EFFICIENT USE OF ELECTRONIC WASTE FOR CNC MACHINE

Kushal Verma
Department of Computer Science and Engineering
B. Tech Student, SRM-IST, NCR Campus, India

Ishita Gianchandani
Department of Computer Science and Engineering
B. Tech Student, SRM-IST, NCR Campus, India

Sumit Saroha
Department of Electrical and Electronics Engineering
Assistant Professor, SRM-IST, NCR Campus, India

Abstract— **In order to minimize the cost of CNC machine, this paper proposed an idea to recycle the waste material of old computer system. The implementation of this paper consists of the followings: Arduino UNO R3 board, Stepper motors – for the motion of X and Y axes, mini Servo motor, L293D driver IC, Arduino Processing software (freeware), Inkscape software to create G-codes for the input data (freeware), any type of pen or pencil - as the main source of ink. This project is able to draw complex line drawings by plotting the coordinates using simple algorithm. Plotting of coordinates is cultured within G-codes prepared by a software after which it is transferred to the microcontroller by which the motor mechanism is instructed to draw the image or text data, motor mechanism includes X-and Y-axes that can each work independently, yet simultaneously.**

Keywords— **Stepper Motor, CNC Machine, G-Codes**

I. INTRODUCTION

The project is the opportunity to show the world the work that has been keeping many geeks and enthusiasts involved day and night. Computer Numerical Control is an advance form of soft automation developed to control the motion and operation of machine tools. Their fabrication includes certain advantages like: efficiency, flexible, low cost, less working time and fewer losses in production [1]. This printer is flexible; it could be made to work like a laser engraver for engraving texts or images on any hard surface or as a compact milling machine also if pen is replaced with a drill machine. Similarly, if the pen is replaced with an embroidery needle then it could create some cool and awesome embroidered patterns and logos on any cloth material. Various modifications like including one more axis or increasing the printing area can be made without rewriting the algorithm of this machine [1-7].

Pinhiero et al. (2016) [1] discussed about the design of the three axis plotter using stepper motors and making them at relatively cheaper costs and with minimal labor. Madekar et al. (2016) [3] discussed about the much broader application of CNC machines. He developed a low cost automatic mini CNC machine for PCB drawing and drilling. He used FTDI module, ATMEGA328, easy drivers 16MHz crystal oscillator for much more flexible operation and flexibility. Kashif et al. (2017) [6] discussed the design implementation of the CNC machine with multi tool attachment. He explains the axis coordination system, tells about the detailed mechanism of the components, their driving mechanisms. Prince et al. (2017) [8] explained the various software required starting from the input data parsing till the output data implementation, he explained how these software's works and adds up together to give exceptional results. It has been concluded that the Bresenham's Line Algorithm is used for plotting in the CNC plotter.

From all of these research papers necessary guidelines were followed and concepts were made clear prior to the manufacturing. All these research papers helped in molding this project and giving it a nice design and well implemented algorithms. Use of electronic components was carefully accomplished which helped in their proper function. This project is a prototype that is enough to explain how the capabilities of these hardware's and software can be grown to such an extent that it can very well replace many technologies that are costlier to implement and function which is going to benefit various companies as well as graduate youths. The parts in this project are all extracted from old damaged spare parts of a computer CPU unit. The construction is very simple and sturdy. Indeed, it is highly flexible to various applications. Placing laser or embroidery needle we can either etch data on metallic or other hard surfaces or create beautiful embroidered designs on any type of cloth material. The programming in CNC machine incorporates all the exacting, high-speed movements needed to produce the object, and it enables detailed customization. The rest of this research paper includes the problem statement, results and discussion, and finally the conclusion carried out for building this project, giving it a desired shape.

The rest of the paper is organized as follows. Proposed embedding and extraction algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROBLEM STATEMENT

The objective of this project is to overcame the biggest disadvantage i.e. cost of printing inks so building one that is quite cheap and delivering remarkable output to the user and provide them a creative environment to see how machine interprets their commands and do something in real time could be a milestone [7]. It consists of stepper motors (extracted from old CD drives) came out to be the fundamental idea for the project, this device can draw images (logo designs, PCB etching designs, etc.) and texts in a small range canvas and data is being loaded from any computer machine.

There is a pool of printers in market which can print any data but this CNC machine could prove to be the initial step to fabricate something to everyone for a non-virtual i.e. real time environment to interact with machines and save the construction and printing costs. The expected output of this machine is beguiling.

People may wonder about 3D printing technology and if it has advantage over CNC machining. The answer depends on several factors:

1. Type of inputs
2. Structure complexity
3. Apparatus and construction

Generally, 3D printing is used to produce prototypes and has relatively low speed compared to CNC machining. Because of this it is not efficient for producing large quantities.

III. PROPOSED STATEMENT

The intent of development of this model is to first of all find out a way to reduce cost of inks used in general purpose printers and then embedding programming knowledge to build something that could be used to print or draw any text, image, logo, etc. directly from a pen or pencil onto a paper. The expectation is that this project is going to help out many college going undergraduates as well as school going students and other professionals to see how the programming languages that students learn in their academic years could make a machine come alive and analyze how machine interprets our commands and function accordingly. With the increasing demand for the use of CNC plotters in universities and laboratories, a cheap and less complex design is an absolute need.

