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Design and Fabrication of CNC Router

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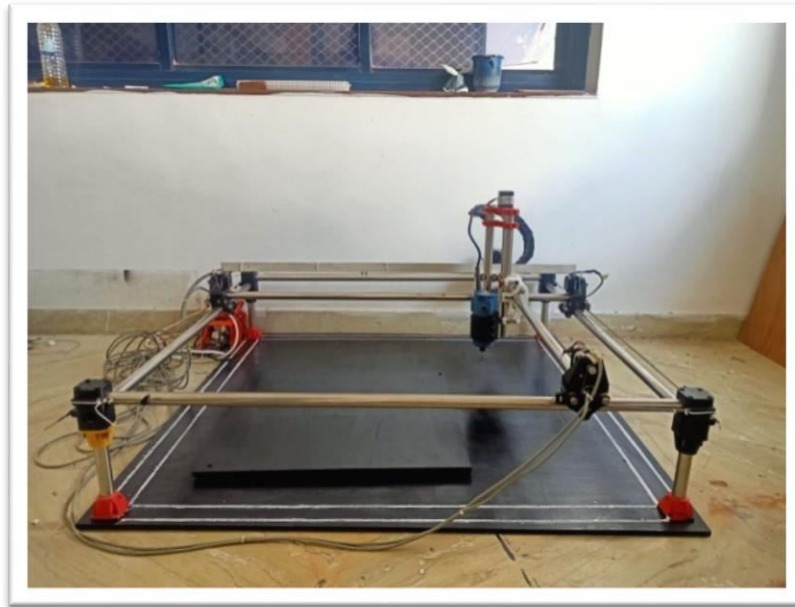
ABSTRACT: The purpose of this research was to designing and fabrication a CNC based router machine for wood, composites, etc. Computer Numerical Control machines (CNC) have extended progressive improvements within the manufacturing areas. within the past, accomplishing productivity up to the best level wasn't possible thanks to number of downsides like inconvenience of shapes and sizes, absence of skilled workers, a lot of wastages and scraps thanks to errors, quality levels and precision. the concept behind this research was to scale back the value and make it efficient. The router machine made is driven by the driving force of a stepper motor, with a 3-axis motion so the results of labour obtained are precise and homogeneous. The reason to create this machine is to scale back the complexity of the conventional CNC machine. During this project, designing and manufacturing a prototype CNC router will occur after reviewing the foremost famous previously existing models.

KEYWORDS: CNC ROUTER, CNC MACHINE, MACHINE DESIGN, MATERIALS, CAD CAM, CNC.

I. INTRODUCTION

CNC Router is computer-controlled machine which is used to cut different materials such as wood, metals, composites etc. it uses hand held router to cut these materials according to design provided by the user. The CNC grinder is very similar in concept to the CNC milling machine. Instead of navigating by hand, tool paths are controlled by controlling computer numbers. CNC Router is one of the many tools with various CNC tools. NC routers can produce a wide variety of precision custom components. Once organized, a single set of information can accomplish cutting-edge operations of three-dimensional objects. Such a simple operation that makes automation provide results in increasing production capacity, minimal waste, duplication, and safety. by using the CNC machine the productivity and efficiency of manufacturers has been increased significantly. Previous methods of routing cannot compete with CNC routers. Now a days it is the most dominant process for fabrication and manufacturing parts and components which are used for products and assembly of goods and it is also used to create one-offs. Material selection is substantial and diverse. Materials such as foams, plywood, fiberglass and plastic like polycarbonate, acrylic, HDPE, LDPE are used for CNC routing process.

