IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AUTOMATIC BLACKBOARD WRITING AND CLEANING

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Abstract: In the teaching field, blackboard, duster, and chalk are crucial elements. Erasing the writing from boards with a normal duster poses a big challenge for both teachers and students. The chalk dust creates difficulties and allergy issues for teachers and students, disrupting the concentration of both lecturers and listeners. The Automatic Blackboard Writing and Cleaning System is an innovative project designed to enhance the efficiency and functionality of traditional blackboards in educational and collaborative environments. The project consists of two main components: the Automatic Blackboard Writing Unit and the Blackboard Cleaning Unit. The Automatic Blackboard Writing Unit utilizes a specialized writing tools to replicate the handwritten content provided by users. This unit incorporates advanced algorithms for precise and legible writing, ensuring that information is accurately transcribed onto the blackboard. The cleaning unit ensures a thorough erasure of content, leaving the blackboard ready for new information without any residual marks or smudges. Key features of the Automatic Blackboard Writing and Cleaning System include user-friendly interfaces, customizable writing styles, and automatic calibration for different blackboard sizes. Additionally, the system promotes environmental sustainability by reducing the need for disposable writing materials and minimizing the use of cleaning agents. The implementation of this project aims to revolutionize traditional teaching methods, making educational spaces more dynamic and interactive.

Index Terms –user-friendly interfaces , *accuracy, automatic calibration , time-efficient*

I. INTRODUCTION

Introducing a design and implementation of automated technology in educational field which leads to the development of innovative solutions that aim to enhance traditional teaching methodologies. One such groundbreaking project is the " Automatic Blackboard Writing and Cleaning System, "which utilizes a combination of advance components such as stepper motors, servo motors, Arduino Uno, and A4988 motor drivers. Stepper motors play a crucial role in the Automatic Blackboard Writing and Cleaning System, providing precise control over the movement of the robotic arms responsible for writing on the blackboard. The stepper motors ensure accurate positioning of the writing tools, enabling the system to reproduce text, diagrams, and equations with high precision.

The step-wise motion of these motors is synchronized with the input data, ensuring legible and well-defined content on the blackboard Servo motors are employed in the system for their ability to provide controlled and precise rotational movement. In the context of the Automatic Blackboard Writing Unit, servo motors are utilized to control the orientation of the writing tools, allowing for adaptive writing styles and the reproduction of intricate details. The heart of the Automatic Blackboard Writing and Cleaning System lies in the Arduino Uno microcontroller.

In conclusion, the Automatic Blackboard Writing and Cleaning System, driven by stepper motors, servo motors, Arduino Uno, and A4988 motor drivers, represents a technological leap in educational tools. This integration of automation not only optimizes the use of blackboards in classrooms but also lays the foundation for a more interactive and dynamic learning environment. The following sections of this project report will delve into the detailed design, implementation, and performance evaluation of this innovative system.

II. EXISTING SYSTEM

2.1. SMART DUSTER

The smart duster consist of the long horizontal and vertical x axis, y axis respectively also consist of the z axis in which it includes the actuator for the real operation. In order to cover the entire board in a continuous process the external frame is provided to stand the running DC motor. The casing is provided with notch on the surface which facing the duster, enabling suction action to suppress the air suspension of chalk dust. The dust collection is done using an exhaust fan with the attachment of suction kit and is collected in a separate chamber.

2.2. BLACKBOARD CLEANING AID

The aim of the project is to save time and energy. Here it uses the dc motor so that the black board can be cleaned very easily within seconds ,as it saves the valuable time. It haves Sequential coordination and uses forward or reverse switch control. It is highly useful , as it possess various advantages .

2.3. CHALK DUST ABSORBING RECYCLING DEVICE

The dust collection blackboard eraser comprises a base plate, a built-in base plate is arranged on the upper side of the base plate, a motor and a negative pressure type fan are arranged on the upper side of the built-in base plate, rotating brush hair is arranged on the lower side of the base plate and connected with a transmission gear, the transmission gear is connected with the motor, an outlet of the negative pressure type fan is connected with an inlet of a filtering bag, the chalk regenerator comprises a forming die, a stirrer is arranged on the upper side of the forming die, and a dryer is arranged on the upper side of the stirrer. The dust collection blackboard eraser can absorb most of flying chalk dust, the dust is collected in the filtering bag, and the chalk regenerator enables the chalk dust collected through the dust collection blackboard eraser and residual chalk ends to be made into chalk again. The chalk dust absorbing recycling device is high in practicality, convenient to use, low in cost and suitable for school classrooms.

