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Automatic Writing and Drawing Machine

Yaman Sahu [1], Rudra Pratap Singh [2], Rahul Sahu [3], Ekta Tamrakar [4]
[1]*Student, Dept. Of Electronics and Telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India*
[2]*Student, Dept. Of Electronics and Telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India*
[3]*Student, Dept. Of Electronics and Telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India*
[4] *Assistant Professor, Dept. Of Electronics and Telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India*

Abstract - *The Automatic Writing and Drawing Machine with digital input is a customizable electromechanical system that can write and draw on a surface like a person. The project's main aim is to make writing and drawing automatic by turning digital directions into precise mechanical movements. A microcontroller (like an Arduino), stepper motors for moving the X and Y axes, and a servo motor for moving the pen up and down are components that make up the machine. The technology may precisely replicate text, geometric figures, or complex images on paper or comparable surfaces by decoding commands in formats such as G-code. A pen or marker is guided across the drawing plane by motor-driven axes that are synchronized to do this. The machine is quite adaptable since it can accept both user-generated input through software interfaces and predetermined designs. This project's applications include assistive technology for those with motor impairments, automated notetaking, the creation of creative patterns, and instructional demonstrations of CNC concepts. The machine is appropriate for students, academicians, and educators due to its small size, affordability, and ease of assembly. The Automatic Writing and Drawing Machine provides a practical introduction to robotics, programming, and digital fabrication through its open-source integration and adaptable architecture.*
Key Words – *Arduino, Stepper Motors, UGS code, ink space, CNC,*

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I. INTRODUCTION

An automated writing and drawing machine is a cutting-edge mechatronic system that can accurately and consistently complete writing, sketching, and drawing jobs. Stepper motors, servo motors, an Arduino-like microprocessor, and a pen or marker-holding plotting mechanism are just a few of the mechanical, electronic, and software components that work together to make it function. In order to replicate images, text, or designs on paper, the machine converts digital instructions from a computer or SD card into exact motions along the X, Y, and occasionally Z axes. This technology shows how automation and robotics can be used in the creative and educational domains, providing a real-world illustration of how machines can mimic human creativity and writing skills. It is extensively utilized for jobs including design prototyping, handwriting automation, and logo drawing at educational institutions, research projects, and small businesses. All things considered, the automatic writing and drawing machine is a significant step toward combining technology and art, lowering manual labor while increasing accuracy and efficiency.

II. Literature Review

A new technology called the automatic writing and drawing machine uses computer-aided design (CAD), robotics, and automation concepts to accurately mimic human writing and drawing. CNC (Computer Numerical Control) and pen plotter technology, which produced exact line drawings using motors and preprogrammed instructions, served as inspiration for early advancements in this discipline. The foundation for today's small and reasonably priced automated drawing devices was established by these early systems.

Automation became more accessible and adaptable with the advent of microcontrollers like Arduino and Raspberry Pi. In order to control the movement of a pen along the X and Y axes, researchers and enthusiasts started creating Arduino-based drawing machines that can read G-code or vector graphics. Flexibility and accuracy were increased by translating digital designs into real-time motor commands thanks to open-source firmware like GRBL.

Recent research focuses on using stepper motors, servo motors, and belt-drive mechanisms to improve motion control, speed, and precision. To translate text or graphics into machine-readable instructions, software

programs like Inkscape and Processing IDE are frequently utilized. These advancements have made it possible to use automatic writing and drawing machines in a variety of fields, such as prototyping, education, and the arts.

Even with these developments, there are still certain difficulties, such decreasing mechanical faults, managing intricate designs, and ensuring constant accuracy. To enable machines to more accurately mimic human handwriting or sketching, future research attempts to combine artificial intelligence (AI) and machine learning for adaptive control.

