered accordingly by the user within the C code. In addition to the personal use for small-scale application in educational institutes, this project can be resourceful to all generations of the society including kids, youth, and elderly people. In favour of the environment, it is ecological in terms of electricity, ink and paper usage. It can be deduced that this CNC Project has wide applications in all spheres of society in an economical approach.

However, the cost is an investment in long-term savings, efficiency, client retention and a reputation for quality and reliability. While CNC machining might create tremendous, new opportunities for all kinds of people in society including youths, it might lead to less conventional machining and ultimately, some unemployment.

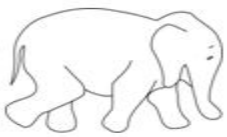
1.Text File- A text file has been designed and sent to the CNC plotter for drawing the text. The original file and the plotted files are shown in the Fig CNC.

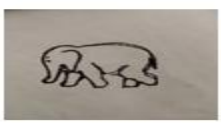
CNC

(a)Original Text

(b)Plotted Text

2. Image File- Fig shows a image file that has been converted into a sketch through bitmapping and edge detection and then plotted via CNC plotter machine.





(a) Orginial image. (b) plotted imageS

VIII.CONCLUSION AND FUTURE SCOPE

Finally, after going through all the problems and troubleshooting of hardware as well as software a mechanical prototype of a CNC plotter machine could be made. This project can benefit society and youth in various aspects: Reliable endurance, this machine can run for hours without interruptions. Precision components, this autonomous machining of CNC practically eliminate human error chances up to a very extent. Lower costs, the collective result of the high speed, efficiency, specialization, and precision, all add up to a better bottom. Line for the future of this model, saving money and time is one of the most popular benefits of CNC machining.

Low maintenance, the G-code based Software will automatically update itself when needed, and generally, do not require much services. The model of CNC plotter machine which is able to draw a circuit layout on PCB or any other solid surface using the electronic component. A plotter is a 3D controlled 2D plotting machines which uses a pen to draw text or image on any given solid surface with complex line drawings. The pen of the machine can be replaced by a laser to make it work like a laser engraving or cutting machine. The servo can be replaced with a stepper motor and the pen with a 5-D pen to make it a 5-D printer which can print objects with dimensions.

REFERENCES

[1] Venkata Krishna Pabolu, Sri K.N.H Srinivasas, “Design and Implementation of a Three-Dimensional CNC Machine”, IJCSE, Vol. 2,pp.2567-2570 No. 08, 2010.

[2] Kajal J. Madekar, Kranti R, Nanaware, Pooja R. Phadtare, Vikas S. Mane, “Automatic mini CNC Machine for PCB drawing and drilling”, IRJET, Vol. 3,PP 1106-1110 Issue-2, 2016.

[3] Mohammad Kamruzzaman Khan Prince, Muhsi-Al-Mukaddem Ansary, Abu Shafwan Mondol. Implementation of a Low-cost CNC Plotter Using Spare Parts, International Journal of Engineering Trends and Technology, 43(6), 2017, pp. 333–339.

[4] Anil Kumar, A., Sai Krishna, K., Sai Reddy, R.B.G. and Shakti Prasad, V. CNC Machine for Drawing, B.Tech. Project Report, MLR Institute of Technology, 2017.pp. 801–808.

[5] Shani Ranjan, Mani Rani, Shweta Ranjan, Dr. Manmohan Singh. Design And Implementation of low-cost 2D plotter Computer Numeric Control(CNC) Machine. May 2018 pp.99-101.

[6] Lakshmi pathiYerra, K. Chinnamaddaiah and Subramanyam B, P. Ravi kanth Raju. Development of an open type CNC system for a 3-axis nicy=rocnc machine, International Journal of Mechanical Engineering and Technology (IJMET). Volume 8,Issue 6, June 2017, pp. 463-470

[7] Dr M Shiva kumar, Stafford Michahail, Ankitha Tantry H, Bhawana C K, Kavana H, Kavya V Rao, “Robotic 2D Plotter”, International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10, pp.300-303 April 2014.

[8].“Low cost build your own three axis CNC mill prototype”, International Journal of Mechanical Engineering and Robotics, ISSN 2321-5747,vol,2 issue1,2014 pp.6-11 by Sundar Pandian ,Raj Pandian.

[9] Paulo Augusto Sherring da Rocha Junior, Roge’rio Diogne de Silva e Souza, Maria Emilia de Lima Tostes, “Prototype CNC Machine Design”,IEEE,2010.

[10].SSherring da Rocha Jr., P.A., Souza, R.D.S. and Emilia de Lima Tostes, M. Prototype CNC machine design, Journal of Energy and Power Engineering, 6, 2012 pp.1884-1890.