3-axis mini CNC milling machine

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Abstract

Nowadays with a digital control it's became more and more useful to use such a machine tools with a coded software. This paper will present the design and fabrication of 3-axis milling machine. computer numerically-controlled (CNC) machine which comprise the use of Arduino micro controller to produce pulse-width modulation (PWM) outputs in order to run the stepper motors that will be used in this work. A milling 3-axis CNC is previously used precisely surfaced designed for snapping of wood, plastic sheet and thin sheet of metal alloy by using a rotating drill bit which its accuracy is much lesser than using a lesser cutter technique this machine tool is portable and it's controlled by computer (PC). Design and Fabrication of CNC with precision Stepper motors that contacted with the lead screw moment along 3 -axis.

Keywords:. Stepper motor, spindle motor, leadscrew, ball bearings, flexible coupling, and control system by Arduino micro controller in Easel software.

1. Introduction

Computer numerical machine (CNC) is the automation of machine tools that are operated by a computer controlled programs to perform a desired product shape. In modern CNC systems, product design is made with computer-aided design (CAD) and is created 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 post processor, and then loaded into the CNC machines for production [1]. With the ongoing development of technology and economy, new industrial requirements such as high precision, good quality, high production rates and low production costs are increasingly demanded. Most of such requirements, including dimensional accuracy, conformance to tolerances of finished products and production rate can be met with better machine tools. With the help of CNC technology, machine tools today are not limited to human capabilities and are able to make ultra-precision products down to nano scales in a much faster manner [2]. The require for a G-code parser using an Arduino based microcontroller which is integrated part of the

system, is offline, a huge reduction in the cost price is achieved, as a

result making the system inexpensive for small scale industries and individuals [3]. Fabrication of CNC milling machine is used low-price milling cutter for the main spindle due to a low voltage supply and it is possible to use the tools of smaller dimension to machine materials like wood, aluminum and plastic materials. There are several advantages of using small machines to produce small sized objects. With a smaller machine size, space is saved. The energy required to operate the machine is reduced as well [4]. This paper focuses on how to build a small size CNC machine that is, fully functional, easy to maintain and inexpensive. The main components used to build the machine are stepper motors, controller board, stepper motor drivers, lead screws, motor shaft coulpings and limit switches

2. Methodology

The CNC machine is constructed in three stages: (a) build mechanical frame, (b) assemble electric system and

(c) install control and computing system. Mechanical system gets

necessary control signals from electronics system which ultimately results in desired actuation of motors. Electronics system gets command or a set of commands from software system and generates controls for mechanical system. The block diagram of the CNC machine system is shown in Fig.1.

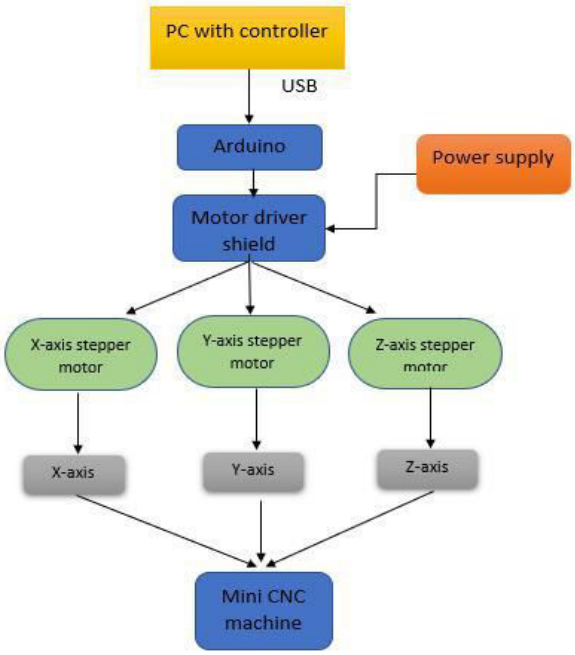

Fig 1 . Block diagram of CNC machine system

3. Structure Design:-

The modeling of the CNC machine was created using AutoCAD software. By calculating of the torque for required tast suitable stepper motor was selected and structure material used to build the prototype include machine mild steel plate 4 mm thick. Machine structure is the “backbone” of the machine tool. It integrates all machine components into a complete system. The machine structure is crucial to the performance of the machine tools since it is directly affecting the static and dynamic stiffness, as well as the damping response of the machine tool. A carefully designed structure can provide high stiffness, result in higher operation bandwidth and more precise operation. A small-scale machine tool generally

requires even higher stiffness than the ordinary large-scale machine tool since it is usually operated at higher speeds. This structure consumes less material, hence is very less expensive to build. The guide rods are selected to provide accurate motion for the machine, and are strong enough to support the weight of the machine table and all of the equipment mounted to it. The Z-axis guiding system will usually be smaller than the other two axes, because it only has to carry the weight of a small carriage and cutting tool.

