Design and Implementation of XY-Plotter

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***Abstract*— The development of the X-Y plotter is to scheming two dimensional data on a rectangular coordinate system. XY Plotter prints by moving a pen or other instrument across the surface of a piece of paper. This project is to operate drawing the figure or text by milling machine. By using this XY Plotter, can draw the complex line art and including text. The result is very accurate. This project mainly uses three software: CorelDraw, Lazy CAM and Mach 3 milling. Based on G-code command the desire outputs can be loaded rapidly. The main components are stepper motor, TB6600 driver, Parallel Port, Mach3 interface card and other mechanisms. This research project controls the mechanical movements with the electronics pulse. The model XY- Plotter is achieved by sketching the figure or by lettering the desired text with a resolution of 0.005mm.**

***Index Terms*- XY Plotter, G-Code, Mach 3, CAM**

1) INTRODUCTION

Numerical control (NC) is the automation of machine tools that are operated by abstractly programmed commands encoded on a storage medium, as opposed to control manually via hand wheels or levers, or mechanically automated via cams alone. In modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs. The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine via a postprocessor, and then loaded into the CNC machines for production.NC, and later CNC, allowed for tremendous increases in productivity for machine tools because the machines could be run automatically without requiring constant attention from their operator. The history of numerical control began when the automation of machine tools first incorporated concepts of abstractly programmable logic, and it continues today with the ongoing evolution of computer numerical control (CNC) technology. The first NC machines were built in the 1940s and 1950s, based on existing tools that were modified with motors that moved the controls to follow points fed into the system on punched tape. These early servomechanisms were rapidly augmented with analog and digital computers, creating the modern computer numerical control (CNC) machine tools that have revolutionized the machining processes.

Other methods of transferring CNC programs to machine tools, such as diskettes or direct connection of a portable computer, are also used. Punched tapes are more robust. Floppy disks, USB flash drives and local area networking have replaced the tapes to some degree, especially in larger environments that are highly integrated. The proliferation of CNC led to the need for new CNC standards that were not encumbered by licensing or particular design concepts, like APT. A number of different "standards" proliferated for a time, often based around vector graphics mark up languages supported by plotters. One such standard has since become very the "G-code" that was originally used on Gerber Scientific plotters and then adapted for CNC use. The file format became so widely used that it has been embodied in an EIA standard. In turn, while G-code is the predominant language used by CNC machines today, there is a push to supplant it with STEP-NC, a system that was deliberately designed for CNC, rather than grown from an existing plotter standard. While G-code is the most common method of programming, some machine-tool/control manufacturers also have invented their own proprietary "conversational" methods of programming, trying to make it easier to program simple parts and make set-up and modifications at the machine easier (such as Mazak's Mazatrol, Okuma's IGF, and Hurco).These have met with varying success. A more recent advancement in CNC interpreters is support of logical commands, known as parametric programming (also known as macro programming). [1]

***Manuscript received July, 2018*.**

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2) LITERATU RE REVIEW OF XY- PLOTTER

The goal of this project is to design and build a high quality Mini CNC XY plotter. The areas of technology that will be covered in this review are:

- Mechanical Systems Review
- Drive Electronic Techniques
- Communication/Linking
- Software

Mechanical Systems Review

The mechanical subsystem of a CNC provides the means needed to cut and machine various materials for a given job. The choice of materials has a direct impact on performance, precision, repeatability, longevity, and mechanical noise transfer into the parts. The mechanical subsystem is comprised of the guide system, the drive system, and the frame housing structure. Each of these systems has a direct impact on the aforementioned qualities of a CNC. The remainder of this section will focus on the types of these systems and look at the advantages and disadvantages of each.[2]

Drive Designs

The purpose of the drive mechanics is to transfer the torque provided by the electric drive motors into linear

motion to move the tool head. Since CNC machines require linear movement in multiple axes, multiple screw systems are most often used to accomplish this goal. These systems offer a simple and compact means of transmitting power and motion with excellent reliability. For these machines, the screws are turned by motors, generating linear motion and thrust in the nut. There are two main types of screws and both power screws and ball screws operate in this way. However, the differences arise in the efficiency with which this motion is transmitted, the friction loss, the allowable rotational speed, and the required linear speeds.

