



Design and Development of CNC Writing and Drawing Machine

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Abstract : The paper presents an approach to design user friendly and fluid movements of a CNC machine to perform writing tasks. The design of proposed writing machine comprises both hardware and software. In this project the concept of converting textual matter into G-code is implemented. With the help of Inkscape software text is converted into G-code. The user needs to convert textfile into G-code and then feed it to the machine using universal G-code sender. Arduino Nano with Atmega328 microcontroller is used as the control device for this project. The microcontroller is used to convert the G-code into a set of machine language instruction which is sent to the motor driver of the CNC plotter.

Keywords - A4988 stepper motor driver, Arduino Nano, CNC (computer numerical control), Servo motor (SG-90), Stepper motor.

I. INTRODUCTION

Fast-growing development of high technology and manufacturing has contributed very much in the human development. In this project, industrial requirement such as good and high precision quality has helped us create the project and all of these can be achieved through machines that are controlled by computer such as computer numerical control machine (CNC) [1]. This project includes an X-Y plotter which draws or writes a two dimensional data on a rectangular co-ordinate system which includes the materials by cost and wide range of applications such as servo motor and stepper motor, which can be differentiated through their peak torque capability, cost, speed range for the betterment of system [2]. There are two stepper motor for movement in the X-Y direction and servo motor for the movement of pen holder. The control language to control the CNC machine is G-code. It is function which tells the machine to move to various points at desired speed [2]. The software named (Inkscape) is used to convert textual content into G-code and via UGS (Universal G-code Sender) the data is fed to Microcontroller. The Microcontroller feeds text content converted into G-code to CNC machine. G-code is supported by the part programmer to specify the co-ordinates of the point which are moved and providing the normal vector to the surfaced at desired point. Arduino Nano with Atmega328 controls the overall motion of the motors. According to the instructions from the controller are sent to the motor drivers to perform particular task which was given by the user [2].

II. LITERATURE REVIEW

A research on CNC machine system named 'A New Developed Technique for Handwriting Robot' presented by Nur Shazwany Zamani, M.N. Mohammed [3] are the authors who have generated cheap handwriting robot which is based on the fundamental of CNC. This handwriting robot consists of motor driver shield for pen movement in X and Y directions to the rotation of stepper motor by using and Arduino IDE microcontroller. The Servo Motor is used for the upward and downward movement of the pen in Z axis. In this writing is created and uploaded by inkscape software and G-code is generated directly. It has compatibility with the utilized

microcontroller to control the motors movement and make the required drawing which is supplied by the inkscape software [3].

A paper on ‘Design and Implementation of a Microcontroller Based Low Cost Computer Numerical Control (CNC) Plotter using Motor Driver Controller’ paper was presented by Md.Mahedi Hasan, Md. Rokonuzzaman Khan [4] in which they presented an approach which would convert human speech into textual matter using the x-y plotter. The paper consists of components such as two stepper motors which were used for sliding in x-y direction and servo motor was used for the movement of writing material such as pen or pencil. The commands for machine were given by the controller which was connected via Bluetooth which are already converted in the g-code form and there is an Android application which convert spoken content into the G code and via Bluetooth communication feed to CNC machine [4].

A paper on ‘Design and Development of Dual Axis Control Robot For Writing Robot Through Speech Recognition’ presented by Ms. M. Ramjan Begum and Mr. S. Chandramouli [5] are the authors presents an approach to design a Universal robot to perform robot writing task. The hardware part consists of the mechanical design of robotic arm, the adequate choice of Motors the electronic devices to drive the robotic joints. The software part contains the high level algorithm that converts the desired word sequence of the target point, and the control algorithms that ultimately make the robot more according to specification. The writing mechanism is made by speech recognition technique these speech recognition can be provided through either by using microphone or by using Android application [5].

A simple prototype of ‘HOMEWORK WRITING MACHINE’ presented by Mr.R.Augustian Isaac and Amit Kumar Singh [6]. Homework machine is a programmed machine used for writing any kind of content and drawing any outline of a picture on paper. Homework composing machine will be working like a CNC machine. This Machine will chip away at 3 pivot which are the axis(X, Y, Z). This three axis motion is controlled by stepper motor and servo motor. It is an extremely good item and can be utilized in day to day life to make more demanding and is exceptionally useful in educational systems such as school, colleges, etc and extremely helpful for the corporate world moreover [6].

A paper on ‘Design and Implementation of low-cost 2D plotter Computer Numeric Control (CNC) Machine’ presented by Shani Ranjan, Mani Rani, Shweta Ranjan , Manmohan Singh [7] are the authors presents an Arduino Uno and motor driver ICs which are based on the technique for implementation of any text or image to its two dimensional plotted text or image by 2D plotter CNC machine. A 3D controlled 2D plotting machine which is also called as CNC plotter machine uses a pen to write text or draw an image on any given solid surface. The programming language for the CNC system is the G-code programming. The function to tell the machine to move to various point at the desired speed, control the spindle speed and turn on and off at various positions is given by the G-code. The image file is transformed into a G-code using a software. Then the code is given as an input to the microcontroller which runs the motor mechanism as per instructed to draw the image [7].