Fig. 1: 4X4 CNC Router



II. METHODOLOGY

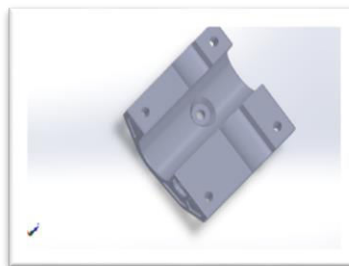
The process of making the CNC router machine is divided into two parts

2.1. DESIGN PHASE

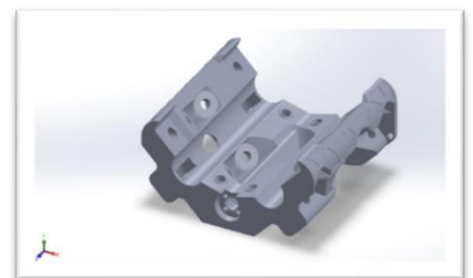
First, we have to select which type of CNC router you want to build like moving gantry or moving bed type. We have decided to make moving gantry type of CNC router. To make designing part relatively easy we decided to use rod as axis on which the gantry travels. We have 3d print parts specifically for the mounting of router and motor. The 3d printed parts we used to be given below.



a)



b)



c)

Fig. 2: a), b), c) 3D Printed Parts

The list of all the 3d printed we used is given below with their quantity respectively in form a table.

QTY	Part Name
	Corner
2	Corner Bottom
2	Corner Bottom Mirrored
2	Corner Top

2	Corner Top Mirrored
2	Lower Belt
2	Lower Belt Mirrored
2	Upper Belt
2	Upper Belt Mirrored
4	Corner Leg Lock
4	Feet
2	Wire Darryl
4	Stop Block (Dual only)
	Trucks
2	Truck
2	Truck Mirrored
4	Truck Clamp
	Z-Axis
1	Z Motor
1	Z Coupler
2	Nut Trap
1	Upper Tool Plate
1	Lower Tool Plate
	Center Assembly
2	Core Z Clamp 1
2	Core Z Clamp 2
3	Core Clamp
1	Core Clamp Y
1	Core

Table 1: List of all the 3d printed parts

CNC Router Components

- CNC controller and Display Module: -Controller is the brain of the machine. Other side display module is key element, and it is used to set program to run the machine. A CNC Router's Controller is the electronics device that is used for executing a g-code programming and sending the necessary electrical signals to the motors for movement and cut the desired shape and size.
- Stepper Motor and servo motor: - Stepper motor moves step by step in each pulse. Other side Servo motor use feedback to control the motors position.
- Stepper motor drivers: - Used for the stepper motor functioning.
- Lead screw nut: - It is used to convert the rotational motion of the stepper motor to linear motion
- Back lash nut: -Used in the assembly of leadscrew.
- Gt timing pulley: -Used to convert the motion from stepper motor to belt which in turn moves the machine.
- Gt timing belt: -Used to move the axis assembly.
- Coupler: -Used in lead screw assembly.
- 3d printed parts: -Used to make the assembly light.
- Guide rails: -Used as an axis on which the machine moves.
- Collet: -It is used to hold the tool.
- Mechanical end stops: - Give signal to stepper motor to stop as it has reached the end point.
- Cables: -Used for power transmission.
- Controller board: -Used to control the machine and its functioning.
- Connector & pins: -Used to connect circuits.
- Solid state relay: -Used to convert the input power.

- q) Router: -It is a CNC component which is used to cut and shape the material.
- r) Lead screw: - It is a mechanical component which is transfer rotational motion into linear motion.
- s) Spindle: -It is the mechanical component which used to rotate the axis of the machine.
- t) Cutting Tool: - It is removing the material from metal, wood etc. and help to better finishing.

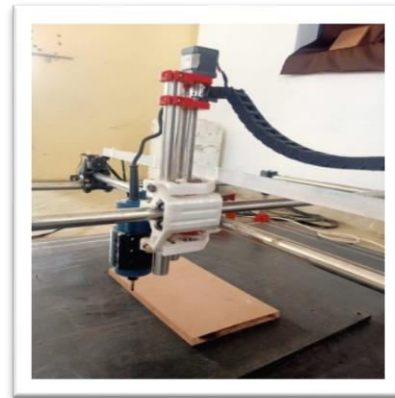
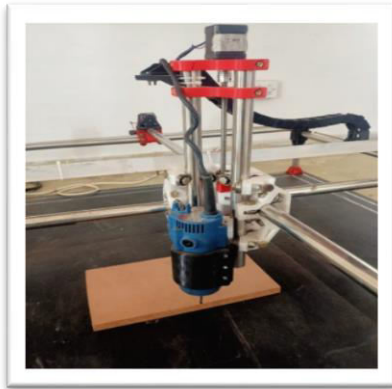


Fig. 3: Cutting Tool

2.2. Fabrication phase

This phase starts by procuring all the necessary parts required to make the CNC router. After procuring the parts we assembled the CNC router as per the instructions. The workflow of the CNC router is given below in the flowchart.

