Development Of Economic 3 Axis CNC Router

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Abstract— In today's market scenario the CNC routers are very expensive as they are focused mainly on Large Scale Industries and for heavy duty applications. Therefore, Small Scale Industries and individual workers like fabricators, carpenters and home decors cannot afford. CNC routers work mainly through XY, YZ, ZX co-ordination. An ARDUINO UNO board is used for this program control. A NEMA stepper motor is used to control its movement. Stepper motors are controlled by a driver. The proposed bed dimensions are 4x2 feet with a thickness of 1.5 inch. m. The system also features an online G-Code parser and then interpreted on the microcontroller from a USB. Improved procedures are employed in the system to reduce the computational overheads in controlling a 3-axis CNC machine, while avoiding any loss in overall system performance.

Index Terms— (CNC technology, user friendly flexibility, low cost)

I. INTRODUCTION

In the dynamic landscape of modern manufacturing and DIY enthusiasts, the integration of Computer Numerical Control (CNC) technology has revolutionized precision and efficiency. The development of an Economic 3-Axis CNC Router for domestic purposes represents a significant stride towards bringing advanced manufacturing capabilities to the doorstep of home users. CNC routers have long been instrumental in industrial settings, offering unparalleled precision and versatility in carving, engraving, and cutting various materials. However, their adoption for domestic use has been constrained by factors such as cost, complexity, and space requirements. This project aims to bridge the gap by introducing an economic 3-axis CNC router tailored for domestic environments. The term "economic" not only refers to the affordability of the system but also encompasses considerations . By developing a CNC router optimized for domestic purposes, this initiative seeks to empower hobbyists, artists, and small-scale manufacturers with the ability to create intricate designs, prototypes, and custom-made items from the comfort of their homes. The introduction of this accessible CNC router promises to democratize precision manufacturing, fostering innovation and creativity at the grassroots level while catering. The Economic 3 Axis CNC Router embodies a fusion of engineering prowess and economic efficiency. Its design prioritizes not only performance but also affordability, making advanced machining capabilities accessible to a broader spectrum of businesses, from small workshops to large-scale manufacturing facilities. By democratizing access to CNC technology, this router empowers businesses to enhance their productivity and competitiveness in an increasingly globalized market burgeoning demand for personalized, high-quality products in the domestic sphere. In the ever-evolving landscape of manufacturing and fabrication, the integration of advanced technologies has become imperative for efficiency, precision, and versatility. One such technological marvel that has revolutionized the realm of woodworking and related industries is the 3-axis CNC router. This cutting-edge tool, driven by computer numerical control (CNC), has gained widespread recognition in industrial settings for its ability to automate and streamline the production of intricate designs with unparalleled accuracy. However, despite its remarkable utility in commercial environments, the accessibility of CNC routers for domestic purposes has been limited, primarily due to cost constraints and complexity in operation. The objective of this research and development project is to address this gap by focusing on the creation of an economic 3-axis CNC router specifically tailored for domestic use. The significance of this endeavour lies

in democratizing the benefits of CNC technology, enabling hobbyists, small-scale woodworkers, and DIY enthusiasts to harness the power of precision machining in their own workshops. The domestic CNC router being developed will feature three axes of motion – X, Y, and Z – allowing it to carve, cut, and shape materials in three-dimensional space. This multi-axis capability enhances the versatility of the router, making it suitable for a wide range of applications, from crafting intricate wooden designs to fabricating prototypes for various projects. The emphasis on economic considerations aims to make this advanced technology accessible to a broader demographic, fostering innovation and creativity at the grassroots level. Furthermore, the project intends to incorporate user-friendly interfaces and intuitive software controls, ensuring that individuals with varying levels of technical expertise can harness the full potential of the CNC router. By simplifying the operation and minimizing the learning curve, the development team seeks to empower users to explore and experiment with digital fabrication in the comfort of their homes. In conclusion, the development of an economic 3-axis CNC router for domestic use represents a groundbreaking initiative to bridge the gap between industrial-grade precision machining and the aspirations of individual craftsmen. This endeavour not only aligns with the current trends in smart manufacturing but 2 also contributes to the democratization of technology, fostering a culture of innovation and self-expression at the grassroots level of the maker community. In this introduction, we delve into the journey of the Economic 3 Axis CNC Router, tracing its evolution, exploring its technological features, and examining its impact on various industries. From its inception to its current state, this CNC router represents a paradigm shift in the way we approach material processing and manufacturing, promising a future

