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Arduino CNC Hot Wire Cutter

Prof. J.B.Mule[1], Rohan Ramesh Ukirade[2], Manish Santosh Hingmire[3], Kishor Navnath Patil[4]
Mechanical 'SPVP'S' S.B. Patil College of Engineering Indapur, India

Abstract: In this project, it is intended to make the mechanical design of 3 axis Computer Numerical Control (CNC) router with linear joints, production of electronic control interface cards and drivers and manufacturing of CNC router system which is a combination of mechanics and electronics. At the same time, interface program has been prepared to control router via USB. The router was developed for educational purpose. Design and Development of portable 3-Axis CNC router machine based on microcontroller which was used to reduce cost and complexity of the bulky sized engraving machine. This machine can be used for engraving, cutting, reaming, marking, drilling and milling on wood, acrylic, and PCB materials. Part programming of the required component to be manufactured was done with the help of image processing.

I. INTRODUCTION

In manufacturing industries various types of painting machines are used for painting profile of different shape. With increased competition and demand it is become necessary to use advance painting techniques. These techniques help in reduction in painting time and also reduce the manufacturing cost. Such techniques adopt NC, CNC machines, but cost of such machine is also high. In these machines manual interference is considerably less. Therefore, chances of mistakes and errors are reduced. Due to elimination of manual activity, unproductive time is minimized. With this point of view an attempt is made to design and develop a machine which reduces the production time and enhance the accuracy of work. The user interface anticipates the needs of the system's users, and to make the necessary functions accessible and understandable. From this point of view, two kinds of use were accommodated..The second was seen as addressing the needs of designers of parts or objects. The ability of designers to have a software path of access to the operation of fabrication equipment is the essence of intelligent, integrated manufacturing.

II. LITERATURE

Based primarily on the nature of the machine tool design practice, requirements for the knowledge- centric frame-work with integration of process and knowledge are analyzed in consideration of the design objects, the (Deactivation and Decommissioning) D&D process, the knowledge-centric demand and its implementing and monitoring demand. Then, the framework of knowledge-centric CNC machine tool D&D process management used in the CNC machine tool industry is proposed, which includes the modelling, simulation and its executionand takes the knowledge into consideration. The design process of KVC1050N Vertical machining centre is also studied as an example to demonstrate the feasibility and availability of the proposed framework. The results of this study significantly contribute to efforts to achieve knowledge and process integration in CNC machine tool D&D. In a word, ongoing efforts are being taken to make the framework more practical in the industrial application.

1) S.K .Dhinesh et.al. (2021) - The Foam Cutting Machine Utilized In To Develop Prototypes For Clear Vision. In Their Model This Improvement Is Executed Through CAD/CAM Software, So It Will Increase The Demand For Personalization Has Made The Rapid Prototyping Companies Develop In Recent Decades. Rapid Prototyping Technology Is Persevering With To Enhance In Speed And Accuracy, The Cap Potential To Deliver > 1 M. The Foam Cutting Process Uses Experimental Cutting Trials And Finite Element Analysis. The Cutting Pressure Speed, Wire Temperature And Kerf Width Were Measured. This Study Is Executed To Discover The Distinction And Reliance Of Cutting Boundaries. Foam Cutting, Rapid Prototyping And Production Machines Are Quite Used Because Of Their Excessive Velocity, Massive Operating Volumes And Low Price In Preliminary Investment. The Effects Of This Study Resource To Enhance The Recent Twine Foam Reduction Through Fixing The Constraints And Disadvantages To Choosing High-Quality Reducing Parameters Of The Computer Numerically Controlled Gadget. The Essential Matters For The Aerodynamic Studies For Cutting Foam For Some Mm Thickness. Research Is Suggested By Selecting the Cutting Parameter Function Curves Of Various Foam Types

