Fabrication of Three Axis CNC Milling Machine

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Abstract:- CNC(computer Numerical Control) is the control and automation of machine using certain alphanumeric codes. Fabrication of 3-axis CNC milling machines based on A4988 driverboard which combined with spindle drill is being discussed through this paper. Cutting, Engraving and Marking on wood, acrylic and PCB objects can be done using this CNC machine. Command data code are generated and send to microcontroller using a Universal Gcode Sender.

Keywords:- CNC; Milling; Microcontroller; Audrino.

I. INTRODUCTION

A machine that is used for automatic control in the industrial world is the working principle of CNC. The performance of other machines can be controlled by using this machine. Both NC (Numerical Control) and CNC (Computer Numerical Control) is a term used to indicate that a manufacturing equipment like milling machines, lathes etc., numerically controlled based computer that can read the instruction code N, G, F,T, and others, where the codes will be instructed to CNC machines to work in accordance with a program that had been made to do work piece to be made, Operation using CNC machines, the accuracy of a product can be guaranteed up to 1/1000 mm (microns) workmanship mass product with exactly the same result at the right time of rapid machining.

Three axis CNC machines still have a place in modern day manufacturing. Whether or not a three axis CNC machine is the best option for business does rely on a number of reasons relating to the size of your production run, the work piece properties, accuracy and finish requirements, materials costs, stock holding capabilities, etc. Three axis CNC machines have simple and intricate parts that can be cut rapidly and precisely with a high quality tool path.

II. LITERATURE SURVEY

A. Computer Numerical Control (CNC) Milling and Turning for Machining Process in Xintai Indonesia.

Machine CNC (Computer Numerical Control) is a machine controlled by a computer with command data code numbers, letters and symbols, according to standard ISO. CNC Machine Tools systems work similar, then the CNC machine tools more accurate, more precise, more flexible and suitable for the production. Yang designed to support production and requires a high level of complexity and can reduce operator intervention during machine operation.

The operation on CNC machine tools is the process of cutting the work piece in the form of chisel instructed by computer numerical control CNC (Computer Numerical Control) to drive a chisel on a machine tool on the work piece, using the coordinate system of the CNC milling and turning machines, namely coordinate system with three axes, axes X, Y and Z axes X-axis is defined as a moving horizontal axis, Yaxis moving bersipat a transverse axis, and the Z-axis is a vertical axis that moves. [1]

B. Study on Computer Numerical Control (CNC) Machines.

The main objective of this paper is to "Study on Computer Numerical Control (CNC) machines for fabrication of rollers. Various processes like facing, turning, drilling, boring and knurling to improve production in order to increase the efficiency and to minimize the production time in conventional lathe and CNC machines are also being discussed in this paper. Production improvement can be done more effectively and efficiently in the study of CNC Machine. Operating CNC machine is by programming CNC. The only drawback of CNC lathe is its cost [2].

C. Implementation 3-Axis CNC Router for Small Scale Industry

This paper discusses the design and realization of complex 3-axis CNC machines based on microcontroller which combined with drill. Design picture that have been made on the PC sent to the microcontroller using serial communication then CNC perform execution on object according to point coordinates. [3].

D. Comparative Study of CNC Controllers used in CNC Milling Machine

The paper gave insights on different controllers used in CNC Milling Machine. Today the CNC are soft wired system that makes its flexibility for the different operations. Software control all the programming and function of the CNC machine. and the Computer is a basically responsible to generate signal i.e. supplied to the controller with the help of communication device or serial port for example the signal generated by the computer are 5V DC supplied to the controller and it communicate by the communication (DB25) or the serial port (DB9) and by this way it communicate with the controller hardware. It interprets a language such as G code into the signals. [4].

III. MECHANICAL DESIGN

The main tools in mechanical design consist of plywood board, stepper motor, torque pulleys, ball bearing, timing belt, leadscrew and nut, power supply and spindle drill.