Communications

In order for the CNC to process any design implanted into it, the machine must have a connection system between itself and the software being used by the computer. Many connections used today are very common to people from using cable linking to add pictures to their computer hard drive or using a modem connection to log on to the internet. We will discuss the four major types of communication systems between computers and other hardware including:

- USB Ports
- Serial Ports
- Parallel Ports
- Ethernet

Software

Low cost, home and small business CNCs require at least one software package to operate. This is the basic package which allows the user to open a graphics file and command the system to machine the part. There are several basic interface software: [2]

- Mach 3
- EMC (Enhanced Machine Controller)
- BOB CAD CNC
- Desk CNC

3) COMPONENTS OF THE PROJECT

There are three major subsystem of this project description. They are

1. Mechanical
2. Electrical
3. Software

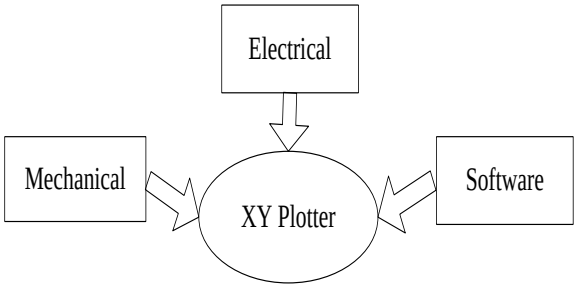

Figure.1 XY-Plotter Major Subsystems

Mechanical

In this project, the following mechanical devices are used. They are:

- CNC Breakout Board with Optical Coupler for Stepper Motor Driver
- SFC 12 Round Rod Shaft Diam-12mm Len-500mm
- SK 12 12mm Linear Rail Shaft Support
- SK8 8mm Linear Rail Shaft Support
- SCS12UU 12mm Linear Ball Bearing
- Lead Screw Set
- SFC8 Round Rod Shaft Diam-8mm Len-500mm
- 5mm Aluminum Bore GT2 Timing Belt Pulley
- LMF8UU 8mm Linear Bearing
- GT2-6mm Open Timing Belt
- Steel Blacket

Electrical

A NEMA 17 stepper motor is a stepper motor with a 1.7 x 1.7 inch (43.2 x 43.2 mm) faceplate. The NEMA 17 is larger and higher torque. NEMA 17 size, with approximately the following specifications, can also work:

1.5A to 1.8A current per phase
1-4 volts
3 to 8 mH inductance per phase
44 N·cm (62oz·in, 4.5kg·cm) or more holding torque
1.8 or 0.9 degrees per step (200/400 steps/rev respectively)

200-steps-per-revolution, NEMA 17 (1.7 in square foot print, 5mm shaft diameter), 12V motor. The Mosaic stepper is typical of common high resolution motors – a full revolution requires 200 steps, while each step turns the shaft only 1.8° for a full step, or 0.9° in half-stepping mode. This sized motor is commonly used in household appliances, medical equipment, stage lighting devices, and in various industrial control applications.[6]

Motor Driver for XY-Plotter

In this project, Single Axis TB6600 Stepper Motor Driver IC is used to control the stepper motors. The pin description of stepper motor driver is shown in Table.1.[5]

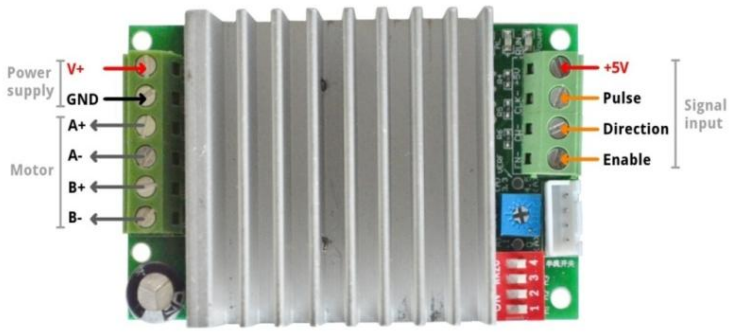

Figure.2 Single Axis TB6600 Stepper Motor Driver IC

Table .1 Single axis TB6600 Stepper Motor pins description[6]

Connecting Terminal	Meaning
+32V,GND	Positive and negative power supply terminal
A+, A-	Motor A
B+,B-	Motor B
CLK-	Pulse input
CW-	Direction input
EN-	Enable input
+5V	input terminal of common end

Mach 3 I/O Interface Card

The following Figure.3 is Mach3 I/O interface card for the project. It is used to run the signal processing of the host computer (LPT port), with Mach 3 CNC system software, and the peripheral machine energetic electrical.

