Mini CNC Plotter

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Abstract: In this paper we are designing a low cost three axis Mini CNC Plotter using stepper motor, Arduino microcontroller and motor control software. In 1775 for the operations like cutting, shaping etc. a Canon boring machine or Lathe was invented but it can do only one work at a time and also other disadvantages like requirement of regular monitoring, skilled labours and less accuracy. In 1947 Mr John parsons tried to control machine tool motion using three-axis curvature data which was further developed for the invention of modern CNC machine. But this one is of high cost and its construction is very difficult. In our project we are trying to create a low cost CNC plotter of small or medium size and an open structure.

Keywords: CNC, Arduino microcontroller, part program, interpolator.

I. INTRODUCTION

Computer numerical control is an advanced form of soft automation developed to control the motion and operation of machine tools. Numerical control machine was invented around in 19th century to reduce work load, it is a method in which the manufacturing machine uses coded format, digits and letters. Its advantages include high efficiency, high flexibility, high production rate, low cost of production, less working time and less losses in production. It includes three main steps that is receiving data, interpreting data and accordingly control action. Based on special characters letter codes and numbers a form of program called part program (a sequential instruction or coded commands that direct specific machine function) is used for automatical operation of a manufacturing machine to produce a specific part of specific dimension. The program is then converted in to electrical signal to feed as input to motors that run the machine and do the tool movements.

A machine control unit (MCU) decides the tool depth of cut, cutting speed etc. Motion of tool is based on Right hand coordinate system [1]. Three axis of rotation x, y, z for three dimensional motion of tool plus an axis of rotation. The z-axis is one of the three which allows the movement of router in up and down direction. This axis is very important because it controls the depth.

The y-axis functions as motor mount to move z-axis in addition with slide mechanism, x-axis uses two pieces one for front and one for back which serves as height stands.

II. MAIN PARTS OF CNC PLOTTER

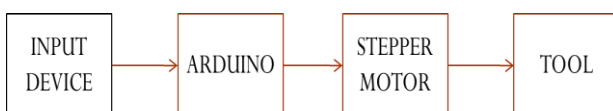The Fig. 1 shows a simple block diagram of CNC plotter

Fig 1 Simple block diagram of mini CNC plotter

Stepper Motor- It is the heart of CNC plotter. The size and type of motor speed, accuracy, CNC router precision etc. mainly two types of motors are used in CNC machines they are stepper motors and servo motors, within these are also many classifications.

Fig. 2 Motors

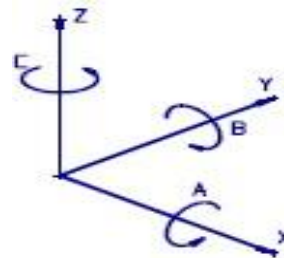CNC axis- x y z using right hand coordinate system

Fig. 3 The CNC axes

Serial communication port- It do the function of data transfer between computer and CNC plotter. We use DB9 serial port to communicate with computer.

Fig. 4 Serial communication port on a CNC machine

Arduino Microcontroller- It controls the position of stepper motor with help of program. It is a open source

prototyping platform based on easy to use hardware and software. They have digital and analog input/output pins that can interface into various expansion boards and other circuits and an Atmel 8, 16 or 32-bit AVR microcontroller with complementary components that helps in programming and incorporation into other circuits.

Arduino programs are written in any programming language with a compiler that produces binary machine code. Here we are using Arduino Uno for controlling process.
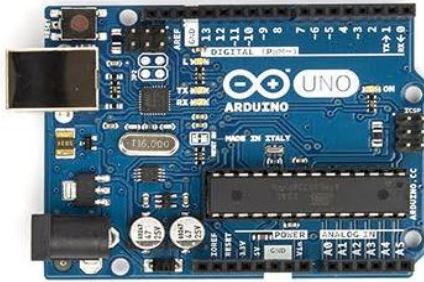

Fig. 5Arduino microcontroller

III. OPERATION OF MINI CNC PLOTTER

Our CNC machine consist of three axes x, y, z axis for three dimensional motion of tool. The numerical data required for working of the plotter is provided by a program called part -program which in turn converts the numerical data to electrical signals. These electrical signals are then given as input to stepper motors. Each signal specifies a specific point in the coordinates and according to the point the tool moves.

As mentioned earlier input device used isserial communication port DB9. Machine control unit (MCU) consists of data processing unit (DPU) and control loop unit (CLU). On receiving part program DPU interprets and encode it into internal machine codes. Then intermediate position of the motion in Basic length unit (BLU) is calculated by interpolator of DPU. Then it is passed to CLU for further process [2].

To control driving system and to perform required motion data from DPU are converted in to electrical signals in CLU. Machine tool can be of any type, machine slide should be of high accuracy and repeatability and also coated with anti-frictional material.
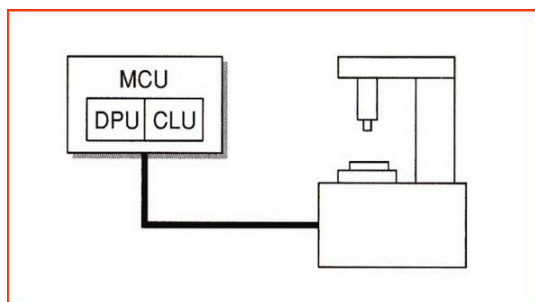

Fig. 6Machine control unit

Here we use open loop control system in which there is no feedback and uses stepping motor whose output angle rotates through a fixed angle in accordance with an input

pulse. The accuracy depends on motor's ability to step through correct number and the frequency on load torque, they have an inverse relation [3].
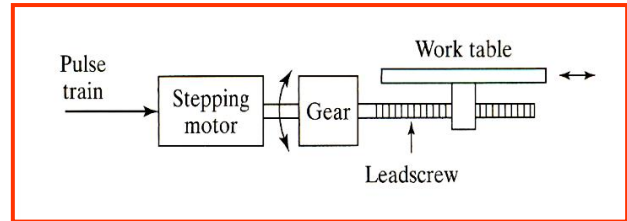

Fig. 7Open loop control system

Driving system includes stepper motor, which converts electric pulses into discrete mechanical rotations of motor shaft. These pulses are provided by the machine control unit. Stepper motor would be the best simple device that can be applied to CNC as it converts digital data to actual mechanical displacements. They are mainly used because of slow speeds, low torque, and low resolution and easy to slip in case of over load.

IV. CONCLUSION

In this paper we have presented the concept of a low cost three-axis mini CNC plotter. The existing CNC machines are of high cost, difficult to maintain and requires highly skilled operators.

Our CNC plotter overcomes these problems. It is of low cost and easy to control and there is no need of highly skilled operators. It can be used for long hours at a stretch which is not possible in existing ones. It is hoped to extend this work for future development.

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