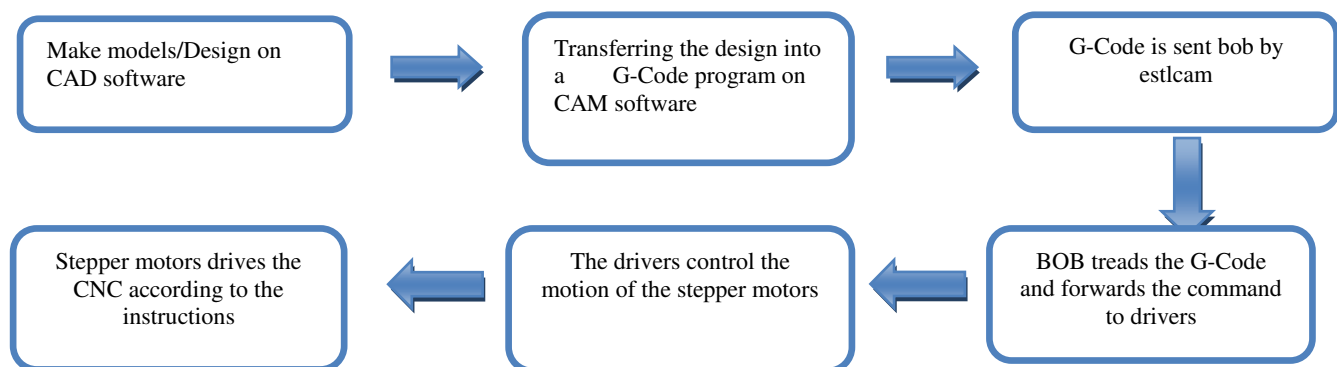


Fig. 4: flow of command

III.RESULTS

3.1. CNC ROUTER

CNC Router is precise machine. It has 3 axis which can move using stepper motor. X and Y is moving direction and Z axis is moves for cutting. It is moves up and down. The working process of CNC router is simple and easy. First, we draw a design which we want. Design can be draw using much software like AutoCAD, Solid works, Fusion360 and many more. This file will save in .DXF file format. After that we convert this file in CNC machine language. For converting file, we use universal g-code, Mech3, Estlcam and other more software we can use. Then this file put into memory card. Then memory card inserts in display module of CNC router. Before starting the machine, work piece is set to the bed and fitted with screw. After that start the power supply and run the program which we inset. Machine automatically work and we get desired shape and size. When machine is working then we can do other works.

Fig. 5: Jobs which is made by CNC Router



3.2. MACHINE TEST

The test is done on the machine to determine and analysis the working of CNC Router that we have built. The test has been done different types of wood and different shapes have been drawn to find the accuracy and precision of the CNC router. The test result is shown in the table 2 below

Test	Design			Measurement		
	X (mm)	Y (mm)	Z (mm)	X (mm)	Y (mm)	Z (mm)
1	40	30	8	40.3	30.1	8.2
2	35	35	8	35.1	35.2	8.1
3	20	10	5	20	10.3	5.1
4	22	22	10	22.3	22.1	10.1

Table 2: result of the CNC Router

from the test result, the measurement of wood piece shows a good accuracy. The Xaxis accuracy about 0.11 mm, the Yaxis accuracy about 0.18 mm and the Zaxis accuracy about 0.32 mm. The average accuracy of the machines is around 99.5 % for X axis, 99.6 % for Y axis and 96% for Z axis as shown in Figure 10.



a)



b)



c)

Fig.6: finished products

IV. CONCLUSION

In This research, a medium size of router machine has been built. The router machines that have been build was controlled by CNC program using EstlCAM for the software. The structure of CNC machine is built with low-budget material with good quality. Experiment test result of the machine shown a good accuracy of the machine, where the average accuracy is about 99.5 % for X and Y axis and 96% for Z axis. It can be concluded that the development of a router machine with CNC programs can be used for cutting wood and engraving.

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