TABLE I COMPARISON TABLE

Paper n o.	System description	Key Features	Results
[1]	Among the earliest automated drawing systems were pen plotters and early CNC machines. To regulate pen movement, they employed motors and preprogrammed orders. G-code instructions were the primary means of operation for these systems. Their accessibility and flexibility were restricted by costly and heavy hardware.	Worked on precise motion control using coordinates. used simple microcontroller and stepper motors	Generated precise geometric shapes and line drawings. Showing early writing and drawing automation. Although slow, the performance was dependent, restricted capacity to adapt to intricate or creative patterns.
[2]	Motion control was developed with inexpensive microcontrollers. Programmable firmware made automation possible. Compact design that is appropriate for use in research and education. less reliance on big mechanical systems.	Using GRBL firmware on Arduino or Raspberry Pi. X-Y axis motion via servo and stepper motors under control. G-code and USB connectivity were supported.	Increased precision and control over pen motion. lower setup costs and complexity. extensively utilized in small-scale automation and student projects. increased task repeatability and flexibility.
Our Work	Stepper motors, a servo mechanism, and an Arduino Uno were used in its design and construction. uses G-code instructions that have been transformed from digital drawings. built on a portable, lightweight frame. centered on low-cost automation and education.	Use GRBL firmware to control motors smoothly. creates accurate motion commands from text and graphics. allows for autonomous lifting and positioning of pens.	Completed writing and drawing assignments successfully and accurately. demonstrated reliable and seamless operation. demonstrated affordability, effectiveness, and dependability. Ideal for both creative automation and academic instruction.

III. Materials and Method

This section provides a thorough explanation of the components utilized in the suggested model as well as the technique intended for the development and operation of the Automatic Writing and Drawing Machine.

III.1 Components:

III.1.1 Arduino Uno

The Arduino Uno is a widely used microcontroller board based on the ATmega328P microcontroller. It is an open- source electronics platform designed to make programming and hardware interaction simple for beginners and professionals alike. The board features 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, a power jack, and a reset button. It can be powered either through a USB cable or an external power supply ranging from 7 to 12 volts. The Arduino Uno is programmed using the Arduino IDE, which uses a simple C/C++-based language, making it user-friendly for creating and uploading programs. Due to its reliability and ease of use, it is commonly employed in robotics, automation, sensor-based systems, and various control applications. The name “Uno,” which means “one” in Italian, signifies its status as the first official Arduino board. Overall, the Arduino Uno serves as an excellent tool for learning electronics and building innovative embedded projects.

Fig. 1 Arduino Uno

III.1.2 Stepper Motor

The 28BYJ-48 is a small and low-cost unipolar stepper motor commonly used in automation and robotics projects. It operates on 5V DC and provides precise and controlled movement using a built-in 1:64 gear reduction system, giving it high torque and accuracy. The motor is usually driven by a ULN2003 driver board, which makes interfacing with microcontrollers like Arduino simple and reliable. Because it moves in small steps, it is ideal for applications like automatic drawing machines, camera control, and small robots.

Fig. 2 Stepper Motor

III.1.3 28BYJ-48 *Stepper Driver Module and Heatsink for Arduino*

The ULN2003 driver board is used to control the 28BYJ-48 stepper motor by connecting it to a microcontroller like an Arduino. It uses the ULN2003A transistor array IC to amplify current and drive the motor's coils safely. The board has four input pins (IN1–IN4) for control signals, LED indicators to show coil activity, and works on a 5V power supply. It provides smooth, reliable, and easy control of the stepper motor for automation and robotics projects.

Fig. 3 28BYJ-48 Stepper Driver

III.1.4 Circuit and Wiring

The wiring of the various components of the electronics system is represented in Fig., shown below. The microcontroller of the Arduino board is connected to the computer system through the USB serial port. The Stepper Motors of three axes (X, Y and Z) relate to the CNC shield driver board as Figures 4 and 5 shown below. D.C. Power supply is provided for all the components of the electronics system.

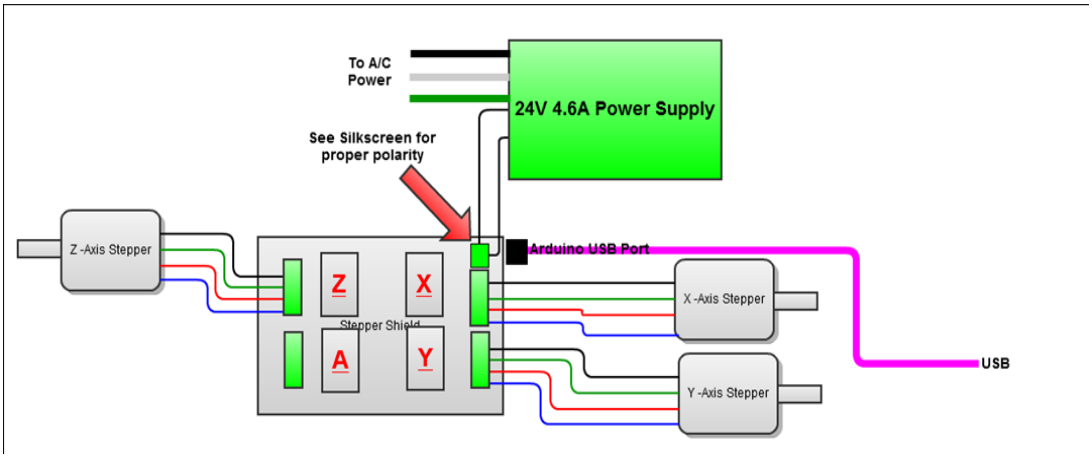

Fig. 4 Electronics Circuit.

