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CNC BASED WRITING AND DRAWING MACHINE

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Abstract: In today's world, automation is making everyday tasks easier and more efficient. One area where this is evident is in writing and drawing, where machines are increasingly being used for precision tasks. This manual introduces a CNC-based writing and drawing machine, designed to not only replicate designs but also write in personal handwriting, offering a unique blend of technology and creativity. Using an Arduino Uno microcontroller, stepper motors, and a servo motor, the machine operates across three axes (X, Y, and Z) to create accurate drawings and text. Software like Inkscape helps generate designs, which are converted into instructions that the machine can understand and execute through v3 control board.

The machine is designed to be accessible and useful for individuals with physical disabilities, enabling them to express thoughts through writing by interpreting images and text and converting them into motor actions using new and unique fonts. This versatile device can also be integrated with a computer or mobile device, offering remote operation. The system is both wired and wireless, allowing flexibility in various environments.

The CNC writing machine is an affordable and efficient tool, perfect for personal, educational, or professional use. Whether you're an artist looking for precision or someone wanting to write in your own handwriting through automation, this machine offers endless possibilities. It also includes the integration of Artificial Intelligence which gives one way to move toward the technology efficiently.

Keywords: V3 Control board, Artificial Intelligence, CNC machine.

I. INTRODUCTION

Automation is at the forefront of technological progress, which is constantly changing how we engage with different jobs in today's environment. Computer Numerical Control (CNC) technology is one noteworthy advancement that has revolutionized a number of industries by increasing accuracy, efficiency, and lowering human labor. The goal of this paper is to develop a sophisticated CNC-based writing and drawing device that uses image sensing technology and audio input to mimic a person's handwriting using unique fonts. This machine's integration has enormous promise, especially for people with physical limitations who would be able to write with just their thoughts. speech-to-text (STT), voice-to-text systems, printers, and scanners are examples of technology that have historically been used to help with writing and text generation. Nevertheless, these systems are constrained by the machine's predetermined typefaces, which include Roman, Calibri, Georgia, and other unique fonts. We can able to create unique fonts whatever we want & Creating a machine that can write in the user's distinctive handwriting on a page, just like a pen, is the present challenge. The objective is to develop a writing machine that replicates natural handwriting by applying the accuracy of CNC systems used in woodworking, where precise drawings are etched onto wood by a driller using precise feed instructions. Fundamentally, the CNC writing machine is a computer-controlled device that moves a pen or stylus across a surface using motors and actuators. This enables it to accurately transfer computer drawings onto materials like paper, canvas, and wood. This technique can be used to create complicated patterns, fine letters, and high-quality artwork by artists, architects, designers, and enthusiasts. The capacity of this technique to give accuracy and repeatability-which guarantee that the output stays consistent regardless of the material used—is its fundamental component.

The mechanical construction, control system, software, and material selection are some of the essential elements involved in the development of a CNC writing and drawing machine. The mechanical structure typically comprises a frame, linear motion systems driven by V3 control Board.

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The CNC writing machine is essentially a computer-controlled apparatus that uses motors and actuators to move a pen or stylus across a surface. Because of this, it can precisely print computer drawings onto materials like wood, canvas, and paper. Artists, architects, designers, and enthusiasts can utilize this technology to produce intricate patterns, exquisite letters, and high-quality artwork. This technique's key component is its ability to provide accuracy and reproducibility, which ensure that the result remains consistent regardless of the material utilized.
A CNC writing and drawing machine's creation involves several crucial components, including its mechanical design, control system, software, and material choice. Usually, the mechanical structure consists of a frame, linear motion systems powered by the system.

The automatic writing machine's contemporary features make it versatile and user-friendly in a range of situations. The device may be remotely controlled and its design can be changed in real time by users connecting it to a laptop, computer, or mobile phone. This machine's versatility is further enhanced by its ability to be operated both with wire and without wire. Programming the machine requires software like the Inkscape 1.2.2, which let users adjust the speed, pen pressure, and other settings to get the best results.

The machine’s low-cost design, paired with its ability to draw any design and write any type of text in a user’s own handwriting, makes it a valuable tool in both academic and professional settings. The three axes on which it functions are X, Y, and Z.

To sum up, the CNC-based writing and drawing machine combines state-of-the-art technology with useful, real-world uses. It is positioned as a groundbreaking instrument in the domains of education, art, and communication due to its capacity to replicate handwriting and its accessibility for those with physical disabilities. Such technologies provide promise break throughs that simplify complex activities and make them more accessible to a wider range of users as we continue to push the limits of what automation can accomplish.

