

COMPUTER NUMERICALLY CONTROLLED MULTI OPERATIONAL MACHINE

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ABSTRACT

This paper discusses design and development of a low cost three axes Mini CNC multi operational machine using stepper motor, with multi tool attachment, with Arduino microcontroller and motor control software. In Early days for the operations like cutting, shaping etc. a Canon boring machine or Lathe was used but it can do only one work at a time. Also, other disadvantages like requirement of regular monitoring, skilled labours were engaged and less accurate. 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 this project a low cost economical & affordable CNC multi operational machine of small or medium size is designed and developed which operates more accurately and exhibits more precision and adopts an open structure.

Keywords: CNC, Arduino microcontroller, part program, interpolator, L293D, Servo motor

1. 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 character 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 automatic 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.

2. MAIN PARTS OF CNC MULTI OPERATIONAL MACHINE

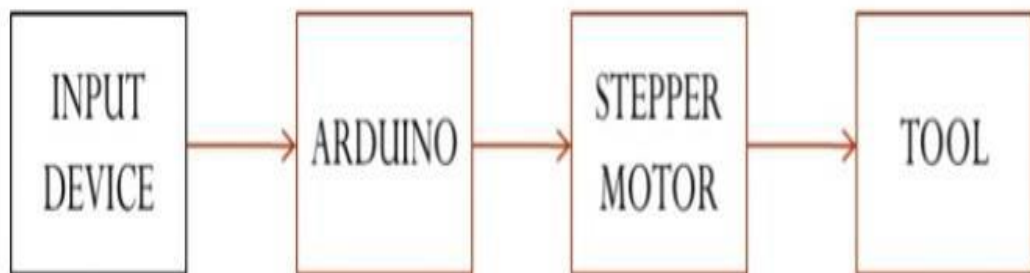


Fig.1 Simple block diagram of mini CNC Multi-Operational Machine

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

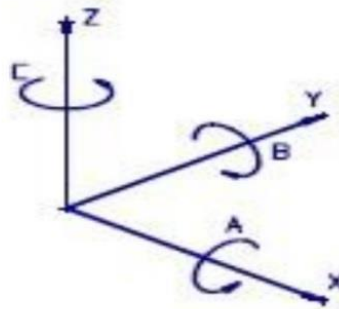


Fig.3 Three dimensional axes

Serial communication port- It do the function of data transfer between computer and CNC multi operational machine. We use COM3 serial port to communicate with computer.

Arduino Microcontroller- It controls the position of stepper motor with help of program. It is an open source prototyping platform based on easy to use hardware and software. They have digital and analogue 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.4 Arduino Microcontroller

3. METHODOLOGY

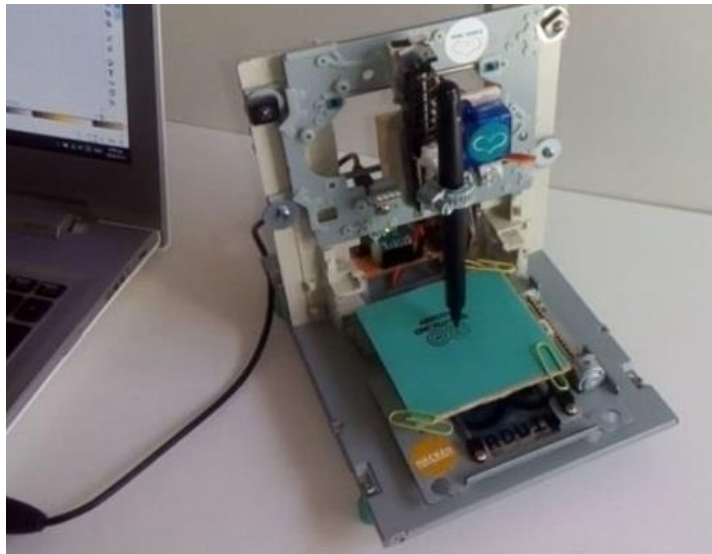


Fig.5 CNC Plotter

CNC multi operational 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 is serial 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.