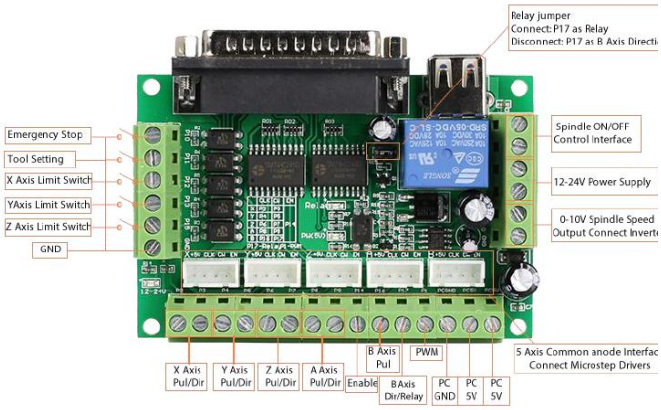

Figure.3 Mach3 I/O Interface Card

Software Installation

Mach3 is distributed by ArtSoft USA over the Internet. When run the downloaded file, will be guided through the usual installation steps for a Windows program such as accepting the license conditions and selecting the folder for Mach3.ArtSoft USA recommends that allow Mach3 to use its default installation folder C:\Mach3.[3]

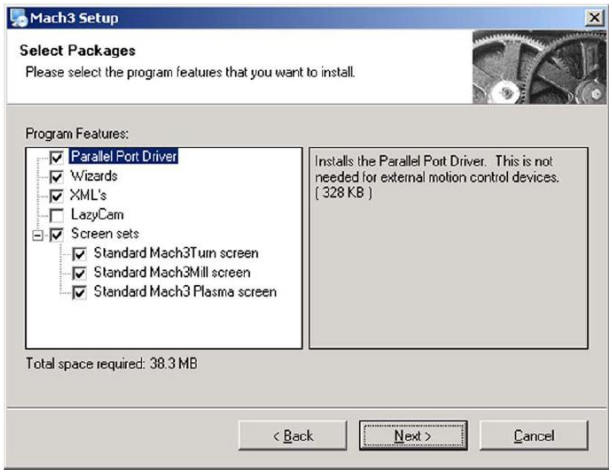

Figure.4 Select Program Components Screen

Need the parallel port driver to interface with the machine tool. Because Mach3 interface to the motor drivers, limit switches, and other hardware through the PC's parallel port(s).

Figure.5 Installation of Parallel Port Driver

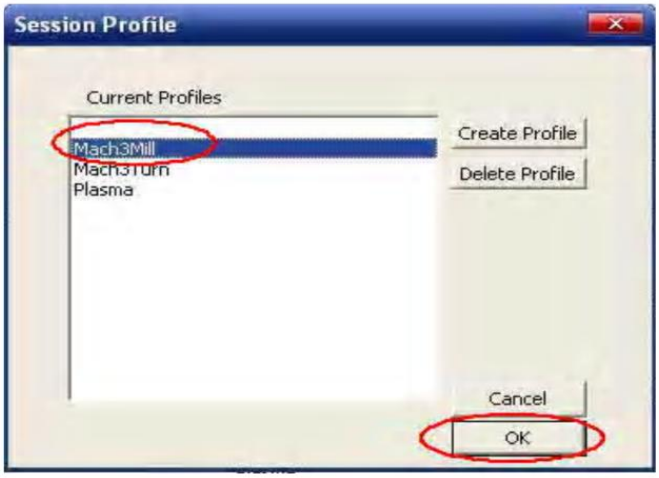

Figure.6 Creation of Mach3Mill

4) HARDWARE IMPLEMENTATION OF XY PLOTTER

XY-Plotter is a mini Computer Numerical Control (CNC) machine. XY-Plotter is a drawing robot based on make block platform, precision is 0.005mm, working area is 310mm × 390mm.In this project, specifications of a simple prototype XY- Plotter is achieved by drawing the figure, by writing the desired text with a theoretical resolution 0.005mm and maximum feed rate 50mm/minutes. If we want to use the XY- Plotter, we first open the Croal Draw Software. Next, we write desired text or plot the figure which we want to design and then save as dxf.file. Second, we open the Lazy CAM Software and .dxf file from Coral Draw is inserted to Lazy CAM Software to produce G Code. XY- Plotter is actually run with Mach3 Software using the G Code. We already use the .dxf and .dwf file type that changing G Code. Finally, the desired output is achieved and we can see it on the drawing paper.

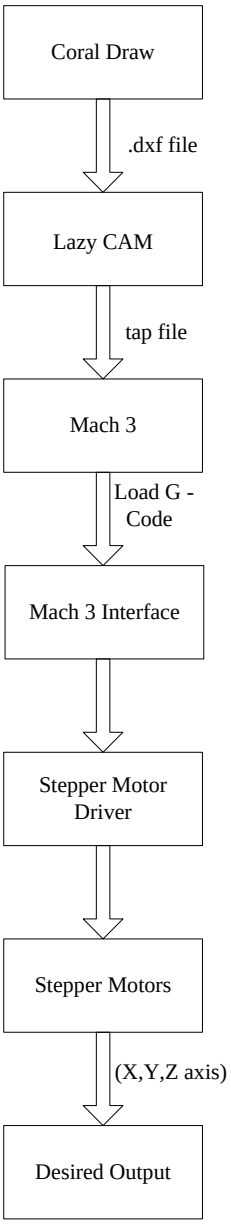

Figure.7 Flow Chart of Proposed Project

Figure.8 Constructed XY Plotter Project

5) TEST AND RESULT OF XY-PLOTTER

The following Figures are test and result of proposed XY-plotter. Firstly, open the Coral Draw software and define inch of the sample text.

