



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 6, June 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118



9940 572 462



6381 907 438



ijirset@gmail.com



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Design Differences between CNC Router and CNC Milling Machine

Md.Zuber Khan ¹, Puran Jat ², Kanhaiya Lal Mali ³, Pushpendra Singh Rajawat ⁴, Akashay Sharma ⁵,

Associate Professor, Department of Mechanical Engineering, Geetanjali Institute of Technical Studies, Udaipur ,
Rajasthan, India¹

Student, Department of Mechanical Engineering, Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, India²

Student, Department of Mechanical Engineering, Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, India³

Student, Department of Mechanical Engineering, Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, India⁴

Student, Department of Mechanical Engineering, Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, India⁵

ABSTRACT: The purpose of this exploration was to designing and fabrication a Computer Numerical Control (CNC) grounded router machine for wood drawing machine. The idea behind this exploration was to help the traditional forestland craft men to make a craft more productive and more effective. The router machine that's made is driven by the motorist in the form of a stepper motor, with a 3 axis stir so that the results of wood drawing attained are perfection and homogeneous. G- law program used on CAM processing uses ESTALCAM software. The workspace of the machine was 1000 mm x 800 mm. The test result showed that the machine delicacy is about 97.5 percent for X and Y axis and 94 percent for Z axis.

KEYWORDS: programming, CAM, CNC mill machine, tool

I. INTRODUCTION

Currently, the processes of manufacturing wood crafts still use the machine with man-made operation. This manually product requires further time and energy, thereby reducing the productivity and profitability of wood tradesmen. Computer Numerical Control (CNC) is the robotization of machine tools that are operated by a computer controlled programs to perform a asked product shape. Design and developement of mill machine using CNC has been done with ATMEGA 328 micro regulators in an Arduino. The test result showed that the milling machine can be used in wood, aluminium with delicacy 0.02 mm. Design of a CNC prototype machine was designed, with three Cartesian axes, with 600 mm of length both X and Y axes and 100 mm of length Z axis. The software use Lab ESTALCAM. Colorful processes like facing, turning, parting, drilling, boring and knurling to enhance product in order to drop the product time and also to increase the effectiveness in conventional lathe and CNC machines by writing the program on HMT STC-25 CNC lathe. A mechanical prototype of a CNC Router which is suitable to draw a PCB layout and wood drawing has been make. The other exploration of the design, perpetration and performance test of CNC has also been done by numerous experimenters using different software. Exploration about delicacy of CNC feed has been done. Low cost CNC machine for Artificial operation and also for drawing machine has been design and fabricate. The designed system is stoner-friendly bone which give accurate results and also flexible to druggies. Perpetration 3-Axis CNC Router for Small Scale Industry and CAM courses has been done. Both of them uses stepper motor and the results showed a good delicacy.

II. RELATED WORK

1.1 Design CNC Router vs CNC Mill

Still both are computer-numerically controlled machine, there are some pivotal differences that separate both. CNC routers are generally large in terms of the trimming area, have a gantry style design, and are substantially used for grinding non- material (Wood, PCB, plywood, etc.) and non-ferrous material. CNC Mills have a small trimming area, C- frame style design, and are primarily used for milling material (steel, titanium, aluminum).

CNC routers vary greatly in phrases of the frame fabric used. The material could be something from plywood, plastic, aluminum, and metal. Generally, the harder the frame material, the better the overall hardness of the machine. Still, it costs further to have a steel frame rather of a plywood frame.

.Generally CNC routers have a gantry style design, with a gantry that moves along the Y- axis, and the Spindle moves in the X- direction on the gantry. The frame of the gantry in a CNC router desires to be mild enough to be driven by using the stepper motors that drive them

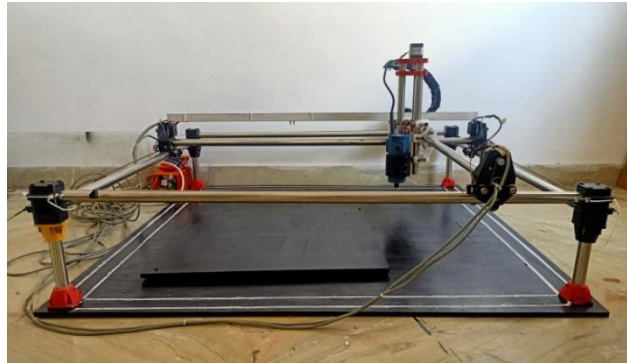


Fig.1 Frame Of CNC Router

CNC Milling machines are tons extra stocky and heavy in basic compared to CNC routers. Budget CNC mills which includes Sherline and Taig CNC mills are manufactured from steel and aluminum. When you pass beyond the price range ones, CNC mills are made from both cast iron or metal making them extraordinarily heavy and rigid. For contrast, an access-stage CNC mill just like the Tormach PCNC1100 weighs 1500 lbs, while a CNC router like Shapeoko 4 XXL weighs only 165 lbs.

