SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR.

Mini Project/Electronic Design Workshop Report

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"The Eco-Friendly Automatic Rolling Blackboard Erasing System"

Submitted By

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1.Introduction

In modern educational settings and collaborative work environments, the need for dynamic and efficient tools for presenting information is paramount. In response to this demand, our project aims to introduce a revolutionary solution: a rotating blackboard with an automatic erasing system. This innovative design integrates cutting-edge technology to streamline the process of creating, presenting, and erasing content on a traditional blackboard surface. Our project centers around the creation of a rotating blackboard equipped with an automatic erasing system. This system comprises several key components meticulously designed and integrated to achieve seamless functionality. At the core of our design is a conveyor belt system, meticulously controlled by an Arduino microcontroller and a DC motor.

This foundational setup facilitates controlled rotation of the blackboard, ensuring smooth and precise movement essential for effective presentation and erasing.
In conjunction with the conveyor belt system, we have incorporated a sophisticated brush mechanism positioned at the rear of the blackboard. This brush, driven by a servo motor, offers unparalleled precision in its movements. By manipulating the servo motor, we can precisely control the forward and backward motions of the brush, allowing for targeted erasing actions.

The brush mechanism serves as the linchpin of our automatic erasing system. As the conveyor belt rotates, the blackboard's surface traverses past the brush mechanism. Upon contact, the brush applies controlled friction to the surface, effectively erasing any markings or letters present on the blackboard. This friction-based erasing method ensures thorough removal of content without the need for manual intervention, enhancing efficiency and user experience.

2.Impact of Project on society and the environment

1. Educational Accessibility: The rotating blackboard with automatic erasing capability can enhance the learning experience in classrooms, especially in settings where traditional whiteboards or chalkboards are used. It allows for quick erasing of content, enabling teachers to use the board more efficiently and making it easier for students to follow along with lessons.

2. Resource Efficiency: By automating the erasing process, the project reduces the need for disposable materials such as chalk or whiteboard markers. This leads to less waste generation and promotes resource efficiency in educational settings.

3. Time Saving: The automatic erasing system saves time for teachers, who would otherwise have to manually erase the board between lessons or during class time. This time-saving aspect can improve productivity in educational environments and potentially allow for more effective use of teaching time.

4. Innovation and Technology Integration: The project incorporates modern technology such as Arduino microcontrollers and servo motors, demonstrating the integration of innovation into educational tools. This exposure to technology can also benefit students by familiarizing them with concepts of automation and control systems.

5. Reduced Environmental Impact: By reducing the consumption of disposable materials and promoting efficient use of resources, the project contributes to a reduction in environmental impact. Less waste generation and resource consumption align with sustainability goals and promote environmentally friendly practices.

6. Improved Classroom Dynamics: The smooth rotation of the blackboard and automatic erasing system can improve classroom dynamics by maintaining focus on the lesson rather than on the logistics of board maintenance. This can lead to a more engaged and interactive learning environment.

7. Potential for Adaptation: The project's design can potentially be adapted for use in other settings beyond traditional classrooms, such as in offices, conference rooms, or public spaces. This versatility expands the potential impact of the technology beyond educational settings.

Overall, the rotating blackboard with an automatic erasing system has the potential to positively influence both educational practices and environmental sustainability, showcasing the benefits of innovation in addressing practical challenges.

3.Block diagram and Functional description

The block diagram represents a project where a conveyor belt is ingeniously repurposed as a rolling blackboard. This innovative setup offers dynamic information display capabilities coupled with automated erasing functionality. User interaction is facilitated through switches, allowing for precise control over the conveyor belt's movement and triggering of the automatic erasing mechanism.

Let's explore the distinctive functions of each block: -

1] Switches Block:
This block represents the physical switches (Switch 1, Switch 2, Switch 3) that are used to control the direction of movement of the conveyor belt (rolling blackboard). Switch 1 controls clockwise movement. Switch 2 controls anticlockwise movement. Switch 3 controls clockwise movement and triggers automatic erasing.