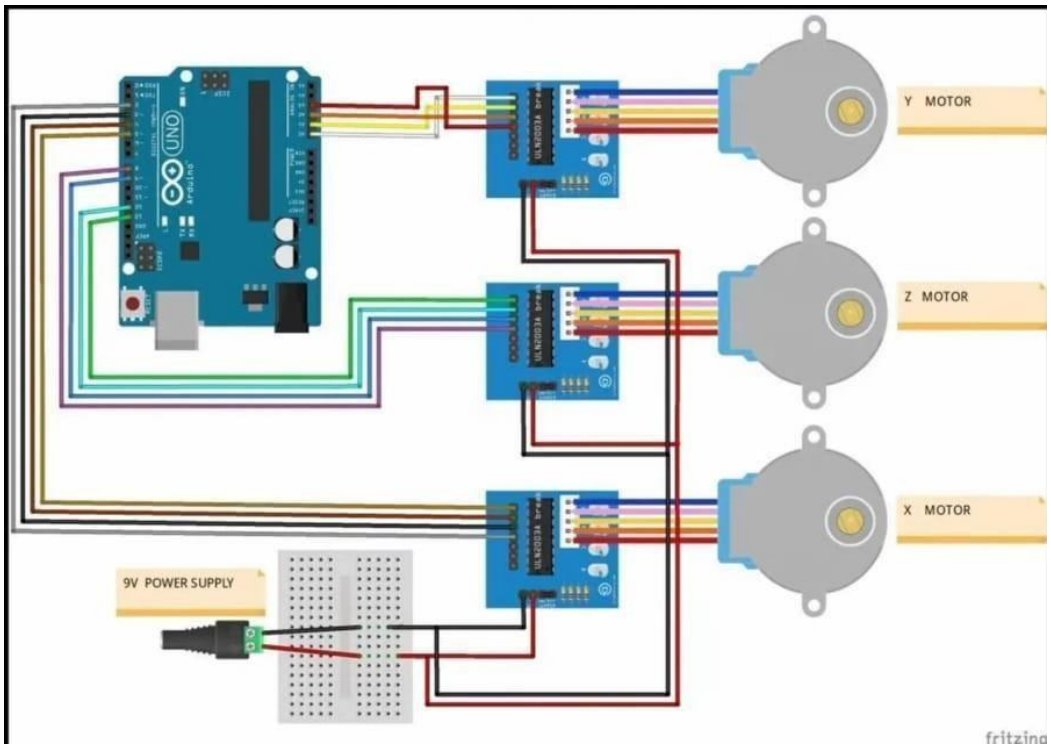

Fig. 5 Wiring

III.1.5 Computer and Software Tools Arduino IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board"(https://www.arduino.cc). It is simplified that C/C++ functions of language-based programming can be downloaded functionality with a rich set of library functions. After downloading and installing on pc can be written the program by C language and from tools and port must be choose the port connection between computer and Arduino through USB. After this step can be verified, the program by error checking and the message is done compiling when it is finished and no error. After this step can be uploaded, the program on the Arduino. Figure 6 shows Arduino software IDE.