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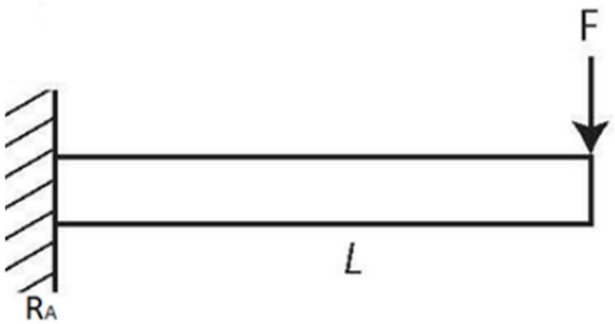
2) Arpan Sherpa et.al. (2022)- CNC is a versatile machine which typically used for cutting, drilling, and milling. CNC router can perform a task of much PCB designing and carpentry Interior and exterior decoration like wood panel, sign board, wooden frame ,musical instruments. A CNC router is very similar to the NC machine Instead of routing by hand tolls path are controlled via computer. NC has less flexibility and so it does not work accurately. The time period is also less than CNC machine for better and huge manufacturing it uses is very rarely.
3) Ganesh Kumar et.al.(2021)- This project proposes the technique used to develop a Computer Numeric Controlled Laser Engraver. The specialty of this machine is the user can modification the tool simply whenever he/she desires to perform several operations like an engraving object (Materials — Acrylic, MDF board, Foam sheets, etc.,) and conjointly turn out a 2D drawing for specific object in A5 size sheet. laser engraver responds to G Codes which can be generated by the software. Frame of the machine and the working of the components will be based on the Cartesian type. It is a commercially viable and cost- effective machine.
4) V. K. Pabolu et al. [2] discuss the design and implementation of low cost three dimensional computerized numerical control system (CNC) for industrial application. In this paper prototyping an Embedded CNC machine was created. Detail description of different modules such as software development, Electronic/Electrical development along with technical details of their implementation has been given in the published paper.
5) J. B. Jayachandraiah et al [3] provide the idea to develop the low cost Router system which is capable of 3 axis imultaneous interpolated. The low cost is prototyping is achieved by incorporating the features of standard PC interface with microcontroller base CNC system in an Arduino based embedded system. With limited budget the author conclude that small machine tools to fabricate small parts can provide flexibility and efficiency in manufacturing approach and reduce the capital cost, which is beneficial for small business owners

III. OBJECTIVE OF PROJECT

The following objectives will be explored to develop a simple and cost effective Arduino Based Router.
1) To minimize and simplify the operation and maintenance of the Router.
2) To optimize the CNC Control System as well as CNC programming for getting high level accuracy.
3) To investigatetheefficiencyandaccuracycomparedtotheconventional Router

IV. MATERIALS AND METHODS

1 Design of drive shaft. Considered capacity = 15 kg per 10 min
To avoid misalignment and proper cutting we have considered 30rpm speed of motor. Selection of motor
The load required to lift weight is considered = 15 kg = 150N Diameter of coupling D = 100mm So Maximum Torque T = Effort x Radius of wheel
Total torque on sprocket shaft = 150 x 50 = 7500 N-mm We know
$P=2\pi*N*T/60$ P = 23.56 watt
By considering application and extra jerk and safe design prime mover power considered =60 watt



P = Load due to seed carrier
T = Max Torque generated due to sprocket wheel. = 7500 N-mm RA = Support reactions. Motor speed
N =30 rpm For speed reduction the worm and worm gear is used. As per Design data book shaft material is selected Carbon steel C40
σ = 145 N/mm2 As per ASME code

$C40 \Rightarrow Sut = 580\ N/mm^2 \quad Yield = 435\ N/mm^2$

0.3 X Yield strength N/mm2
0.18 X ultimate strength N/mm2} whichever is smaller
0.3 x 330 = 99 N/mm2 ..... (a)
0.18 x 580 = 104 N/mm2 ..... (b)
From equation (a) & (b) Allowable stress value will be 99 N/mm2 If key ways will provide to shaft then
τ = 99 x 0.75 = 74.25 N/mm2
Max torsional moment equation is given by

we know,

$$T_e = \frac{\pi}{16} d^3 \tau$$

Where T = 7500 N-mm
By using above equation drive shaft diameter d = 8.02 mm ..... A
We know that, Max bending moment equation is given by

$$M = \frac{\pi}{32} d^3 \sigma$$

P = 150 N
The sprocket diameter D = 150mm
$\Sigma FY = 0$
RA + RB = P RA=150.....
We know that,
Max bending moment equation is given by
we know,

$$M = \frac{\pi}{32} d^3 \sigma$$

According to maximum shear stress theory Stepper Motor Belts and Pulleys calculation Steps per Revolution
The stepper motor will play a factor in the above equation. This will depend on the type of stepper motor you select. Some motors can be odd, and move in different amounts for each step. This equation is helpful in determining how many steps your stepper motor requires to move one full revolution. Typical stepper motors are 1.8 degrees per step, which is 200 steps per revolution.