II. METHODOLOGY

The implementation of the Automatic Writing and Drawing Machine involves a CNC-based motion system that operates along three axes: X, Y, and Z. These axes are controlled using stepper motors and a servo motor to enable precise movement for writing or drawing tasks.

I) System Components and Implementation

a. The major hardware components used in the system include: Stepper Motors (X & Y-axis): Responsible for horizontal and vertical movement.
b. Metal Gear Servo (Z-axis): Controls the pen’s up-and-down motion.
c. V3 Control Board (Maker Q): Replaces the traditional Arduino Uno, providing enhanced motor control and improved processing capability.
d. A4988 Motor Driver Expansion Board: Facilitates motor control by regulating stepper motor movement.
e. Power Supply (Battery): Powers the control board and motors.

In our system, the V3 control board is used instead of Arduino Uno to manage the motion of the machine. The stepper motors for the X and Y axes, along with the metal gear servo for the Z-axis, are connected to the control board through the A4988 motor driver expansion board. The power supply is linked to the control system to ensure stable operation.
Unlike conventional CNC-based machin

II) Software Integration and Operation

es that rely on multiple software tools, this machine is entirely operated using Inkscape with an extension plugin. The workflow is as follows:
1. Input Design Preparation:
The user creates or imports a text or design into Inkscape.
The design is converted into instruction using an Inkscape extension.

2. Data Processing and Execution:
The Instructions is transferred to the V3 control board , which processes the commands through Inkscape Software.
The stepper motors execute precise movements along the X and Y axes, while the servo motor controls the pen's vertical motion (Z-axis).

3. Automated Writing/Drawing:
The machine follows the programmed path to reproduce the text or design on paper. The process is fully automated, eliminating manual intervention during operation.

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This approach ensures higher precision, efficient control, and seamless integration between hardware and software components. The use of a single software (Inkscape) simplifies the execution process, making the system user-friendly and efficient.

CNC machine follows a basic principle that is all the motors can be controlled using computer through a software. In this paper, machine which has been developed has three motors which includes two stepper motors whose function is to divide full rotation into a number of equal steps for XY plane and one servo motor which acts as an angle precision tool for adjusting the pen. Motor drivers (A4988) are used to control the motion of the stepper motors and Microcontroller is used for controlling servo motor.
The X-axis is attached to two wooden parts and made it is functioned to cut and construct in vertical position. The Y-axis is placed in horizontal position with respect to plotter base and pen is gripped by servo motor to move up and down in the Z-axis which is free to move along 2D plane(X-Y).

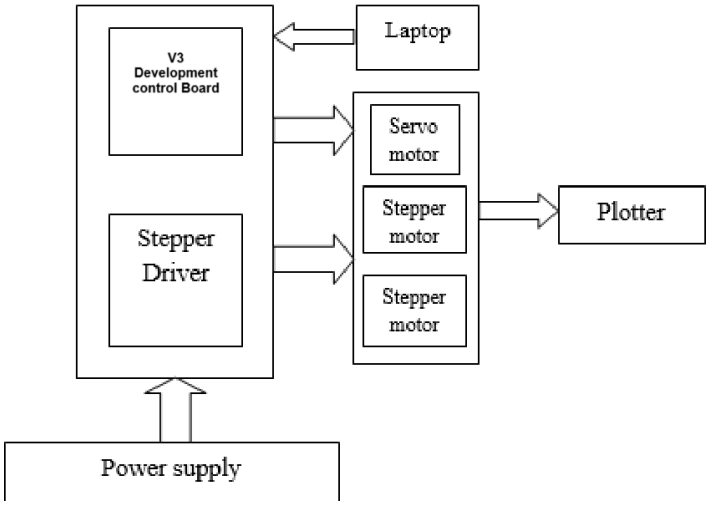

Fig 1: Block Diagram of CNC based Writingand Drawing Machine

Using Inkscape the input text is converted to G-code and is transmitted to Microcontroller via Universal G-code Sender. Inkscape software can also be used to convert the image content into G-code using ‘G-code tools’ extension. Universal G-code sender is used to feed the G-code in Microcontroller. Upload the sketch for each module to Development board V3 using Inkscape 1.2.2 software. Connect the Universal G-code sender to microcontroller by pairing both devices in order to control the movements of the X-Y Plotter.

The starting process of plotter is described by the flowchart in the Fig 2 where firstly the connection of the laptop is done with the microcontroller and then the content to be written is given in the Inkscape software and by using Universal G-code Sender accordingly the X-Y plotter operates the stepper driver is used to control the stepper motors and the microcontroller is used to control the servo motors.

Any Artist can draw an outline diagram for their work. The principal can use as a sign the certificate. Write anything in Smartphone case cover. A student can draw their outline of a sketch. Also, they fill up a colour in it. The student does their homework with this machine at home.