Further to the overall weight difference, CNC mills are smaller in footprint with the load majorly concentrated in a small region. This mass gives pressure to CNC mills which is essential to dampen vibrations while milling tough metals. A drawback of this heavy weight is that you frequently need an engine hoist to gather a CNC Mill.

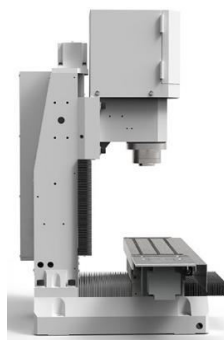


Fig.2 Frame of PCNC 440 CNC mill

The body additionally consists of a column to aid different device components together with oil reservoir, arbor assist, and worktable. Industrial CNC mills may be horizontal mills or vertical mills. A vertical milling machine uses an extended and thin cutting tool, which plays numerous milling operations and machining techniques along with drilling, boring, and tapping.

Design CNC Router vs Mill		
	CNC Router	CNC Mill
Design	Gentry style	C-Frame/Bridgeport style
Frame	Plastic, Plywood, Aluminum, Steel	Aluminum, Cast Iron, Steel

1.2 Cutting Area

It is one of the huge difference among a CNC router and a CNC mill. CNC Routers have a extensive range in terms of the cutting area while CNC mills have a much smaller constrained work place. As CNC routers are used to mill wood, MDF, plywood, and aluminum sheets, they want a massive cutting place and massive slicing beds.

The most important CNC routers utilized by Small businesses are normally 5x10 CNC Routers like the AVID CNC PRO60120. Even large ones exist (which includes Biesse CNC routers), however those are used in wood processing factories.

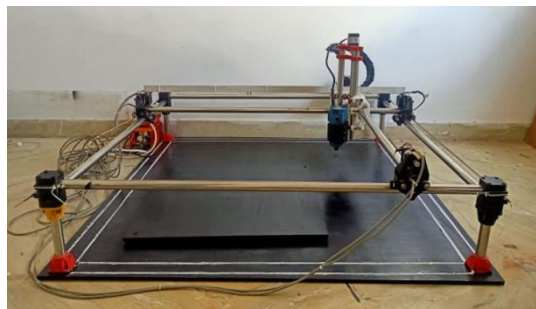


Fig.3 Cutting Area of CNC Router

CNC mills have a whole lot much less slicing region compared to CNC routers. However it truly is via design, as CNC mills usually work on thick metal inventory (like steel and Titanium). The smaller travel also aids well in the normal rigidity of CNC mills.

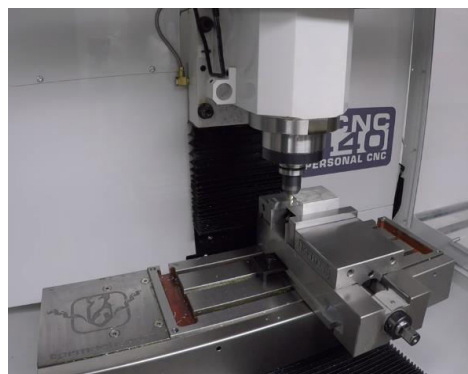


Fig.4 Tormach PCNC Cutting Area

Hobby CNC mills which include the Sherline 12" CNC mill have only 8.65" x 5" tour, that is minuscule in comparison to CNC routers. entry-stage professional CNC mills like the Tormach PCNC 440 gives you 10" x 6.25" of tour, which is not a whole lot better than the Sherline CNC mill. Even in the Haas VF1 CNC mill, which charges upwards of \$50k, you handiest get a tour of 20" x 16". Usual, in case you need to work on large workpieces along with wood boards, MDF sheets, and aluminum sheets, a CNC router is what you want. If you want to work on thick metal stocks with a small region, a CNC mill is what you want.

1.3 Z-Axis Travel

Some other ordinary difference is the Z-axis tour on each machines. Routers are used for jobs that do not require very deep cuts and generally have a Z-axis travel ranging among 2 inches to 12 inches.

Alternatively, a CNC mill may have a large Z-axis travel and is suitable for making deep pockets or drilling holes.

CNC routers are designed to cut huge and thin sheet stocks. Therefore, they have got huge X and Y-axis tour and low Z-axis height to optimize for rigidity.