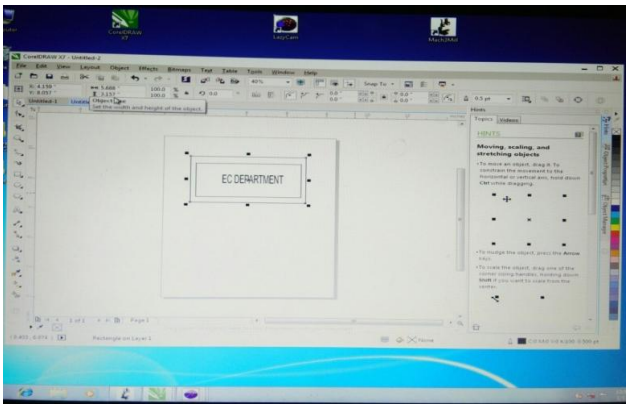

Figure.9 Coral Draw software and define inch of the text

Figure.10 shows the G-code file of the sample text and run the cycle start.

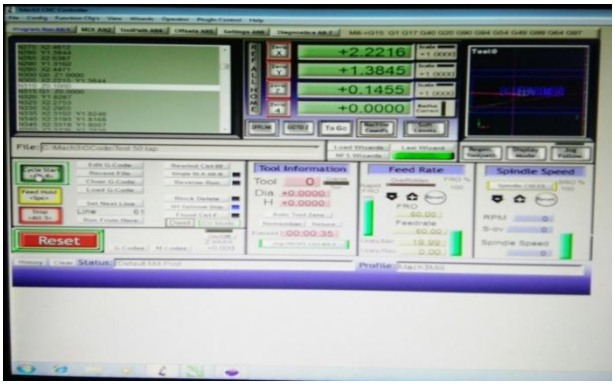

Figure.10 Test and Result of G-Code of sample text

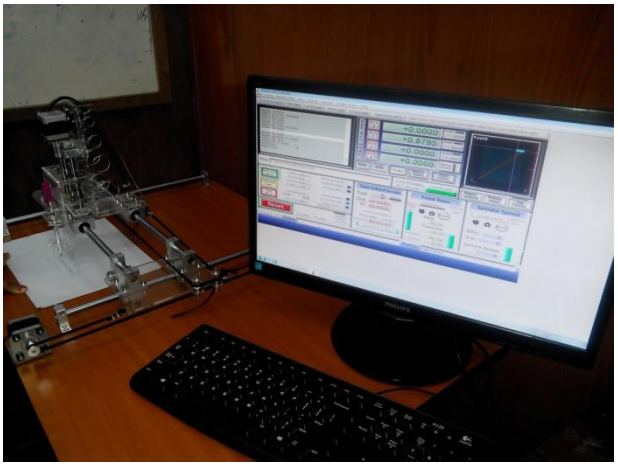

Figure.11 Proposed XY-Plotter

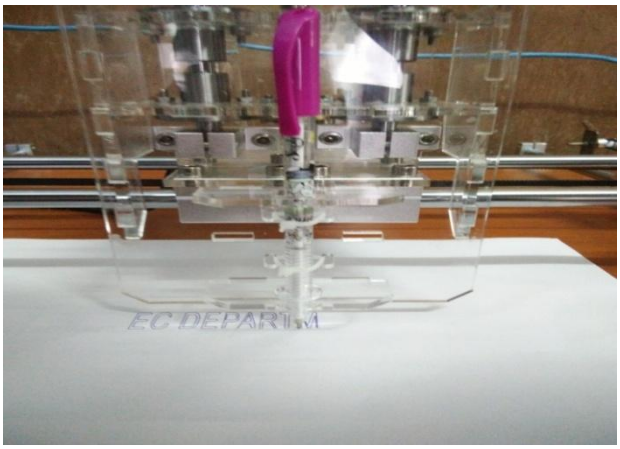

Figure.12Result of XY-Plotter of Desired Text Output

6) CONCLUSION

This project is XY-Plotter that is portable mini CNC machine. An XY-Plotter that operates in two axes of motion ("X" and "Y") in order to draw continuous vector graphics. XY-Plotter uses pencil to plot the paper that is lying on the flat surface area of the plotter. It is achieved because the XY-Plotter is connected to a computer, which is equipped with specialized plotting design or drawing computer software programs. Those computer software programs are responsible for sending the necessary plotting dimensions or designs in order to command the pencil to produce the correct project plotting needs.

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