III. BLOCK DIAGRAM AND CIRCUIT DIAGRAM

3.1. BLOCK DIAGRAM

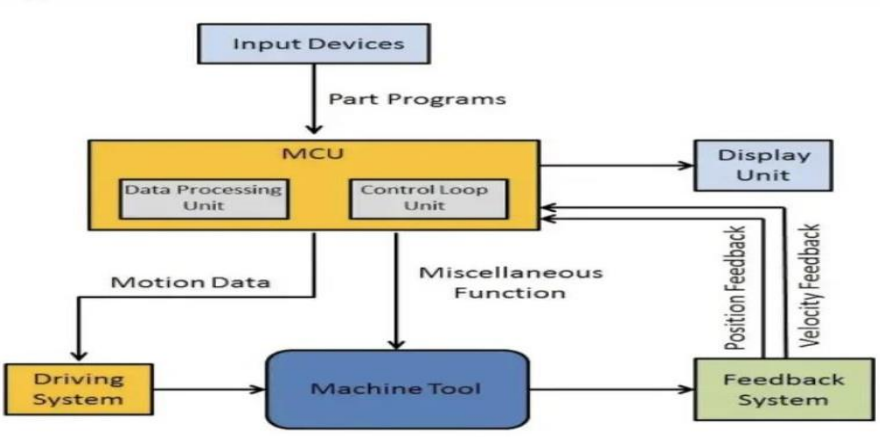
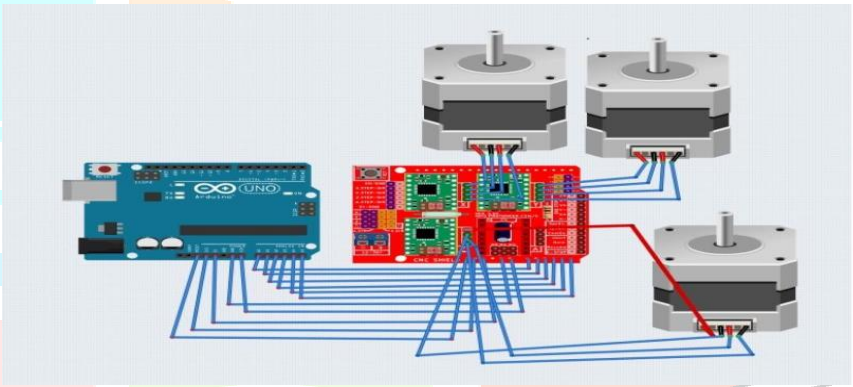


Fig. 1.Block diagram of the system

The block diagram outlines the flow of information and control within the AutomaticBlackboard Writing and Cleaning System. From user input to the coordinated actions of stepper and servo motors, facilitated by the MCU and supported by feedback systems, this integrated approach transforms traditional blackboards into

dynamic and automated educational tools. In the block diagram the Part programs is given to MCU , 'from MCU motion data moves to driving system and miscellaneous function reaches directly in to the machine tool'. The driving system is then connected with the machine tool , from the arduino feedback is taken which gives the position and velocity information, that is again given to MCU. The system performed functions are displayed on the display unit.

1. **Input Devices**: This is the devices that used to give the part programs to the MCU.
2. **MCU**: This is the control unit of the system that consist of data processing unit and control loop unit .
3. **Driving system**: This system collecting the motion data from MCU and directing this data in to Machine tool.
4. **Machine Tool**: This tool used perform the functions by using the data obtained from machine tool and MCU.
5. **Feedback System**: This system take feedback taken which gives the position and velocity information that are again given to MCU.
6. **Display Unit**: The system performed functions are displayed on the display unit.



3.2. CIRCUIT DIAGRAM

Fig. 2. Circuit diagram of the system

Circuit diagram involves a visual representation of the electrical connections and components in the system. The circuit diagram including the Servo Motor, Stepper Motor, CNC shield , Arduino and A4988 Stepper Motor Driver. The Arduino Uno serves as the central microcontroller unit. It is connected to the power supply and serves as the main control unit for the entire system. It processes user input and generates control signals for the motors.

1. **Arduino UNO**: Easy to programmable open source microcontroller board used to control the working of stepper and servo motor.
2. **Stepper Motor:** Used for x y directional motion of the writing and cleaning system connected to arduino uno.
3. **Servo motor:** Used for up and down motion of writing and cleaning system, also connected to arduino uno.
4. **CNC shield v3 :** Open sourcefirmware that runs on an Arduino UNO that turns G-code commands into stepper signals.