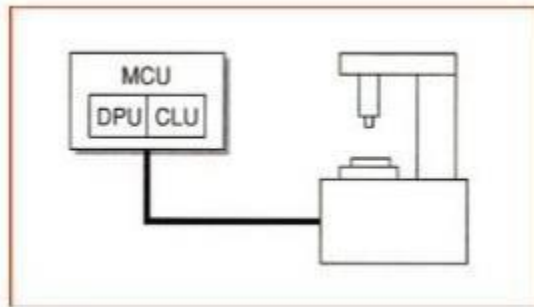


Fig.6 Machine control unit

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.

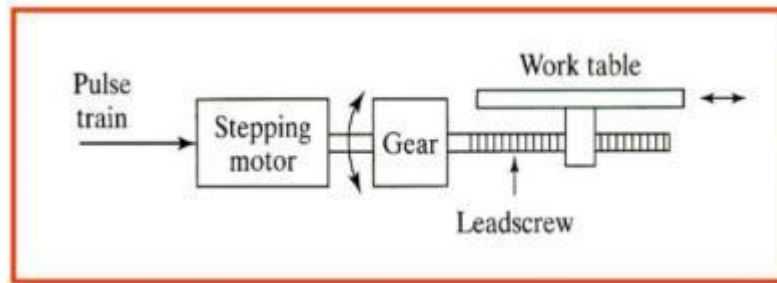


Fig.7 Open loop control system

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.

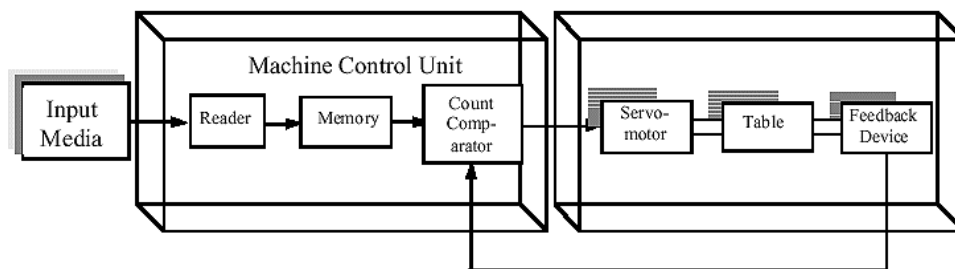


Fig.8 Machine control unit

COMPONENTS USED

IC L293D:

It is a typical motor driver or motor driver IC which allows DC motor to drive on either directions. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction.

ARDUINO NANO:

It is a small, complete and bread board, friendly board based on the Atmega 328 (Arduino Nano 3x) it has more or less same functionality of the Arduino Uno. It is in general an open source computer hardware and software for building digital devices and interactive objects that can sense and control objects in the physical world.

SERVO MOTORS:

Servo have integrated gears and a shaft that can be precisely controlled. Standard servo allows the shaft to be position at various angles, usually between 0-180 degrees and at various speeds using DC motor (12V).

4. RESULTS AND DISCUSSIONS:

The construction of CNC multi operational machine is constructed and fabricated successfully as per the design. The machine is built to ensure cost effectiveness keeping in mind to see that it is made easily available and affordable, so that it can be made used in small workshops and fabrication units. The machine which has been built is portable to avoid the wastage of space and to enhance effective utilization of the available space in the work area. The machine can perform more than one operation which is beneficial to the manufacturers.

COST EFFECTIVENESS:

Compare to other CNC machines the work has been done to reduce the building cost so that it is easily available and affordable.

PORTABILITY:

As we see the existing CNC machines are bulky and requires more space to install and most of the machines are work centric but though this machine that problem has been eradicated by making it portable and compact.

EFFICIENCY:

Most of the existing CNC machines are efficient, but by this machine the concept of compactivity is adopted due to that the power consumption is comparatively less.

MULTI-OPERATIONAL:

It is designed in such a way that multi operations can be performed with the same system just by changing the tool heads like Milling Cutter, Drill Bits, Laser Engraver [4], Laser Peening [5].

5. CONCLUSION

In this paper, the concept of a low cost three-axis mini CNC multi operational machine is presented. The existing CNC machines are of high cost, difficult to maintain and requires highly skilled operators. This CNC multi operational machine overcome the following 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 machines, there is a possibility to extend this work for future development.

6. ACKNOWLEDGMENT

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