This paper developed ‘Arduino Based Cost Effective CNC Plotter Machine’ by Puja Girhe, Shubham Yenkar, Arpita Chirde [8] have designed this system three stepper motors are required for x y and z axis. ATMEGA 328core microcontroller is used which can be interfaced with pc by using FTDI module. FTDI module converts human interpretation language into ASCII value with is understandable by machine. Then the g-code is interfaced with microcontroller this code is further passed to stepper motor and then as per instructions the stepper motor moves [8].

The simple prototype ‘Automated Writing and Drawing Machine’ by M. Aditi S. Karpagam, B. Nandini, B. S. Murugan [9] have designed a mechanism programmed with speech recognition system and makes the user to write what he speaks. For this CNC machine is used which consists of Servo Motor and stepper motor. program code will be uploaded in the arduino UNO board the sensors used recognise the user and fetch user input which two documents and written result and start writing on paper [9].

This paper developed ‘Automatic Mini CNC Machine for PCB Drawing using Arduino’ by Mahesh Raut, Ganesh Shete, Vipul Shinde, Ashok Suryawanshi [10] developed a new mini CNC machine using atmega 328 microcontroller, two stepper motor and 1 servo motor. Inkscape software is used for PCB designing. The gerber file is converted into g-code. Then g-code is interfaced with microcontroller in serial connection with pc. G-code gives message to Arduino Ide for the movement of servo and stepper motor according to the PCB diagram. Z axis is connected with PCB engraver pen which will draw the actual image of PCB on the board [10].

A simple prototype of ‘Implementation of Arduino UNO based Two Directional [2D] Plotter’ by Sheetal N. Patil, and Prashant G. Patil [11] have designed an affordable model of a plotter machine which is able to write the text according to the voice command In the beginning, the G code is created using text file by means of Ink space software and then is input is given to the machine using Processing software. There's also an Arduino UNO with an ATmega328P microcontroller which is used as the controlling device for this project. The microcontroller ATmega328p converts G-code into a set of machine language and is further sent to the motor driver of the 2D plotter [11].

A paper on ‘Implementation of a Low-cost CNC Plotter Using Spare Parts’ by Mohammad Kamruzzaman Khan Prince, Muhsi-Al-Mukaddem Ansary, Abu Shafwan Mondol [12] have designed the Computer Numeric Control (CNC), capable of processing logical instructions, microprocessor is used which is interfaced with a computer. The logical instructions (text or drawing) are provided by code or text or image which is then transformed into a machine language (G-code) by microprocessor which is to be executed by the machine [12].

A paper on ‘Design and Implementation of XY-Plotter’ by Mya Thandar Kyu, War War Htun [13] have developed a XY-Plotter which is portable mini CNC machine. An XY-Plotter operates in two axis of motion to draw continuous vector graphics. XY-Plotter uses pencil to plot on the paper that is lying on the flat surface under the plotter. XY-Plotter is connected to a laptop, which is equipped with specialized plotting design or drawing computer software programs. Those computer software programs sends the necessary plotting dimensions or designs in order to command the pencil to produce the correct project plotting needs[13].

A paper on ‘Mobile Application Base Voice Command Wireless CNC Writing Machine’ by Abhijit Ghule, V. N. Mahawadiwar [14] have developed voice mobile application based wireless CNC writing machine which is interfaced with HC-05 Bluetooth and microcontroller is used. CNC machine's voice signal is given to mobile application and the voice is converted into text command and sent into paired HC-05 Bluetooth receiver through Arduino UNO which already stores g code file (generated with ink space software) which is opened into micro SD CARD and send the G-Codes file to Arduino UNO both controller board (master and slave communication) which will proceed into G codes file according to the CNC machine. With the assistance of two scrape DVD/CD stepper motor joined into 2 L298- motor driver controlling to (x- axis and y -axis) and servo motors connected pen movement controlling to (z- axis) to draw the any text, picture as per the fed program[14].

A paper on ‘Wireless Base CNC Mini Plotter Three Axis Control Machine’ by Ghulam Dastgeer, Prof. Muhammad Asad [15] have designed a cheaper cost wireless CNC mini plotter which is a three axis control machine that is combined with a microcontroller. CNC machines measures area and unit processed numerically and then uses them for drawing cartoon images suitable accuracy. The mechanically part is design to fed the program into their controller unit. Controller unit are both the laptop and microcontroller. Wireless CNC machine consists of stepper & servo motors to draw any images or signature as per the requirements. This system works with a HC-05 Bluetooth element for wireless communication two Stepper motors for axis of rotation and one servo motor for zaxis[15].