IV. PROJECT DESIGN AND WORKING

4.1. PROJECT PARTS DESIGNS

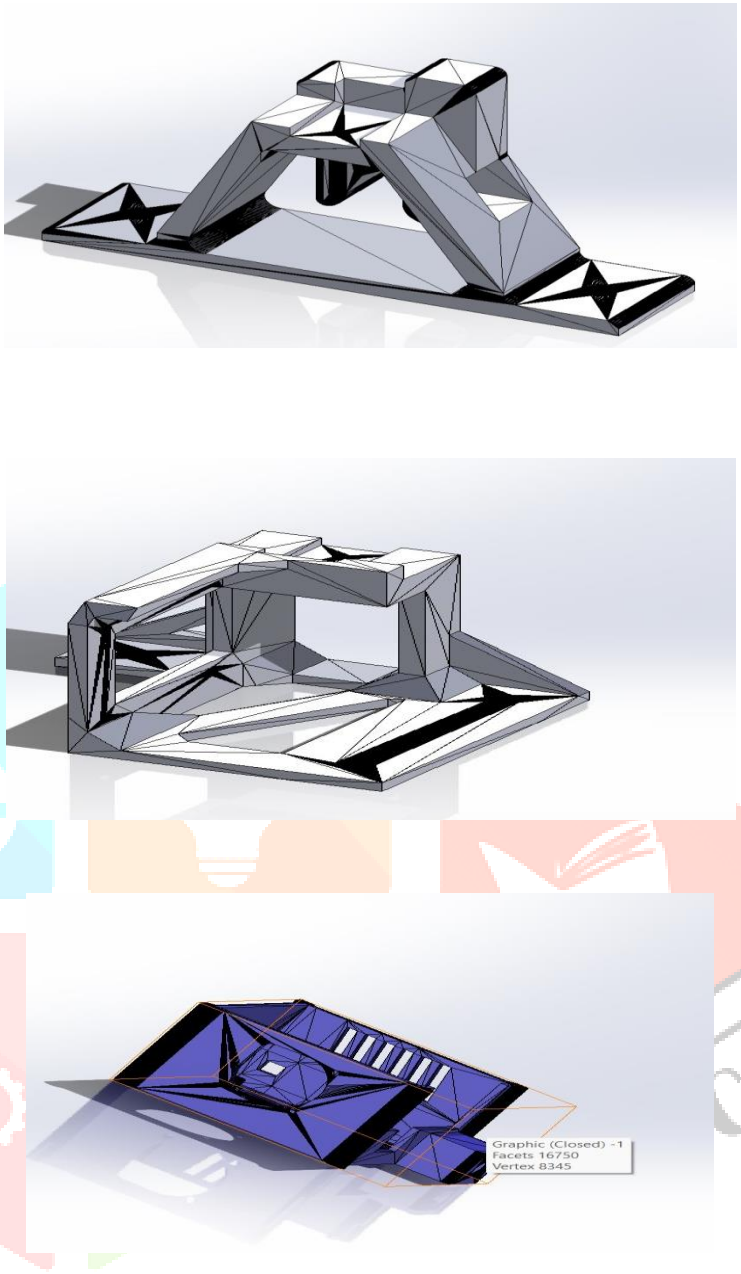
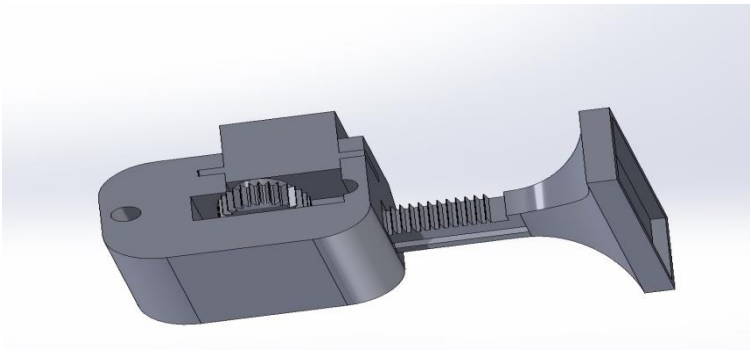


Fig.3. 3D views of the frame parts

The Automatic Writing and Cleaning System is a sophisticated project designed to streamline tasks associated with writing and erasing on surfaces, providing efficiency and convenience. This system integrates robotics and automation technologies to achieve itsobjectives. The system consists of three main components - a robotic writing arm, a cleaning mechanism, and a control unit. The robotic writing arm is equipped with a writing tool, such as a pen or marker, and is mounted on a movable platform. The cleaning mechanism includes a device capable of erasing or cleaning the written surface. The control unit manages the coordination and operation of both the writing and cleaning processes. The user inputs the desired text or drawing into the control unit, specifying the writing parameters .The robotic writing arm, controlled by precision motors, moves to the designated starting point on the surface.