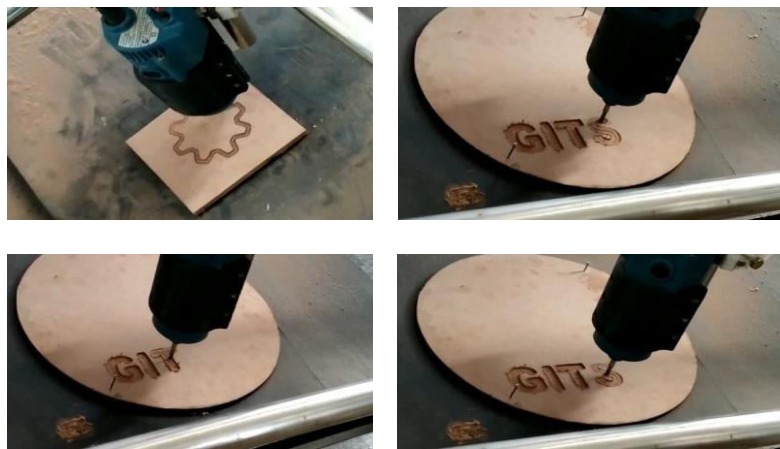


Fig.5 Wood engraving using CNC Router

1.4 Spindle/Router

CNC Routers are designed for cutting soft materials like wooden, plastic and soft metals like aluminum and brass therefore they use a high-velocity spindle/router which allows them to reduce those materials optimally.

The RPMs in a CNC router can range in the middle 10,000 to 30,000 RPM and mainly these spindles/routers use a single phase a hundred and ten V 15 A deliver that permits you to plug them directly into your wall socket.

CNC routers, as their name indicates, can have either CNC spindles or customer-grade routers along with the Makita RT0701C at the slicing stop.

CNC mills are durable machines and always use spindles and never routers.

They usually run at low RPM with excessive torque, which permits them to cut tensile materials, which include ferrous metals.

The RPMs in a CNC mill can range in the middle 1,000 to 15,000 RPM.

The spindles in CNC mills come in numerous force mechanisms like direct drive, belt drive, and gear drive and are designed to function for extended intervals without breakdown.

Maximum CNC milling machines require a three-phase energy supply. That is to give enough current to the motors to generate enough torque. But, there are CNC routers that use a three-phase supply, however they're normally used for bulk production and have ATC spindles.

1.5 Material Capability

One more important distinction between a CNC router and a CNC mill is the substances that they can work on. In case your project demands operating on noticeably soft materials like wood, plywood, plastic, HDPE, acrylic, MDF, and aluminum sheets, a CNC router is needed. At the minimum as long as the workpiece thickness is within the limits of a CNC router.

Generally, CNC routers are not used for milling ferrous metals like steel, and cast iron. but, there are exceptions right here. It is feasible to mill metallic on accurate CNC routers if you use the proper settings. but it's not their number one activity, and it is risky to push CNC routers to mill metallic. you also can't assume to get the tolerance you want with metallic when you mill on a CNC router. CNC mills are built for heavy-duty metal machining jobs and excel in cutting hard materials like thick aluminum, steel, and even titanium.



Fig.6 Titanium cutting using PCNC 440 CNC mill

At the same time as all CNC mills can work on steel, their pace and performance range significantly with rate. Price range benchtop CNC mills including the Sherline CNC mill can be quite slow when operating on metal. An high priced \$50k CNC mill will battle through metallic like a hot knife on butter. A CNC mill can be used to mill wood, however, it is not recommended as wood dust often clogs up machine approaches and tools. Additionally milling wood causes heat build-up and consequences in bad finishing when milled at low RPMs standard in CNC mills.

1.6 Coolant

From start to finish of CNC metal machining, the workpiece can get heated. Consequently, it's far required to keep the cutting tool cool if you perform it for lengthy durations. CNC routers use a excessive-speed cutting tool to cut extraordinarily soft materials and typically don't require coolant. CNC mills work on tough metals and this produces plenty of warmth. hence, normally you need to apply a coolant while the use of a CNC milling machine.

1.7 Linear motion

CNC router and CNC mill have fundamentally exceptional configurations for linear axis movement. commonly, in a CNC router, the router/spindle movements across the workpiece, and the workbed stays static throughout the whole cutting procedure. However there are exceptions like Genmitsu 3018 PROVer in which the Y-axis movement is achieved through shifting the workbed. CNC routers are to be had in various alternatives in phrases of linear motion components. you could pick from belt drives, lead screw, ball screw, and rack and pinion to operate the axes. For motion guides, you get to select from V-wheels, linear bearings, and linear rails.

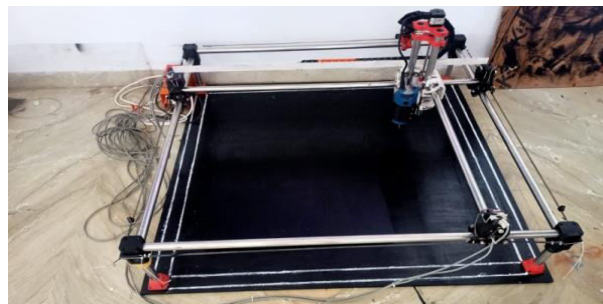


Fig.7 Timing Belt for linear motion on CNC Router

Because of their large tour, CNC routers need to move speedy to be effective. This makes it best to apply speedy movement systems including belts and rack and pinion drives in CNC routers. usually, CNC routers are available with 3-axis motion. but, you can locate 4, five, and 6-axes routers for complicated initiatives. for instance, a CNC router with a rotary axis helps to do CNC wood turning.