Fig. 2. A model of CNC milling

3.1 Mechanical System

The mechanical system is assembled in such a way that the 3-axis movement is achieved by using the linear bearings and guide rods. Stepper motors are mounted to the each axis which is the source of motion acted according to the control signal generated from the electronics circuit. Each stepper motor is coupled to the screw rod which carries nut with the help of coupling bush. This screw rod and nut arrangement is responsible for converting the rotational motion of the stepper motor to linear motion. The linear motion of each axis is carried away smoothly by the linear bearing and guide rod assembly connected to the each axis which is capable of load carriers and allows linear motion in each axis. The controlled motion in each axis is achieved directly by controlling the rotation of the stepper motor. The speed of the motion in each axis can also be controlled by direct control of the speed of the stepper motor by giving required control signals. Thus the tool path of the spindle fixed to the end effector is controlled in each axis for smooth carving or cutting action of work piece.

Fig. 3. stepper motor

Fig 4 lead screw and nut

Fig 5 spindle motor

Linear rods are rigit strong steel shafts which are used to carry the load with out affecting the motion and supports linear movement. The load is carried away by the linear bearing and reduces friction slides over linear rods.

Fig. 6. Linear rail assembly (linear rods, linear bearings, end shafts)

3.2 Electrical System

Arduino uno r3 is selected to be the control unit in this project. The arduino uno is a microcontroller board based on

the ATmega328 chip. The microcontroller board is flashed with Gcode interpreter code which was written in the C language. The control board is responsible to generate the control signal for corresponding command signal from the computer to the stepper motors which is directly controls the motion of the tool path. Fig. 6. displays the functionally of the Arduino pins as used by GRBL. The driver called easydriver is used as the stepper motor driver. It receives steps signal from microcontroller and convert it into voltage electrical signals that run the motor.

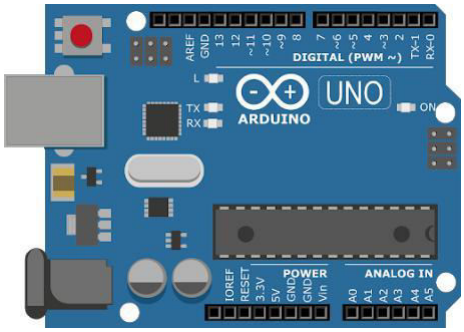

Fig 7. Arduino

3.3 GRBL Software

GRBL is opensource software that runs on Arduino Uno that taks G-code commands via Serial and truns the commands into motor signals. GRBL source code is added to Arduino library and Arduino IDE is used to flash GRBL directly to the Arduino board. Grbl Controller is software that is designed to send G-code to CNC machines, such as 3D milling machies. It just needs to give the user a nice way to get command down to whatever controller they are using. Grbl Contoller is written using the Qt crossplatform libraries. It also gets some help from the QextSerialPort library to simplify choosing the correct USB serial port.

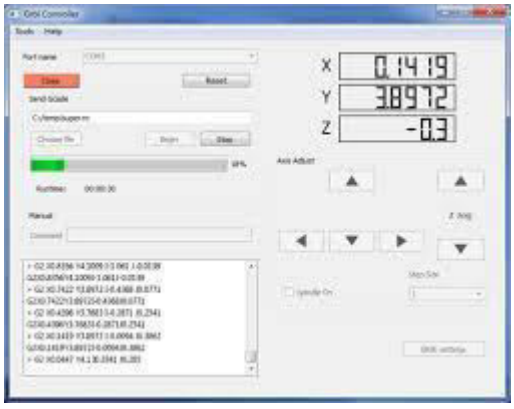

Fig 8. Grbl controller

4. Advantage & Disadvantage of Mini CNC machine

1) Advantages :-

1. Machining is accurate
2. Time taken to perform a job is very less
3. Safe to operate
4. Number of operators required to operate a machine are reduced
5. No possibility of human error
6. Reliable
7. Even very complex designs can also be made
8. Low maintenance required
9. They are versatile
10. Uniformity in designs
11. They could run for all 24 hours a day

2) Disadvantages:-

1. They are costly
2. Trained operator is required to operate the machine
3. In case of breakdown a highly skilled professional is required to solve the problem

5. Applications of Mini CNC machines

1. Metal removal industries
2. Material fabrication industries
3. For non-conventional machining industries where the machining task is difficult to perform manually

Conclusion

In this work, a small-scale 3 axis CNC milling machine was designed and fabricated with a low price. This proposed machine is easy to implement, inexpensive and comparable to the commericaly available machines. The components of CNC machine are selected to provide accuracy and simplicity within limited budget. The accuracy of the CNC machine body parts assembly has succeeded to achieve the objectives in precisely and repeatability goal. In future work, the Y-axis guideways of the machine are modifying to be able to machine more load of object and to increase machine rigidity. And aslo it is planned to do the stress analysis of the machine body stuructures.

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