The writing tool engages with the surface and accurately reproduces the inputted text or drawing.The robotic arm, with its precision control, ensures smooth and precise movements for accurate writing. After completing the writing task, the cleaning process can be initiated either manually or automatically, depending on the system's configuration. The cleaning mechanism comes into action, using methods such as a eraser or cleaning pad, depending on the surface and writing medium.The system ensures thorough cleaning, leaving the surface ready for new content



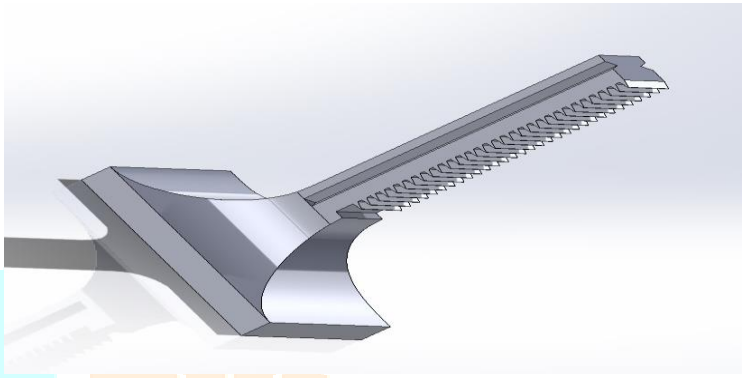


Fig. 4. 3D designs of frame

4.2. WORKING

1. **Working of Stepper Motor:** Stepper motors play a crucial role in the Automatic Blackboard Writing and Cleaning System, providing precise control over the movement of the part responsible for writing on the blackboard. The stepper motors ensure accurate positioning of the writing tools, enabling the system to reproduce text, diagrams, and equations with high precision. The step-wise motion of these motors is synchronized with the input data, ensuring legible and well-defined content on the blackboard
2. **Working of Arduino UNO:** The Arduino Uno R3 is a microcontroller board based on a removable, dual-inline-
   package (DIP) ATmega328 AVR microcontroller. Programs can be loaded on to it from the easy-to-use Arduino computer program. The Arduino UNO board hassix analogue input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.
3. **Working of Servo Motor:** Servo motors are employed in the system for their ability to provide controlled and precise rotational movement. In the context of the Automatic Blackboard Writing Unit, servo motors are utilized to control the orientation of the writing tools, allowing for adaptive writing styles and the reproduction of intricate details. The versatility of servo motors enhances the system's capability to cater to diverse writing requirements, making it suitable for a wide range of educational applications.
4. **Working of A4988Motor Drive:** The A4988 motor driver acts as the interface between the Arduino Uno and the stepper motors. It translates the control signals from the microcontroller into precise movements of the stepper motors, ensuring accurate and synchronized operation. The A4988 motor driver offers micro stepping capabilities, allowing for finer control over the motor movements, resulting in smoother and more accurate writing on the blackboard.

V. FLOW CHART

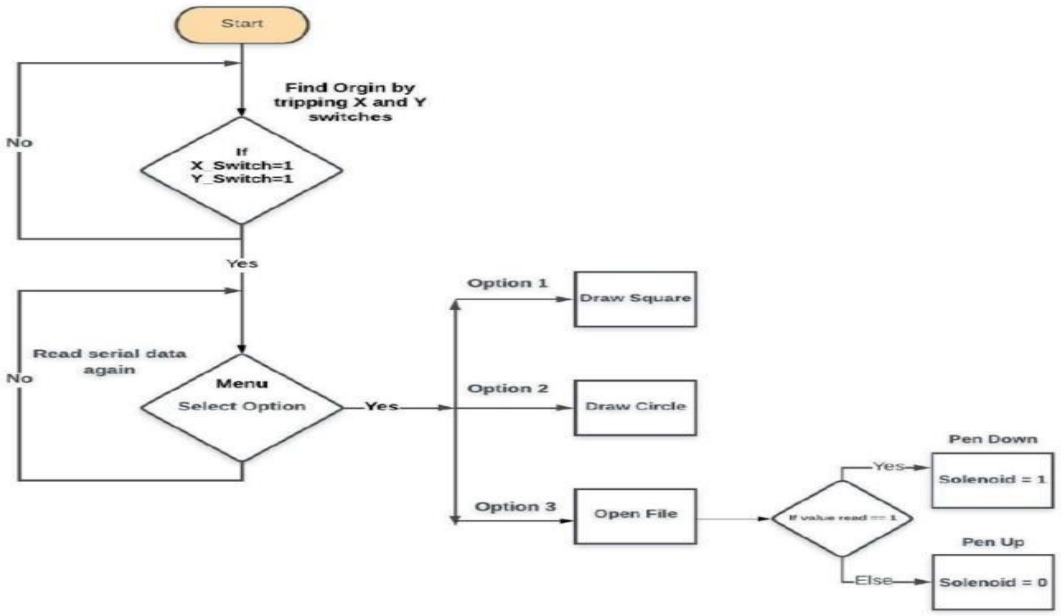


Fig. 5. Flow chart

The flow chart which explaining about the working of the automatic system by using stepper motor and servomotor controlled by motor drive used in Arduino UNO . Here the process of writing and cleaning done automatically and simultaneously .