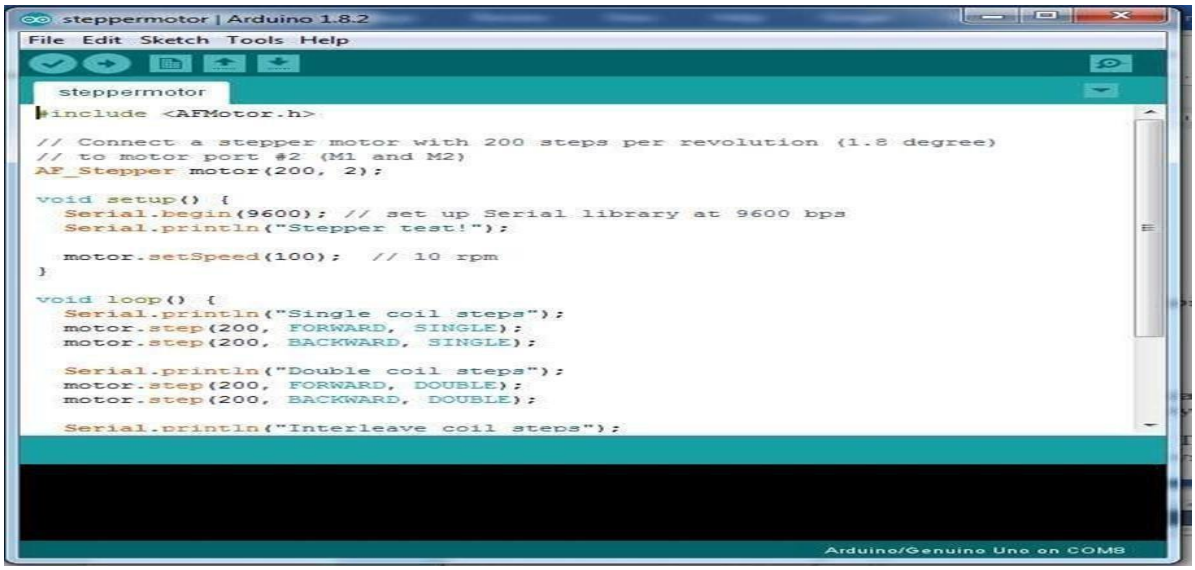

Fig. 7 Arduino Software IDE

III.1.6 Inkscape Software

Inkscape is a free and open-source vector graphics software used to create and edit scalable designs like logos, drawings, and diagrams. It supports the SVG format and offers powerful tools for shapes, text, and path editing. In automation projects, such as automatic writing and drawing machines, Inkscape is used to convert designs into G-code for machine control. It is user-friendly, works on all major platforms, and serves as a strong alternative to paid design tools.

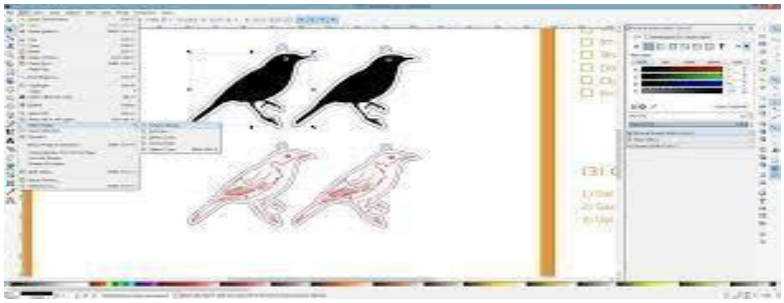

Fig.8 InkScape Software

III.2 *Miscellaneous*

Pen holder, Cardboard, Cables and connectors, PCB, IC, Adapter.

III.3 Proposed Methodology:

The proposed methodology for the Automatic Writing and Drawing Machine focuses on developing an efficient, low-cost, and precise system that can automatically write, or draw based on computer-generated inputs. The project integrates mechanical design, electronic control, and programming to achieve accurate pen movement along X, Y, and Z axes. The first step involves the design and planning of the machine structure, including the arrangement of motors, pen holders, and frames. The system is built on an X-Y axis mechanism driven by stepper motors, while a servo motor controls the Z-axis for pen lifting. The entire structure is designed to be lightweight and stable, ensuring smooth and precise operation.

The hardware implementation uses an Arduino Nano microcontroller as the core controller of the system. It interprets commands and controls stepper motors through A4988 motor drivers. A 12V DC power supply is used to power all components. The mechanical structure of the machine is constructed using materials such as acrylic sheets, aluminum rails, or 3D-printed parts to ensure rigidity and minimize vibration. The servo motor, attached to the pen holder, lifts and drops the pen based on instructions, enabling clear writing and drawing on paper.

The software part of the project involves the use of Inkscape to create or import digital text and image designs. These designs are converted into G-code using a plugin, which is then sent to the Arduino through the GRBL Controller interface. The GRBL firmware installed on the Arduino processes the G-code commands and converts them into motion signals to control the motors precisely. Through this process, digital input is

transformed into accurate physical motion of the pen along the X and Y axes.