2] Arduino Nano:
Arduino Nano is a microcontroller that processes the input from the switches and generates control signals accordingly. Sends control signals to the L293D driver module for motor control and to the servo motor for automatic erasing, coordinating the overall operation of the system.

3] Power Supply:
Provides electrical power to all components of the system, including the Arduino Nano, L293D driver module, DC motor, and servo motor. Ensures that each component receives the necessary power to operate effectively and maintain system functionality.

4] L293D Driver Module:
Acts as an interface between the Arduino Nano and the DC motor. Amplifies control signals received from the Arduino Nano to drive the DC motor. Controls the direction and speed of the DC motor based on input from the Arduino Nano, ensuring precise movement of the conveyor belt.

5] DC Motor:
This block physically drives the conveyor belt, translating electrical signals from the L293D driver module into mechanical motion. Rotates the conveyor belt in the desired direction (clockwise or anticlockwise) based on signals received from the L293D driver module, enabling user-directed movement.

6] Servo Motor:
Responsible for the automatic erasing function, the servo motor moves the attached duster across the rolling blackboard. Receives control signals from the Arduino Nano to move precisely 90 degrees and attach itself at the backside of the conveyor belt for erasing, ensuring efficient removal of writing.

7] Board Mechanism:
The mechanical unit of the conveyor belt system includes a plywood board covered with Formica, supported by a frame made of rectangular wood pieces with integrated rollers. A leather sheet forms the writable surface of the blackboard. Additionally, the rexine sheet is enhanced with a whiteboard sticker, allowing for easy writing and erasing.[1]

8] Brush:
Represents the physical component responsible for erasing the writing on the rolling blackboard. Attached to the servo motor, the brush or duster moves across the surface of the blackboard, effectively removing the writing as the conveyor belt moves.

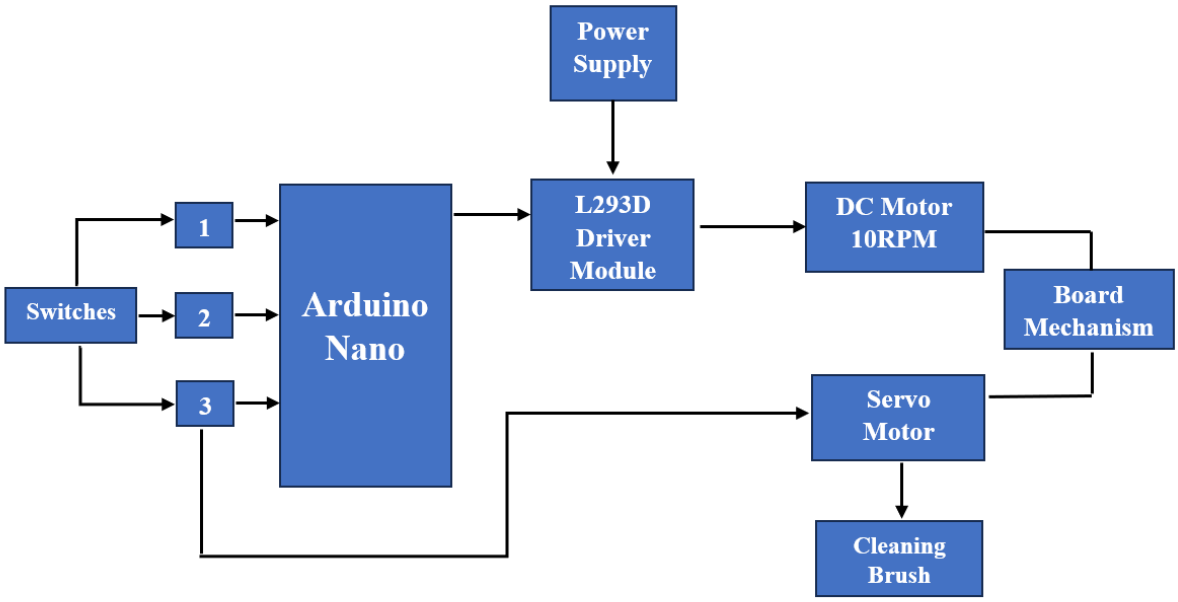


Fig – Block Diagram [2] [3]

Each block plays a crucial role in the overall operation of the project, enabling user control, motor movement, automatic erasing, and power management to create a fully functional rolling blackboard system.