VI. SOFTWARES AND HARDWARES

6.1. SOFTWARES

6.1.1. GRBL Firmware

GRBL is an open source software or firmware which enables motion control for CNC machines. We can easily install the GRBL firmware to an Arduino and so we instantly get a low cost , high performance CNC controller. The GRBL uses G-code as input , and outputs motion control via the Arduino UNO.

6.1.2. INKSCAPE

INKSCAPE is a Free and open source vector graphics editor for GNU/Linux, Windows and macOS. It offers a rich set of features and is widely used for both artistic and technical illustrations such as cartoons, clip art, typography, diagramming and flowcharting .

6.1.3. Arduino IDE

The open source Arduino software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. we using this software for programming to control our system smoothly.

6.2. HARDWARES

6.2.1. CNC Shield V3

The latest Arduino CNC Shield Version 3.10,GRBL 0.9 compatible. (Open sourcefirmware that runs on an Arduino UNO that turns G-code commands into stepper signals) Coolant enable, Jumpers to set the Micro-Stepping for the stepper drivers. (Some drivers likethe DRV8825 can do up to 1/32 micro-stepping)Compact design.4-Axis support (X, Y, Z, A- Can duplicate X, Y, Z or do a full 4th axis with custom firmware using pins D12 and D13) 2 x End stops for each axis (6 in total).

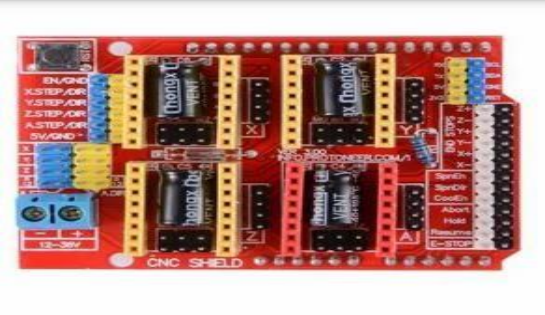


Fig.6 . CNC Shield V3

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6.2.2. Stepper Motor NEMA17

1.8° step angle (200 steps/revolution)2 A at 4 V Holding torque of 3.2 kg-cm**.** A stepper motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is correctly sized to the application in respect to torque and speed. Switched reluctance motors are very large stepping motors with a reduced pole count, and generally are closed-loop commutated.

Fig.7. Stepper Motor

6.2.3. Servo Motor

The servo motor with a torque rating of 1 Nm, a speed of 100 RPM, and operates on a voltage range of 4.8V to 6V. This means the motor can exert a force of 1 Nm, rotate at a speed of 100 RPM, and it should be powered within the specified voltage range. In summary, a servo motor is a device that translates electrical signals into precise and controlled mechanical movements. The specifications provide information on its performance characteristics such as torque, speed, voltage requirements, and control signal details.

Fig. 8. Servo Motor

6.2.4. Arduino Uno

The Arduino Uno is a versatile microcontroller board based on the ATmega328P chip. It features numerous digital and analog input/output pins, allowing for various interactions with external components. The board can be programmed using the Arduino IDE, making it accessible to beginners and experienced developers alike. It is powered via USB or an external power source and is widely used for prototyping and creating a wide range of electronic projects. With its user-friendly design and extensive community support, the Arduino Uno has become a popular choice for makers and enthusiasts worldwide.

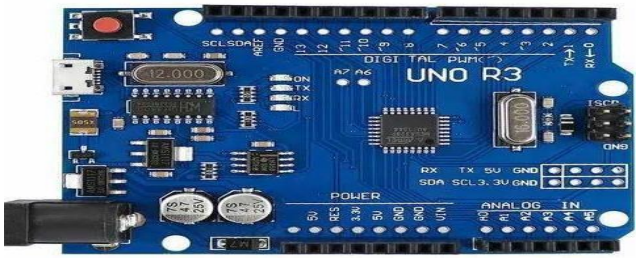

Fig. 9. Arduino Uno

6.2.5. 12V SMPS Power Adapter

SMPS power supply transfers power from a source, usually an AC outlet to a DC device. SMPS power supplies have the ability to regulate the output voltage. It can increase or decrease the output voltage to maintain a constant output regardless of changes in load. This dual ability gives it an advantage over linear regulators, which can only regulate the output down.