III. METHODOLOGY

CNC machine follows a basic principle that is all the motors can be controlled using computer through a software. In this paper, machine which has been developed has three motors which includes two stepper motors whose function is to divide full rotation into a number of equal steps for XY plane and one servo motor which acts as an angle precision tool for adjusting the pen. Motor drivers (A4988) are used to control the motion of the stepper

motors and Microcontroller is used for controlling servo motor. The X-axis is attached to two wooden parts and made it is functioned to cut and construct in vertical position. The Y-axis is placed in horizontal position with respect to plotter base and pen is gripped by servo motor to move up and down in the Z-axis which is free to move along 2D plane(X-Y).

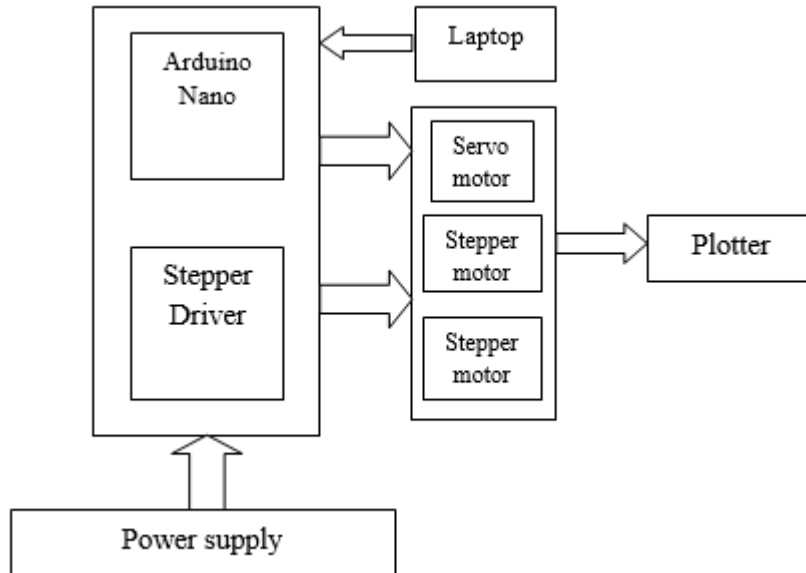


Fig 1: Block Diagram

Using Inkscape the input text is converted to G-code and is transmitted to Microcontroller via Universal G-code Sender. Inkscape software can also be used to convert the image content into G-code using ‘G-code tools’ extension. Universal G-code sender is used to feed the G-code in Microcontroller. Upload the sketch for each module to Arduino board using Arduino IDE software. Connect the Universal G-code sender to microcontroller by pairing both devices in order to control the movements of the X-Y Plotter.

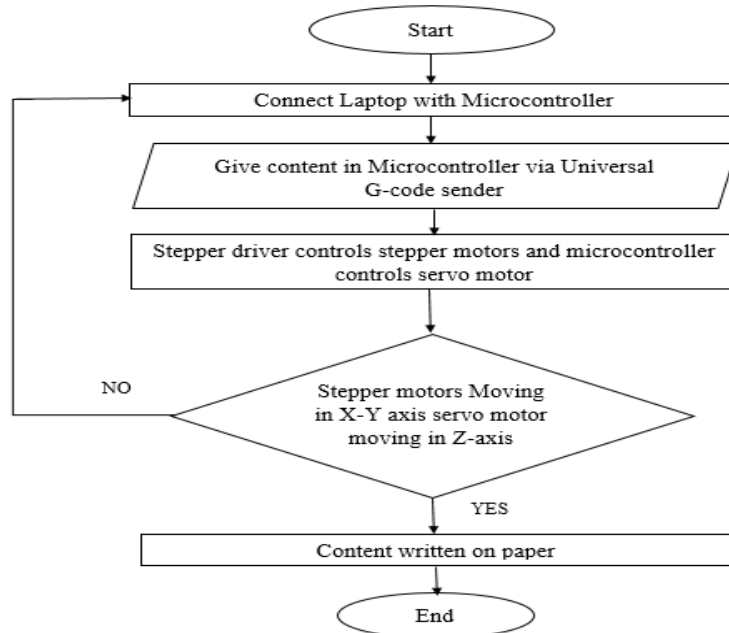


Fig 2: Flowchart

The starting process of plotter is described by the flowchart in the Fig 2 where firstly the connection of the laptop is done with the microcontroller and then the content to be written is given in the Inkscape software and by using Universal G-code Sender accordingly the X-Y plotter operates the stepper driver is used to control the stepper motors and the microcontroller is used to control the servo motors. If the stepper motor does not move in x-y axis and the servo motor does not move in z-axis, then the connection between the Microcontroller and Universal G-code Sender is established again. Once the connection is properly established then the content is written on the paper.