II. LITERATURE SURVEY

Sl no	Title,Author,years	Objectives	Major Findings
1.	Fabrication of low cost 3axis CNC router Dr.B.Jayachandraiah O.Vamsi Krishna P.Abdullah Khan R.Ananda Reddy International Research Journal of Engineering and Technology (IRJET). Year 2020	The idea behind fabrication of low cost CNC router is to full fill the demand of CNC routers from small scale to large scale industries with optimized low cost	These routers offer high precision in cutting, carving, and engraving tasks, allowing for intricate designs and fine details
2.	Design and Development of Portable 3-Axis CNC Router Machine Mr. Prashil N Patel, Mr. Shreyas D Pavagadhi, Dr. Shailee G Acharya International Journal of Engineering Science Invention Conference Year 2019	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.	They can work with a variety of materials, including wood, plastic, and soft metals, making them suitable for various DIY and home improvement projects.
3.	Development of a3-axis CNC milling Machine with an open source controller Akshay r sonawane Arun Bhiva Rane D. S. S. Sudhakar In Journal of Physics Year 2020	In this project, it is intended to develop controller which will be universal and takes preparatory codes (G-code) and miscellaneous codes (M-code) generated by any CAD/CAM software.	Timing belt error is one of the key problem for maintaining accuracy and precision in CNC machine In this project, tension in the belt is so adjusted that the error occurred earlier will be minimized.

III. MOTIVATION

The motivation behind from after the literature survey Developing an Economic 3-Axis CNC Router use stems from the increasing demand for user-friendly and cost-effective manufacturing solutions. Traditional CNC routers have been instrumental in industrial settings, but their complexity and high costs have limited their adoption in household settings. The Economic 3-Axis CNC Router aims to bridge this gap, providing enthusiasts, hobbyists, and small-scale manufacturers with a tool that is not only affordable but also user-friendly. This democratization of precision manufacturing aligns with the growing trend of empowering individuals to unleash their creativity and turn ideas into tangible products within the comfort of their homes.

IV. EASE TO USE

Using a CNC router for economic purposes can be quite advantageous due to its ease of use and versatility. CNC routers are relatively user-friendly, especially with modern software interfaces that simplify the design and machining process. They offer precise control over cutting, carving, and engraving various materials like wood, plastic, and metal, allowing for efficient production of products or prototypes. Additionally, their automation reduces the need for manual labour, saving time and labour costs in the long run. Overall, investing in a CNC router can be economically beneficial for businesses looking to streamline production processes and increase productivity

V. DESIGN CALCULATION

Total feed rate (F)

1.Steps per mm (SPM)

SPM =360/step angle x 1/P

=360/1.8 x 1/2 =100 steps/min

2.Micro stepping resolution (MSR)

MSR = 1/Micro stepping factor

= 1/16 MSR = 0.0625

3.Micro stepping per revolution (MPR)

MPR = MSR x 200 MPR = 0.0625x200

MPR = 12.5 micro steps per revolution

4.Find the maximum speed(v)

v= (RPMx2π/60)x8

v=25.13x103 m/s

5.Feed rate(F)

F = (Spindle speed x Number of flutes x Chip load) / 1000

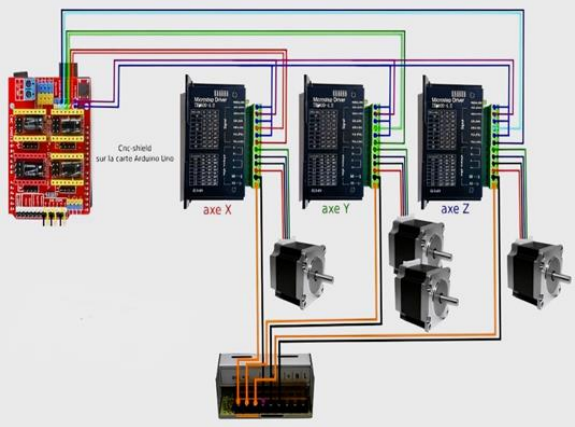
F = (30000 x 2 x 0.027) / 1000

F = 1.62 mm/min

VI. POWER SUPPLY AND ELECTRICAL CONSIDERATIONS

The power supply for the CNC router must be stable, reliable, and capable of providing the necessary power for the motors, controller, and other components. The voltage and current requirements of the router's components should be carefully analysed to ensure that the power supply meets the specifications. Generally, CNC routers operate on standard household voltage (110-120V or 220-240V), and the power supply should be selected accordingly. One critical consideration is to incorporate a power factor correction (PFC) circuit to optimize power usage and improve overall energy efficiency. PFC helps reduce harmonic distortion and ensures that the CNC router operates at its maximum efficiency, minimizing power losses.