After assembling both hardware and software, the system undergoes calibration and testing to ensure accuracy in movement and drawing. Various test patterns, shapes, and text are drawn to verify system performance. Adjustments in step size, motor speed, and pen pressure are made to improve precision and reduce errors. The testing phase helps in refining the machine's performance for smooth and consistent output. Finally, the system's performance is evaluated based on accuracy, speed, repeatability, and reliability. The proposed methodology effectively combines mechanical, electrical, and software components to build a cost-effective and precise automatic writing and drawing machine suitable for educational, artistic, and industrial applications.

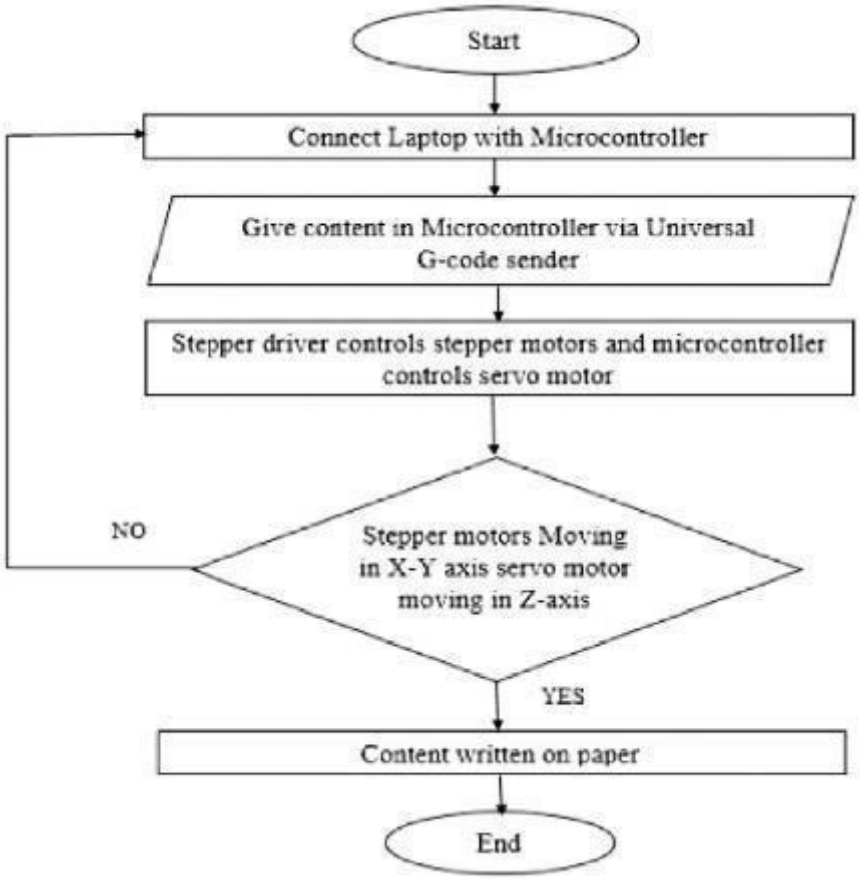

Fig 2. Flow Chart of proposed methodology

III.4 Implementation*:*

3.3.1 Hardware Setup: The system was implemented using an **Arduino Nano** as the main controller, **A4988 motor drivers** for stepper motors, and a **servo motor** for pen up/down movement. The hardware was assembled on a stable frame supporting the **X and Y axis mechanism**. Stepper motors provided precise linear motion, while the servo motor handled the vertical pen movement. A **12V DC power supply** was used to power all the components efficiently.

3.3.2 Software Configuration: The software component involves creating text or graphics in Inkscape and then using an extension to convert them into G-code. The Arduino Nano was given the GRBL firmware, which allowed it to decipher G-code commands. After that, the system received the G-code via GRBL Controller software, which converted digital coordinates into motor control signals.

3.3.3 System Integration: Both hardware and software components were integrated to achieve synchronized movement. The Arduino received G-code instructions and generated appropriate signals for the motor drivers. The motors moved the pen along the **X-Y plane**, while the servo motor lifted and dropped the pen as needed. The integration ensures smooth and accurate drawing or writing based on the input design.

3.3.4 Testing and Calibration: The complete system was tested through a series of trials using simple shapes, letters, and drawings. Calibration was performed to fine-tune the **motor steps, pen height, and speed settings** for precise output. Minor issues such as vibrations or misalignment were adjusted by refining the frame alignment

and motion parameters, resulting in stable and accurate performance.