IV. RESULT

The G-code has been designed and sent to CNC plotter for drawing the text. The G-code file and the plotted text shown in the Fig 3

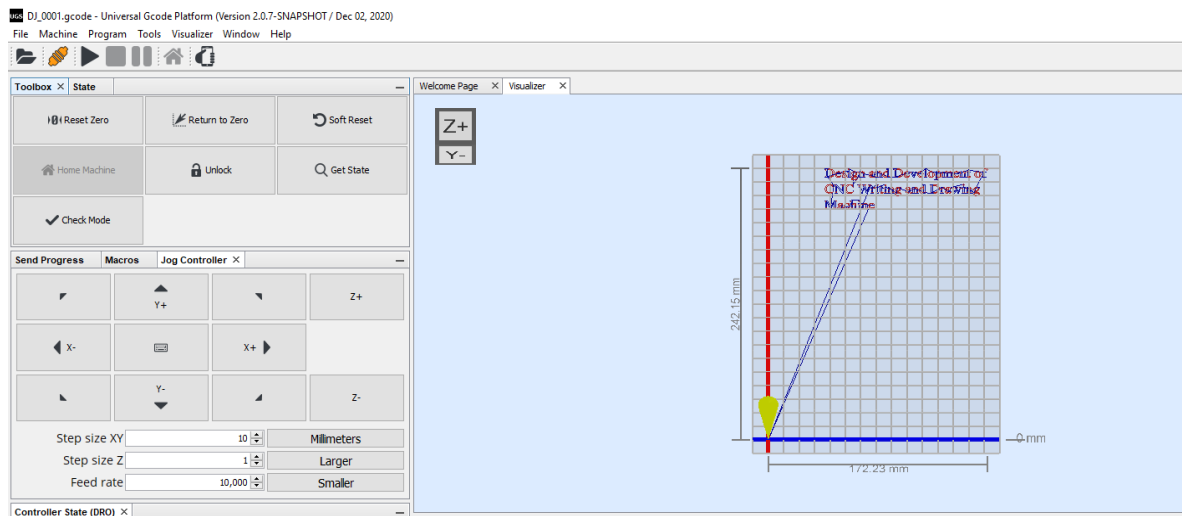


Fig 3(a): G-code File

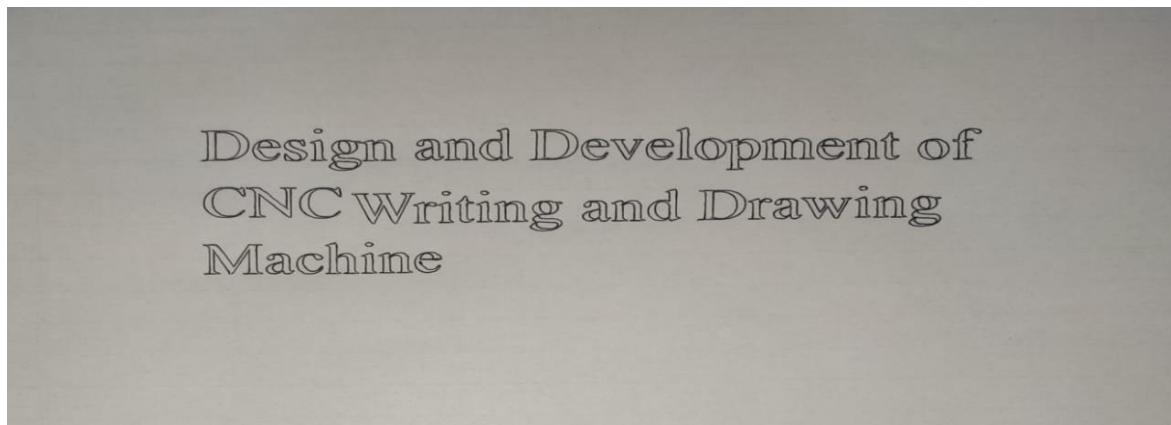


Fig 3(b): Plotted Text

Fig 3 Comparison of Text file 3(a) G-code File 3(b) Plotted text

V. CONCLUSION

In this project, the development of writing and drawing machine which is a portable machine is done that operates in two axis of motion i.e. X Y axis and the servo motor is used to control the movement of the pen in vertical direction i.e. Z axis. Its output is obtained with the help of stepper and servo motors and G-code plays a major role in the successful operation of the CNC machine which is the only code which understands the CNC machine. With the help of Inkscape software this conversion becomes easy and through Universal G-code Sender

this code conversion is sent to the microcontroller which will send the commands or instructions to the motor drivers to perform the movement and according to the task the data is plotted with the help of the pen. In future, it can be used by person for writing and drawing operation. Similarly high precision components can be implemented in plotter for getting accurate co-ordinates in order to locate the pen precisely and faster.

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