In a CNC mill, the spindle remains in place while the workpiece that's fixed to the workbed is moved in the X and Y-axis, The spindle normally moves most effective within the Z-axis (up or down). CNC mills use linear rails, bearings, and bearing carriages for precise linear motion. for directing the axes dovetail slides are usually utilized in price range CNC mills as they offer higher rigidity than rolling guides.



Fig.8 Ball screw for workbed movement in CNC mill

CNC mills are classified into horizontal and vertical CNC mills. Horizontal CNC mills may be divided into ordinary horizontal and conventional milling machines. Vertical CNC mills may be divided into turret and bed milling machines. The workbed of a ordinary horizontal CNC mill has longitudinal, cross, and vertical movements, permitting it to have better chip elimination and surface finishing. Further to the longitudinal, cross, and vertical movements, the workbed of a conventional milling machine has extra horizontal swivel movement, which facilitates to supply spur, spiral bevel gears, and twist drills. The workbed of a turret vertical milling system movements parallel and perpendicular to the spindle axis. It makes turret mills versatile for exact work including creating parts for plaques and toys.

1.8 Stepper Motors

Generally, CNC routers and CNC mills run on stepper motors, that have an open-loop control and provide high torque to drive linear motion components.

Industry-grade CNC routers and CNC mills run on servo motors, which have closed-loop manage that gives comments to the computer device. In general, stepper motors in CNC mills are a whole lot greater effective with NEMA 34 motors with excessive torque (>a thousand) used for the Z-axis in mills.

1.9 Accuracy

Considering the fact that CNC routers work on non-metals, their accuracy/tolerance is less as compared to CNC mills. The exactness in terms of dimensions is much less an problem while making furniture, at the same time as a machine spare made of metallic needs to be relatively accurate to fit efficiently. CNC routers require less time to cut workpieces, consequently offer rapid manufacturing. However this sort of speedy pace does not produce correct cuts on metals.

CNC mills are much more precise and are used to make metallic elements for medical, military, and industrial applications and for prototype introduction. Despite the fact that CNC mills take more time to finish the activity, they're appropriate to make delicate and complex cuts and accurate cuts within 1,000th of an inch (ordinary accuracy).

1.10 Cost- CNC Router vs CNC Mill

As you in all likelihood realize, there is a huge range inside the rate of CNC routers and mills. However, CNC routers begin at \$200 for computer engravers and pass up to \$25,000 for industrial CNC routers (Shopbot, CAMaster). There are extra high-priced CNC routers, however those aren't very common. numerous CNC brands provide CNC routers for

underneath \$5,000 (Inventables, Carbide 3D, Onefinity). CNC mills arise at around \$3000 for hobby benchtop mills (Sherline, Taig, Proxxon) and get costly pretty fast as you cross up in price. When you go past hobby CNC mills, you've got Tormach CNC mills costing between \$10k-\$20k.

Thereafter, you have industrial CNC milling machines costing greater than \$30k (Haas, Doosan, DMG), as a consequence hobby-grade/budget CNC mills are few and a long way between. But it is anticipated as metal milling is a lot greater hard in comparison to milling wood.

III. RESULTS AND DISCUSSION

CNC routers are in particular designed for large workpieces, often cut fairly softer materials. They have got large gantry-style construction, which makes them less rigid as compared to CNC mills.

While CNC routers excel with wood, plastic, foam, or even aluminum, their much less rigidity makes them unreliable for hard metals. In case you need to work on thick metallic stocks (steel, titanium, and aluminum) with a small footprint, then a CNC milling machine is required. But, if you want to mill aluminum sheets, then a CNC router is required.

IV. CONCLUSIONS

In This research, a medium length of router machine for wood engraving has been build. CNC routers are usually worked higher speeds, and the CNC mills are slower. CNC mills use pressure to make cuts, and CNC router has less pressure, it makes use of rotational speed to drive the power. CNC Milling Machines offer the technology, precision, accuracy, and constant flow of processes for a high manufacturing price. They have the features that make them speedy, with low to zero human errors. you may save time and money and reduce the chance of wastage of materials.

ACKNOWLEDGEMENT

We would like to acknowledge the Head of Department of Mechanical Engineering, Mr. Deepak Paliwal and Mr. Zuber Khan (Advisor), Geetanjali Institute of Technical Studies, Udaipur for helping in this research. We also like to thanks full to the research team of Mechanical Engineering Department, Geetanjali Institute of Technical Studies, Udaipur.

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