3.3.5 Performance Evaluation: The final implementation was evaluated based on its **accuracy, repeatability, and drawing quality**. The system successfully produced clean and consistent results, demonstrating effective conversion of digital designs into physical output. The evaluation confirmed that the proposed design met its objectives of creating a cost-effective, efficient, and reliable automatic writing and drawing system.

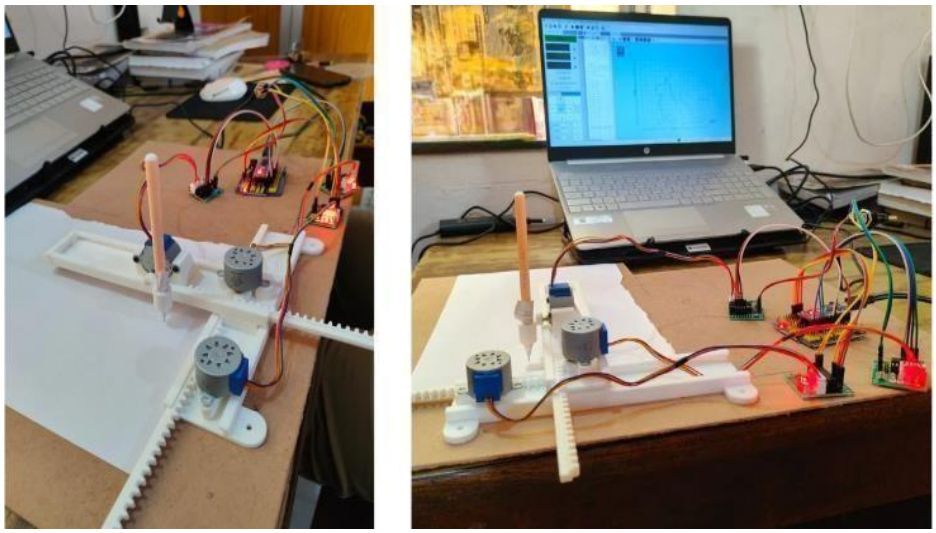

Fig 3. Proposed Setup

IV. RESULT AND DISCUSSION

Result:

- Text and simple shapes were accurately and smoothly drawn using automatic writing and drawing equipment.
- Stepper motors and servo movement were efficiently and precisely controlled by the Arduino Nano and GRBL firmware.
- Without human assistance, the device could translate digital G-code files into coordinated pen movements.
- With an average positional accuracy of roughly 1-2 mm, the system is appropriate for small-scale applications.
- Throughout several test runs, the servo motor-based pen lifting and positioning mechanism operated dependably.
- The entire arrangement turned out to be inexpensive, small, and simple to put together, making it perfect for educational use.
- During lengthy writing and drawing jobs, the machine showed consistent performance and repeatability. It could **reproduce pre-designed images and text** with good consistency and minimal mechanical error.
- It could accurately and consistently replicate pre-designed text and pictures with little mechanical error.
- The design-to-execution process was made simpler using open-source software (Inkscape + GRBL Controller).

IV.2Discussion*:*

- Strengths of the System:
- The developed system has several strengths, including **low cost, compact design, and reliable performance** for writing and drawing tasks. It provides **high precision and repeatability** using simple electronic components and open-source software, making it suitable for educational and creative applications.

- Future Enhancements:
- For future enhancements, the system can be upgraded with **wireless control**, **touchscreen interface**, and **AI-based handwriting recognition** to make it more advanced and user-friendly. Additionally, integrating **camera feedback** or **machine learning algorithms** could improve accuracy and enable automatic error correction during operation.

V. CONCLUSION

The Automatic Writing and Drawing Machine project effectively illustrates how automation and robotics can be used to carry out jobs that call for creativity and accuracy. The device can precisely replicate words and graphics on paper with little assistance from a person thanks to the Arduino Nano, stepper motors, and GRBL firmware. The project demonstrates how programming, electronics, and mechanical design can collaborate to produce an automated system that is both economical and successful. This system not only reduces human effort in repetitive writing and drawing tasks but also serves as an excellent learning tool for understanding motion control, coding, and mechatronics. The results show that the machine operates with good accuracy, smooth motion, and reliability. Overall, this project demonstrates the potential of low- cost automation in educational, artistic, and industrial applications, paving the way for future advancements in intelligent and creative robotics.

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