$$\frac{\frac{360\ Degree}{1\ Revolution}}{\frac{Degree}{Step}} = \frac{Step}{Revolution}$$

Example 1: Some stepper motors are able to move in very small increments. In this example, it moves 0.9 degrees per step or 400 steps per revolution.

$$\frac{\frac{360\ Degree}{1\ Revolution}}{0.9\ \frac{Degree}{Step}} = 400\ \frac{Step}{Revolution}$$

Example 2: Most stepper motors, including the ones we sell, move 1.8 degrees per step, or 200 steps per revolution.

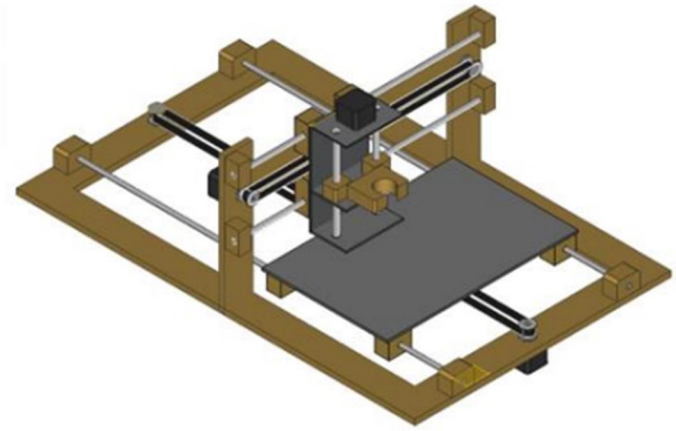
$$\frac{\frac{360\ Degree}{1\ Revolution}}{1.8\ \frac{Degree}{Step}} = 200\ \frac{Step}{Revolution}$$

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Calculation with our hardware 200 steps = 1 revolution
1 revolution=360 degrees
1 step =1.8 degrees
10:1 ratio of stepper motor to timing pulley 200 steps length = pitch of belt x teeth of pulley 200 step = 1 revolution
So 1 revolution= 40mm 360 degree=40 mm
1.8 degree=40/200
1.8 degree is 1 step
so 1 STEP=.02mm

NEMA 17 Stepper Motor torque calculation
Step angle: 1.8°
Holding torque 4.2 kg/cm GT2 pulley (20 teeth)
Pulley Bore Diameter (mm) 5 Pulley Pitch (mm) 2
No. of teeth 20

Pulley Outer Diameter 12.22 mm Belt Pitch 2 mm (GT2).
Maximum torque handle with timing pulley Holding torque/Pulley Outer Diameter Holding torque= 4.2 kg/cm
Outer Diameter=12.22 mm Outer Diameter=1.222cm Torque Pulley =4.2/1.222



The assembly of chain and motor alignment for X-axis-axis and Z-axis movement. The Motor is used in this mechanism is PMDC, The motor we can operate forward and reverse and so that by changing the direction of rotation as per our requirement we can able to operate the spray gun and its movement.

V. RESULT

Design	Measurement	Time
Circle	Diameter 50 mm	145sec
Triangle	40*40* 50 mm	164 c

VI. CONCLUSION

CNC machine engineering is a highly complex science. It involves physics, electronics, pneumatics, mathematics and a bunch of other disciplines. There is no scientifically proven best way to design a CNC machine. Every decision, every component is a compromise. In no area of machine design can we gain something without giving up something else. In this paper we have used concept of low cost in CNC Router machine, which is easily control with computer and suddenly stop and paused by click action on computer. By using this we have make Difficult and Complex Design in paper. This is small machine which is easily transportable and assembled everywhere on Requirement of it.