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Using Inkscape the input text is converted to instruction and is transmitted to Microcontroller V3 control Board Inkscape. software can also be used to convert the image content.

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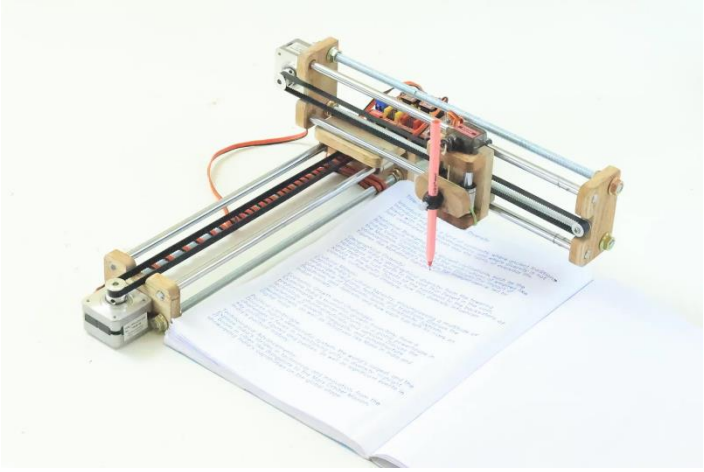

Fig 2: Image of CNC based writing and Drawing Machine

III. CONCLUSION

This paper involves the creation of a portable writing and drawing device that has two axes of motion (X and Y), and uses a servo motor to control the movement of the pen in a vertical direction (Z axis). Stepper and servo motors are used to produce its output, and G-code, the only code that can comprehend a CNC machine, is crucial to the machine's smooth operation. This conversion is made simple with the aid of the Inkscape software and Universal G-code Sender. This code conversion is delivered to the microcontroller, which then instructs the motor drivers to move in accordance with the task. The data is then plotted using the pen in accordance with the task. It will eventually be usable by people for writing and drawing tasks. Plotter components with a similar level of accuracy can be used to obtain precise coordinates and locate the pen more quickly and accurately. The design and development of a CNC writing and drawing machine requires a multidisciplinary approach, involving mechanical, electrical, and software engineering principles. The methodology involves defining design objectives, designing the mechanical structure, selecting appropriate motors and control system, developing software for INKSCAPE/G-CODE, material selection and preparation, assembly and integration, testing and validation, documentation, and continuous iterative improvements. A well-designed CNC writing and drawing machine can offer a precise, accurate, and efficient solution for creating artwork, designs, and calligraphy with consistent quality. It has the potential for various applications, including art and design industries, education, advertising, and customization of various objects. conclusion.

IV. RESULT

The CNC-based Writing and Drawing Machine was successfully developed and tested, demonstrating its ability to automate text writing and design drawing with precision. The machine operates using a two-axis motion system (X and Y axes), while a servo motor controls the vertical (Z-axis) movement of the pen. The system functions by processing input designs using Inkscape software, which sends movement instructions directly to the V3 control board, allowing for seamless operation.

The key outcomes of the paper include:
Accurate reproduction of handwritten text and intricate drawings with minimal manual effort.
Smooth and controlled movement of the pen using stepper motors and a servo motor, ensuring precise execution.
User-friendly operation, where designs are created and processed in Inkscape software, simplifying input handling.
Portability and cost-effectiveness, making the system accessible for various applications.

V. DISCUSSION

The implementation of the CNC-based Writing and Drawing Machine highlights both its effectiveness and areas for improvement. The system successfully automates writing and drawing tasks, providing a consistent and repeatable output. By using Inkscape software, the machine efficiently processes input images and text and translates them into motion instructions for the control board, ensuring accurate pen movement.

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However, some challenges were identified during testing:
Mechanical Precision: The accuracy of the pen's movement is dependent on the stepper motors, which may introduce slight deviations.
Speed Limitations: The machine operates at a controlled speed to maintain precision, which may result in longer processing times for complex designs.
Surface Dependence: The system performs optimally on smooth surfaces, but inconsistencies may arise when writing on textured or uneven materials.

To enhance the machine's performance, future improvements could include:
Higher precision stepper motors** to improve accuracy and reduce deviations.
Optimized motor control algorithms** to increase writing speed while maintaining quality.
Adjustable pen pressure mechanisms to accommodate different writing surfaces and materials.
Wireless operation support, allowing users to control the machine remotely for greater convenience.

Overall, the CNC-based Writing and Drawing Machine provides a reliable and efficient solution for automating text and design reproduction. With further enhancements, it can be widely used in applications such as education, assistive technology, and artistic design, making it a valuable innovation in the field of automated writing systems.

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