Fig. 10. 12V SMPS Power Adapter

6.2.6. CNC frame

The CNC machine tools are also manufactured based on polymer concrete frames, whose vibration damping capability is even better . A machine tool of this type must be very accurately levelled and statically stable, since should it breaks, the frame would be irreparable. Steel is a strong and durable material that is often used for the construction of CNC router frames. It has high tensile strength and is resistant to deformation,

making it an ideal choice for heavy-duty application

Fig. 11. CNC Frame

6.2.7. Chromed Steel Rod

They're made of chrome-plated high-carbon steel and provide smooth, consistent motion when paired with linear bearings, Manufactured for use in 3D printers, Hydraulics as well as in CNC / linear motion applications, are stand up to frequent use without a problem.

Fig.12.Chromed Steel Rod

6.2.8. Contact Switch

A contact switch here used to regulate whether or not a electric current passing from a power source to electric device.

Fig. 13. Contact Switch

6.2.9. GT2 Timing Pulley

This is Aluminum GT2 Timing Pulley 20 Tooth 6.35mm Bore For 6mm Belt. For precise motion control, GT2 belts and pulleys offer excellent precision at a great price. This pulley is meant for use with GT2 6mm wide belts only – MXL belts will slip due to the different tooth profiles. This pulley has 20 teeth and a 6.35mm inner bore. Two set screws can be used to attach it firmly to any 6.35mm diameter shaft. Full aluminum construction means these are very light and very durable.

Fig.14.GT2 Timing Pulley

6.2.10. GT2 Timing Belt

This is GT2 Timing Belt 200mm Width-6mm Closed-Loop Rubber Belt for 3D Printer. The Power Grip GT2 system is an extension of the HTD system with greater load-carrying capacity.

Fig.15.GT2 Timing Belt

VII. IMPLEMENTATION SCOPE

1. Education Sector:.

- Schools and Colleges: Automated cleaning and writing can save time for teachers
- Ensure neat and organized blackboards for students.
- Special Education: Assistive technologies can help students with disabilities interact with

blackboard more effectively.

2. Corporate Training:

- Training Rooms: Automated systems can maintain clean and updated information during training sessions and workshops.
- Conference Rooms: Ensuring that presentations and notes are accurately displayed on the blackboard during meetings..

3. Business Presentation:

- Meeting Rooms: Automated blackboard systems can be integrated into multimedia presentations for interactive sessions..
- Training Centers: Facilitating interactive

4. Public Spaces:

- Public Libraries: Providing automated writing and cleaning services for community events, workshops, or presentations.

Research and Development:

- Laboratories: Blackboard systems can assist researchers in visualizing and documenting experimental procedures and results.
- Engineering and Design: Automated drawing and annotation on blackboards can aid in collaborative design.

VIII. INNOVATION OF THE SYSTEM

1.Cleaning Mechanism

- Design a cleaning mechanism that can efficiently remove chalk dust, smudges, and other marks from the blackboard surface. This could involve using brushes, vacuum systems, or specialized cleaning solutions.

2. Writing Mechanism

- Implement a writing mechanism that allows the system to write text, draw diagrams, or illustrate examples on the blackboard. This could use chalk, markers, or other writing tools controlled by the system.

3. Automatic Maintenance

- Implement self-maintenance features such as automatic refilling of chalk or markers, cleaning of the writing tools, and monitoring of system components for wear and tear.

4. Energy Efficiency

- To reduce energy consumption, the system may incorporate energy-efficient components and standby modes when not actively writing or cleaning.

5. Machine Learning Algorithms

- Advanced algorithms are employed to improve the system's performance over time. Machine learning algorithms can learn from past writing and cleaning experiences, optimizing movements, speed, and accuracy based on feedback..

6. Scalability and Customization

- The design allows for scalability to fit different classroom sizes and configurations. It can also be customized based on specific school requirements or preferences.

IX. COST OF THE PROJECT

SI NO.	COMPONENTS	RATE	QUANTITY	COST
1.	GT2 pulley	₹ 88.00	2	176
2.	A4988 motor drive	₹ 150.0	1	150
3.	CNC shield v3	₹ 122.0	1	122
4.	Switch	₹ 50.00	1	50
5.	CNC frame	₹ 2000	1	2000
6.	Jumper wire	₹100.0	1	100
7.	GT2 belt	₹107.0	1	107
8.	Arduino Uno R3	₹ 500.0	1	500
9.	Servomotor	₹280.0	1	280
10.	Stepper motor	₹649.0	2	1298
11.	Chromate rod	₹600.0	1	600
12.	Rail	₹2000	1	2000
13.	Linear bearing	₹54.00	3	162
14.	Barrel connector	₹45.00	1	45
15.	Miscellaneous	₹1200	-	1200
Total Cost Of The Project = 8790/-				

Table 1. Cost of the project

X. ADVANTAGES AND DISADVANTAGES

10.1. ADVANTAGES

1. Chalk Dust Free Classroom: The use of a smart duster or any mechanism that effectively collects chalk dust leads to a cleaner and dust-free classroom environment, enhancing the overall learning experience.
2. No More Allergy Issues: By minimizing the presence of chalk dust in the classroom, students and teachers are less likely to experience allergic reactions or respiratory discomfort.
3. Eco-Friendly: The implementation of a chalk recycling unit or any environmentally friendly solution reduces waste by recycling collected chalk powder..
4. Low Power Consumption: A system save energy but also reduces operating costs and contributes to a more sustainable and efficient use of resources.
5. Sustainability: Promoting sustainability and reducing the impact on the environment.