1. The very first step includes the user feeding the input data into the vector graphics software i.e. INKSCAPE, where the input data could be any vector image, text input, solid filled image, sketched image, etc.
2. G-codes are the computer numerical machine language codes generated by plotting the respective coordinates of input data. These G-codes are used to control the feed rate, coordination and speed of axes of the motors. It guides whether the motor has to move clockwise or anticlockwise and the duration for which it has to be in motion. Second step involves generation of G-code through inkscape software because manually writing G-codes is a tricky job therefore this project generates this using python scripting language. The parameters generated by G-code are required by the machine in order to maintain coordination for printing the input data.
3. Third step is feeding the prepared G-codes into the Arduino for main action. For this the project uses a grbl platform to feed data and on show the dynamic commands being transferred in real time action.
4. In the final stage, the outputs of the intermediate stages are passed in to the stepper motors through their driver IC and servo motor to deliver the expected output for the given input data out on the canvas.
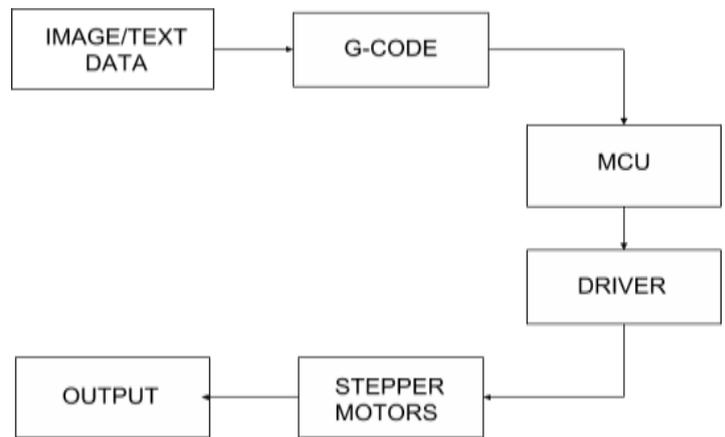

Fig. 1 Block diagram of CNC printer

Working of the model:
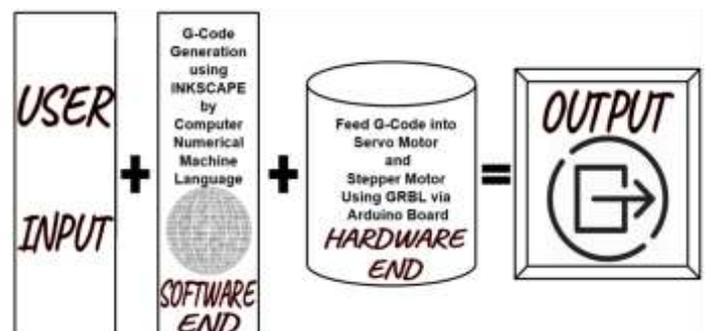
The various components utilized for the fabrication has been given in Table 1:

Table 1: Components Used

S. No.	Type	Component	Functionality
1.	Hardware	Arduino UNO	Send synchronous data inputs to the L293D driver IC.
2.	Hardware	Driver IC (L293D)	Acts as a current amplifier
3.	Hardware	Servo Motor	Rotary actuator that allows for precise control of angular position, velocity and acceleration.
4.	Hardware	Stepper Motor	Control motion on the pen using number of steps.
5.	Software	G-Code	Controls the feed rate, coordination, speed of axes of the motors, direction and duration of motion.

IV. RESULTS AND DISCUSSION

The fabrication of this project finally ended up with a finished product: A fully functional CNC Printer that could work efficiently according to programmer's commands as demonstrated in fig. 2. The accuracy and speed can be maintained by using high speed motors with high end drivers to drive the motor at 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.

The biggest advantage behind making this model is being the cost effectiveness, one can ask why there is the need for making this CNC printer when there are other printers available in the market. An answer to the question is the fact that, 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; anyone can easily make this machine a real ice breaker where implementation of theoretical knowledge comes into practical implementation. This project is designed with a very simple construction scheme and can be carried anywhere without much efforts. A very simple algorithm is implemented which can handle any type of modifications made within the machine without rewriting it.
Using of open source and user friendly software's were preferred.

Though the archetypal 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 where network of wires is assembled. Compact wiring of the circuit is represented in fig. 3 and fig. 4. Mechanical design of the CNC printer is demonstrated below:

Fig. 2: Mechanical implementation
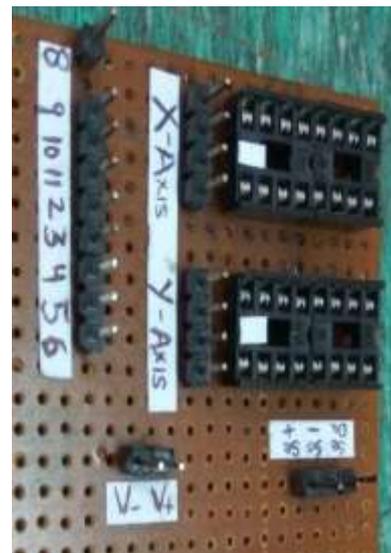
Fig. 3: Front-view of the circuit

Fig. 4: Back-view of the circuit

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 the favor of 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 into 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. However, most experts do not agree that manual skills will become obsolete. In fact, some think conventional machining will thrive through small and specialty projects.

V. CONCLUSION

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 benefit of CNC machining. Design retention, once a design has been loaded into the CNC machining software and a perfect prototype has been created, the program can easily retrieve the design to run it and create that object. Low maintenance, the g-code based software will automatically update itself when needed, and generally do not require much service.

VII. REFERENCE

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