VII. CIRCUIT DIAGRAM



In this CNC machine have controlled by Arduino uno control bord and CNC shield. It has connected through a power supply 230V Ac To 24V Dc 10A SMPS.

And the motor controller was TB6600 Stepper motor controller and it can be connected in several pins. The CNC shield was powered to 12V Dc power supply and

the Arduino was connected to the computer USB port. Motor Control: The CNC router's motors play a crucial role in its performance. Stepper motors are commonly used for CNC applications. The electrical system should include a motor driver circuit capable of precisely controlling the stepper motors for accurate and smooth motion. Micro stepping technology can be employed to enhance the precision of movements. Controller Board: The heart of the CNC router is the controller board, which interprets G-code instructions and translates them into specific movements. Ensure the controller board is compatible with the chosen stepper motors and power supply. opt for a user-friendly interface and consider including safety features like emergency stop buttons and overload protection. End stops and Limit Switches: Incorporate end stops and limit switches to prevent the CNC router from exceeding its mechanical limits. These switches are essential for homing the machine and avoiding damage during operation. Cooling and Ventilation: Electronic components generate heat during operation. Implement an effective cooling and ventilation system to maintain optimal operating temperatures. This may include fans, heatsinks, and proper enclosure design to dissipate heat efficiently. Emergency Stop System: Include a failsafe emergency stop system to immediately halt all machine movements in case of a malfunction or operator intervention. This ensures safety and prevents potential damage to the machine or workpiece. Noise Suppression: 30 CNC routers can produce electrical noise that may interfere with other electronic devices. Implement noise suppression techniques such as shielding cables, using ferrite cores, and grounding to minimize electromagnetic interference. conclusion, the power supply and electrical considerations for the development of an economic 3-axis CNC router for domestic purposes are crucial for achieving optimal performance, reliability, and safety. By carefully selecting and designing the power supply, motor control, controller board, and other electrical components, one can ensure a well-functioning CNC router that meets the needs of domestic users while adhering to safety standards. A comprehensive electrical system design contributes to the overall success of the CNC router, making it a valuable tool for hobbyists and small-scale manufacturing.

VIII. SOFTWARE DETAILS

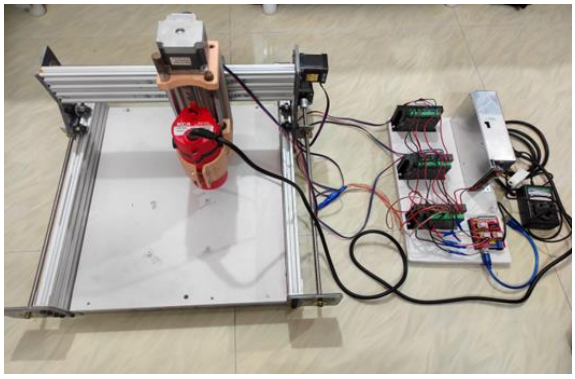
Easel

Easel is a user-friendly, web-based CNC software developed by Inventible. It is designed to simplify the process of creating and sending toolpaths to CNC machines, including routers like the one you're using.

Universal G code Sender (UGS)

Universal G code Sender (UGS) is a Java-based open-source software application that sends G-code commands to CNC machines. It acts as a communication interface between your computer and the CNC router.

IX. ASSEMBLED PICTURE OF CNC ROUTER



Components Figure

1.

2.

3.

4.

5.

6.

1) CNC Shield
2) TB6600 Driver
3) Shaft Coupler
4) NEMA 23 Stepper motor
5) NEMA 17 Stepper motor
6) SKF 20 Series Ball Bearing

X. RESULT AND CONCLUSION

The development of the Economic 3 Axis CNC Router has yielded promising results, showcasing enhanced precision and efficiency in various woodworking and machining tasks. Leveraging software such as Easel and UGS (Universal G code Sender), the machine offers user-friendly interfaces for designing and controlling operations, streamlining the manufacturing process. The utilization of G-code programming further optimizes performance, enabling intricate designs and minimizing material wastage. Through rigorous testing and refinement, the router has demonstrated its capability to meet industry demands for cost-effective yet high-quality production. In conclusion, the integration of Easel and UGS software, alongside G-code programming, has significantly contributed to the success of the Economic 3 Axis CNC Router, positioning it as a reliable solution for diverse manufacturing needs.

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