IV. ELECTRICAL DESIGN

The electronic system used on 3 axis CNC machine was the power supply which used as a voltage source on personal computers and CNC machine. Personal computer was used as a device to run some software Universal Gcode Sender, and Arduino IDE, also to send design file to Arduino Uno microcontroller using serial communication. 12V 10A power supply was used as a voltage source for A4988 driver motor to run the 3 Nema 17 stepper motors which controlled by Arduino Uno microcontroller. 48V 10A power supply was used as a voltage source for spindle drill, the voltage that goes into the spindle drill was set using a motor controller. The 3 Nema 17 stepper motors will move the spindle drill in the direction of the X, Y and Z axes, so that the object can be formed in the plywood board according to the design.
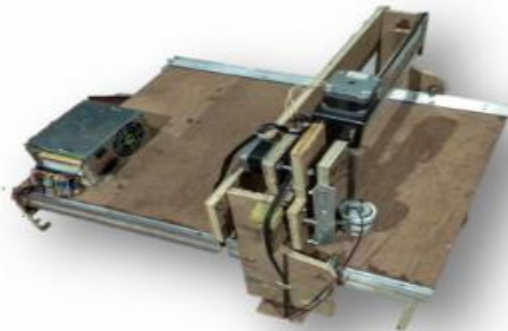

Fig 1:- Three Axis Milling Machine

V. CONSTRUCTION

The milling machine frame is made plywood. Table's slides over the sliding member called drawer. Tables made of ply wood material. Trimmer router attached on the vertical axis as shown in figure 1.The advantage of this type of construction is that there is good absorption of the cutting force and the weight of the work piece. High torque on the work spindle allows working without problems even in the lower speed ranges for example when machining materials, which are hard and difficult to cut. By means of modern electronically regulated drive technology extremely silent running can be achieved. Axis drive - strong, stepper motors, which via lead screw drive the axes in Z-axis and timing belt in X and Y-axis.

Steps of Construction;
1st step: Frame Work
2ndstep: Table Setting & Making Seating For Stepper Motor
3rdstep: Attachment of Hub & Bearing

4th Step: Fixing Stepper Motors & Lead Screws
5th Step: Setting Of Trimmer Router& Control Panel
6th Step: Wiring & Connection with System

VI. COMPONENTS OF CNC MILLING MACHINE

A. Stepper Motor
A stepper motor is an electro-mechanical device. It converts electrical pulses into discrete mechanical movements. When electrical command pulses are applied to it in the proper sequence the shaft or spindle of a stepper motor rotates indiscrete step increments. To the applied input pulses the motors rotation has several direct relationships. Direction of motor shafts rotation is directly depended on sequence of the applied electric pulses. Frequency of the input pulses determines the speed of the motor shaft rotation. Length of rotation is depended on number of input pulses given.
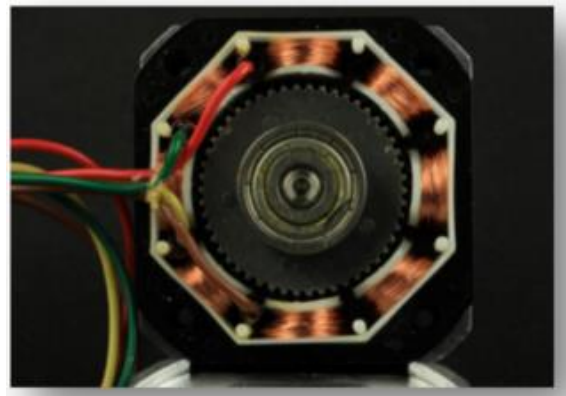

Fig 2:- Stepper Motor

These are DC motors which move in discrete steps. By energizing each winding certain position of rotor is achieved, by energizing the winding in a combination stepper motors can be rotated to desired angle. Since the current to stepper motor are given in pulse high precision and accuracy is attained. These are normally used open loop system in which there is no feedback taken. For this reason, stepper motors are the motor of choice formany precision motion control.