10.2. DISADVANTAGES

1. Repairing Difficulty: The repairs or maintenance challenging and potentially leading to downtime or disruptions.
2. High Cost of Repairing: The repair cost may high from estimated cost.
3. Hardware Glitches: There use of hardware may cause glitches during working time.

XI. SIMULATION AND RESULT ANALYSIS

11.1. SYNERGIZING PRECISION

The Interplay of Arduino, Stepper Motor, CNC Shield, and A4988Driver Modules.

- Delving into the intricacies of precision control, our technological symphony features the collaborative prowess of Arduino, Stepper Motors, CNC Shield modules, and A4988 Driver modules. Arduino, serving as the open-source maestro, directs each component, orchestrating finely-tuned movements and functions.
- At the heart of this synergy is the Stepper Motor, a specialized device designed for meticulous, step-by-step precision. Connected to the A4988 Driver module, this motor gains the capability to execute controlled movements, making it an optimal choice for diverse applications, particularly those demanding precision, such as CNC machining.
- Facilitating seamless communication and control, the CNC Shield module acts as the linchpin between Arduino and the Stepper Motor. This vital translator converts Arduino's high-level instructions into synchronized movements, ensuring accuracy in applications ranging from 3D printing to CNC milling and automated systems.
- Adding another layer of precision, the A4988 Driver module plays a pivotal role by regulating the current supplied to the Stepper Motor. This adjustable component allows for fine-tuning, catering to the specific requirements of various projects.

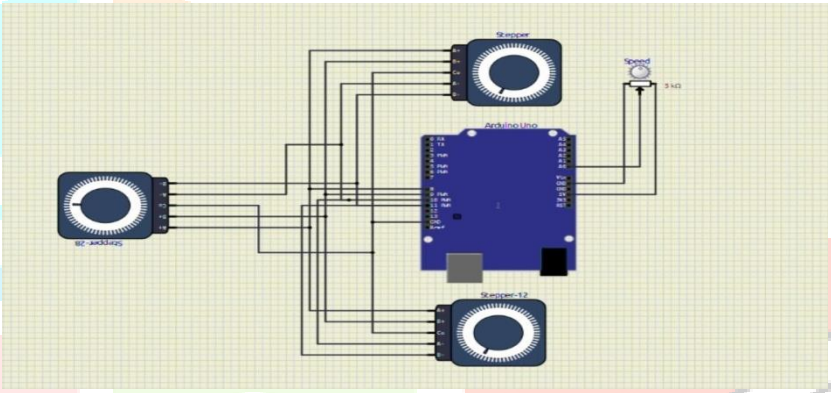

Fig.16.Simulation Circuit

11.2. CASE STUDY

11.2.1 Problem Statement

Traditional blackboards require manual cleaning and writing, which can be time-consuming and labor-intensive, especially in educational institutions with frequent use of blackboards. The challenge was to develop an automated system that could clean the blackboard surface efficiently and also write or print content as needed.

Solution Overview

The Automatic Blackboard Cleaning and Writing System is a combination of hardware and software components designed to automate the maintenance and usage of blackboards. The system includes:

- Cleaning Mechanism**:** An automated cleaning mechanism using brushes or erasers to remove chalk marks from the blackboard surface.
- Writing Module: A writing or printing module capable of generating text or diagrams on the blackboard surface as per input commands.
- Control System: A control unit or software interface that allows users to input text or graphics to be displayed on the blackboard and manages the cleaning and writing processes.

11.2.2 Problem Evaluation.

- Measure the system's ability to clean the blackboard surface effectively without leaving residues or streaks.
- Evaluate the precision and legibility of the text or graphics generated by the system.
- Quantify the time saved in blackboard maintenance and content generation using the automated system .