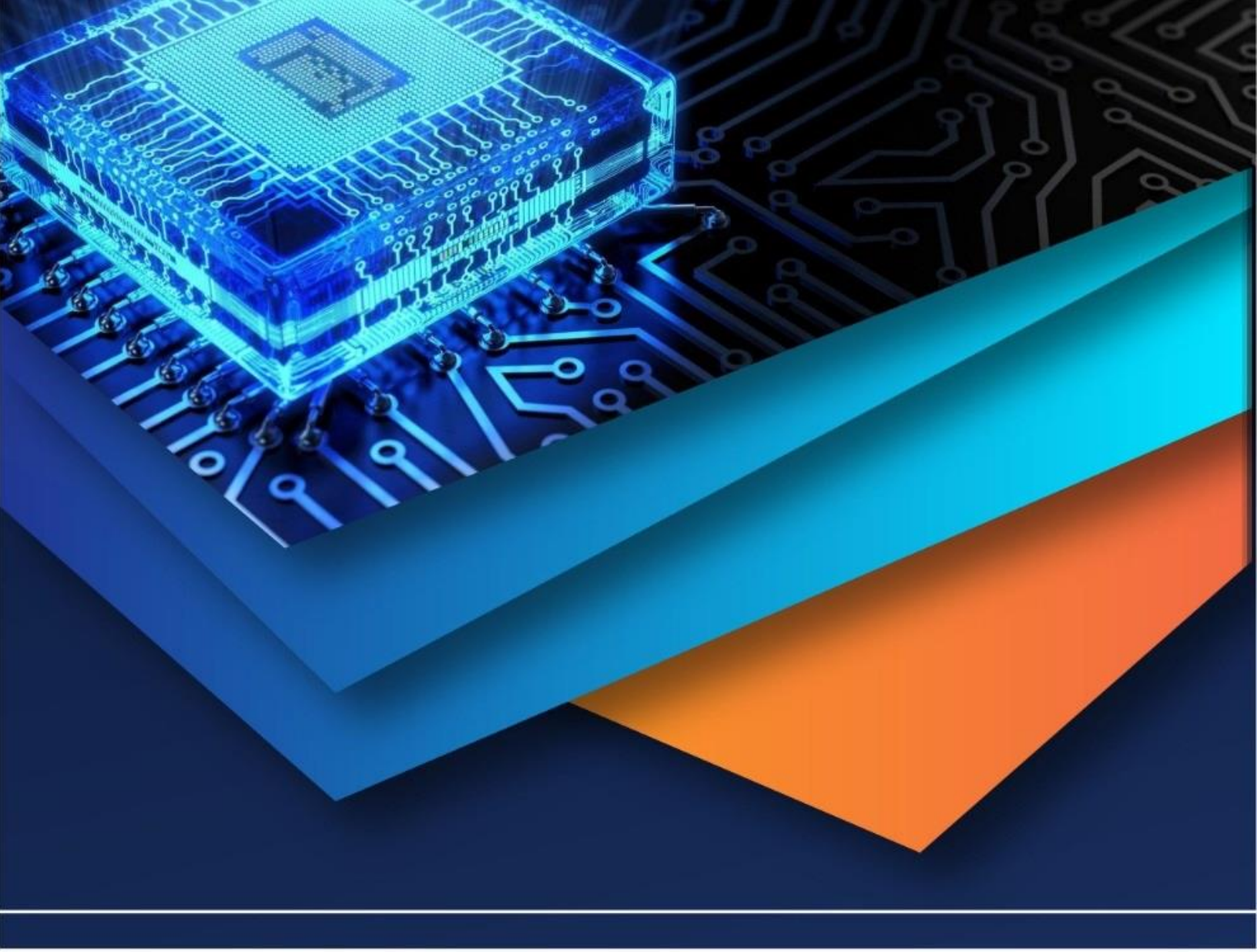
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Bed Size of this machine is 80×60mm. Stepper Motor will be run on in this criteria of bed size. If we have increase the size or length of lead screw, it will be free to make big size of design in paper. We have used G codes to giving command. On the successful work of this machine we have some change on it and make it commercial used and applying tools for cutting, grinding, engraving of soft material, wood, plastic etc.

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