B. Coupling
Coupling is used to connect the shaft of stepper motor with lead screw. It is done by using key.

Fig 3:- Coupling

C. Lead Screw

Lead screw is used to either carry the load or for fastening purposes. A sequence threaded lead screw can carry heavy loads with minimal friction and no backlash. While a V threaded lead screw helps in fasting the system here we are using square headed lead screw since the trimmer is attached which needs to carry loads. Lubrication of lead screw is minimized by using modern materials. Lead screws are different from ball screws through the use of sliding instead of rolling, friction between the nut and screw. Without any external lubrication modern materials allow us to keep friction very low (less than 0.10).

Fig 4:- Lead Screw

D. Timing Belt

Fig 5:- Timing Belt

A timing belt is a toothed belt, where tooth are present inside surface of belt. Synchronization of cam shaft and crank shaft are achieved by timing belt; some engine instead use gears to directly drive the camshaft. Timing belt help the engine designers to keep the camshaft further away from the crank shaft which is a great advantage for engine with multiple crankshafts.

E. Trimmer Router

The end mill is attached in trimmer router. It proved a rotating effect to the end mill(cutter).Before Trimming, run the tool for about 10 seconds to ensure that all moving parts are running smoothly, and there are no loose parts, rattles, or sparking that would indicate damage. Be sure the bit is firmly and properly installed before use. Improperly installed bits may eject suddenly at high speed from the Trimmer, resulting in personal injury.

Fig 6:- Trimmer Router

F. A4988 Microcontroller

A4988 Microcontroller is an Arduino Board. This driver board has separate slots for connecting different stepper motor which controls each axis of the CNC machine. Command from software is received to this A4988 microcontroller and then it is transferred to each stepper motor connected to it. There are slots for coolant and spindle control in this driver board.

Some of the product features are;
- A4988 chip - High power, maximum 3.5A drive current chipset.
- Accuracy is high compared to normal driver board and operation carried out using A4988 is quite smooth.
- This board is equipped with overload safety, over- current safety and over-temperature safety. By these.
- safety devices computer and peripheral equipment are protected.
- Current can be varied on board which help is achieving desired power output.
- Full closed-type optical isolation to protect the user's computer and equipment.
- Output is limited to one source either spindle motors or coolant pump since the output voltage is less (maximum of 36V 7.5A).
- XYZ limit and emergency stopping is possible
- Signal is processed in two staged additional to super anti-jamming.
- Creep effect is eliminated by controlling motor through range which is achieved by Bipolar constant current chopper.
- Setting of limit and emergency stop is possible by 4 control inputs.
- Universal architecture - Supports most parallel software MACH3, KCAM4, EMC2 etc.
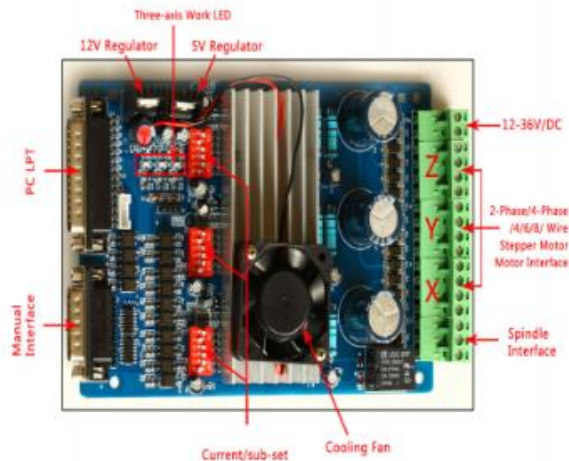
Fig 7:- A4988 Driver Board

VII.   CONCLUSION

The 3 Axis CNC Milling Machine is fabricated successfully using A4988 microcontroller along with 3 Nema 17 stepper motor and spindle drill. Later, real time test were conducted on different materials using various Gcodes by using Universal Gcode Sender and satisfactory results were obtained.

The CNC milling can be used for cutting, engraving and marking on plywood, foam board to form 2D and `3D objects. The process of synchronizing the 3 stepper motors was controlled using Universal Gcode Sender Software.

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