- Analyze the system's utilization of resources such as power, consumables (e.g., ink, cleaning solution), and maintenance requirements.
- Gather feedback from educators, students, and maintenance staff on their experience with the system
- Conduct usability tests to evaluate how easily users can operate the system and navigate its features.
- Install the 'G code tools' extension in Inkscape if it's not already installed. This extension allows you to generate G-code for CNC machines.
- Select your design in Inkscape.
- Go to Extensions > Gcodetools > Path to Gcode to convert your design into G-code. Configure settings such as cutting depth, feed rates, and toolpath options as per your CNC machine specifications.
- Save the generated G-code file (*.gcode) to your computer.
- Save the generated G-code file (*.gcode) to your computer
- Open a GRBL-compatible CNC control software (e.g., Universal Gcode Sender, GRBL Controller)

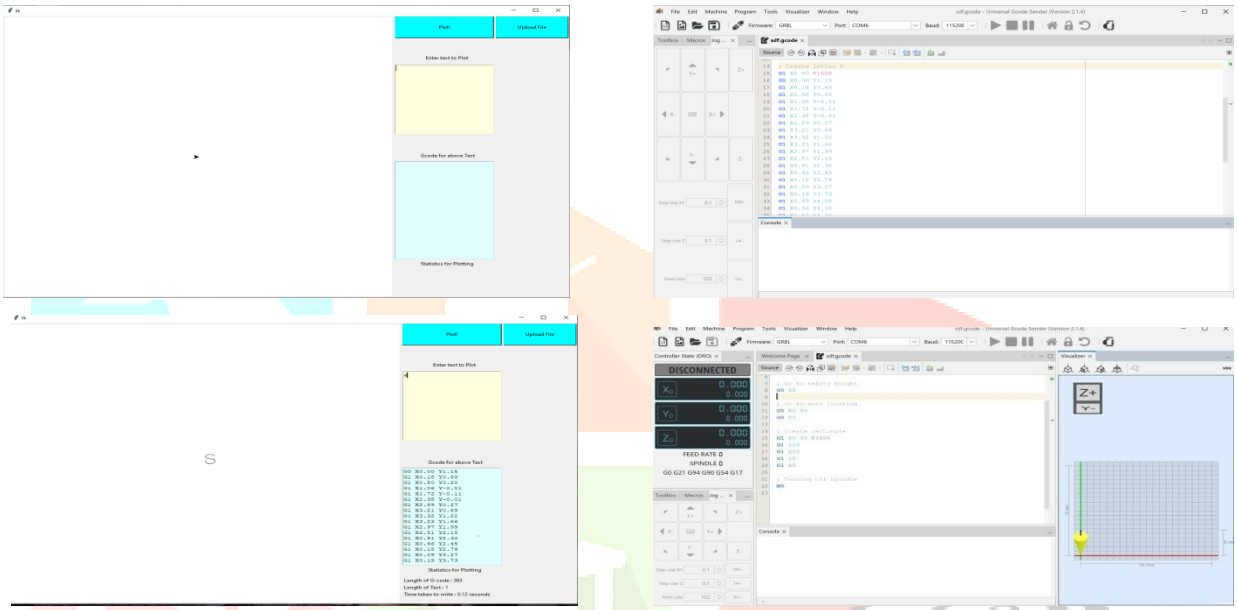

Fig.17. Input Platform

Fig.18. Output Platform

- Configure the software settings, including COM port and baud rate, to communicate with your CNC controller.
- Load the G-code file you created in Inkscape into the CNC control software.
- Calibrate your CNC XY Plotter by setting the origin point and adjusting the stepper motor settings as needed.
- Use manual control features in the CNC control software to move the plotter along the XY axes and verify proper operation.

- Once calibrated, send the G-code commands from the CNC control software to the CNC XY Plotter.
- Monitor the plotter's movements and verify that it accurately reproduces your design on the plotting surface.
- If you encounter any issues during testing, troubleshoot by checking connections, stepper motor settings, and G-code parameters.
- Refer to GRBL documentation and CNC machine guides for troubleshooting tips and solutions.
- Fine-tune G-code parameters, such as cutting speeds and depths, to optimize performance and achieve desired results.
- Experiment with different designs and materials to explore the capabilities of your CNC XY Plotter

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XII. CONCLUSIONS

The project successfully addresses the challenges associated with the teaching environment. The Automatic Board Cleaning and Writing System represents a forward-thinking and versatile solution that addresses the need for efficiency and convenience in various settings. By successfully integrating the novel technology which is more précised and user- friendly 'interfaces positions it as a valuable asset for enhancing productivity and creativity in diverse fields'. The potential impact of the project extends beyond mere automation, contributing to a more dynamic and interactive environment. In educational contexts, the system can revolutionize teaching methods, making lessons more engaging and facilitating effective presentations.
For creative professionals, the system offers a versatile tool for realizing intricate designs and fostering innovation. In office spaces, collaborative sessions become more efficient, with the ability to quickly transition between brainstorming and erasing ideas. The project not only streamlines the process of writing on surfaces but also ensures efficient and thorough cleaning, contributing to increased productivity and convenience.

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