4.Circuit diagram and its description

The following circuit diagram outlines the setup for controlling a DC motor using an Arduino Nano microcontroller, a L293D motor driver, and a servo motor. This setup allows for bidirectional rotation of the DC motor using two switches connected to the Arduino Nano, as well as synchronized rotation of the DC motor and servo motor using a third switch.

Components used:

1] Arduino Nano: The Arduino Nano serves as the central controller in the circuit due to its small form factor, low power consumption, and ease of programming. As a microcontroller board based on the ATmega328P, it provides a versatile platform for interfacing with various electronic components. Its digital and analog input/output pins facilitate communication with sensors, actuators, and other peripherals. In this circuit, the Arduino Nano coordinates the operation of the motor driver and servo motor, processing user input from switches and generating control signals accordingly.

2] L293D Motor Driver: The L293D motor driver is essential for interfacing the Arduino Nano with the DC motor. As a dedicated integrated circuit (IC) designed for driving small DC motors, the L293D offers several advantages, including bidirectional control, current amplification, and protection features. Its built-in H-bridge configuration enables the motor to rotate in both forward and reverse

directions, allowing for precise speed and direction control. By offloading the high-current requirements from the Arduino Nano, the motor driver protects the microcontroller from potential damage and ensures reliable motor operation.

3] DC Motor: The DC motor serves as the primary actuator in the circuit, converting electrical energy into mechanical motion. DC motors are widely used in robotics, automation, and electromechanical systems due to their simplicity, efficiency, and controllability. By varying the voltage and polarity applied to the motor terminals, its speed and direction can be adjusted, making it suitable for a wide range of applications. In this circuit, the DC motor's bidirectional rotation capability allows for versatile control, enabling tasks such as propulsion, lifting, and positioning.

4] Servo Motor: The servo motor provides precise angular control, making it ideal for applications requiring accurate positioning and motion control. Unlike DC motors, servo motors incorporate built-in feedback mechanisms (such as potentiometers or encoders) to maintain precise position control. By sending PWM (pulse-width modulation) signals to the servo motor, the Arduino Nano can control its angular position within a specified range. In this circuit, the servo motor's synchronized movement with the DC motor enables coordinated actions, enhancing the system's functionality and versatility.

5] Switches: The switches serve as user input devices, allowing for manual control over the operation of the DC motor and servo motor. By connecting the switches to the Arduino Nano's digital input pins, the system can detect when a switch is pressed or released, triggering specific actions based on user commands. In this circuit, the switches enable bidirectional control of the DC motor's rotation and activate the servo motor's movement, enhancing the system's interactivity and usability. The Vss and Vs pins of the L293D motor driver are connected to a 12V power supply to provide the necessary voltage for operation.

Circuit connections:

1] The ground pin of the L293D motor driver is connected to the ground (GND) pin of the Arduino Nano to complete the circuit.
2] Pins 6 and 7 of the Arduino Nano are connected to the input pins of the L293D motor driver to send control signals for the direction and speed of the DC motor.
3] The servo motor is connected directly to the Arduino Nano without the need for a motor driver. One pin of the servo motor is connected to a 5V pin on the Arduino Nano for power supply, while another pin is grounded. The third pin is connected to pin 9 of the Arduino Nano to receive control signals.
4] Two switches are connected to pins 4 and 3 of the Arduino Nano to control the clockwise and anticlockwise rotation of the DC motor, respectively.
5] A third switch is used to control the servo motor. When pressed, it causes the servo motor to rotate 90 degrees along with the DC motor. Upon release, the servo motor returns to its original position, and the DC motor stops rotating.

Functionality:

1] Pressing the first or second switch triggers the DC motor to rotate in the clockwise or anticlockwise direction, respectively.

2] Pressing the third switch causes the servo motor to rotate 90 degrees in synchronization with the DC motor.

3] Releasing the third switch returns the servo motor to its original position, and the DC motor stops rotating.

Circuit diagram:

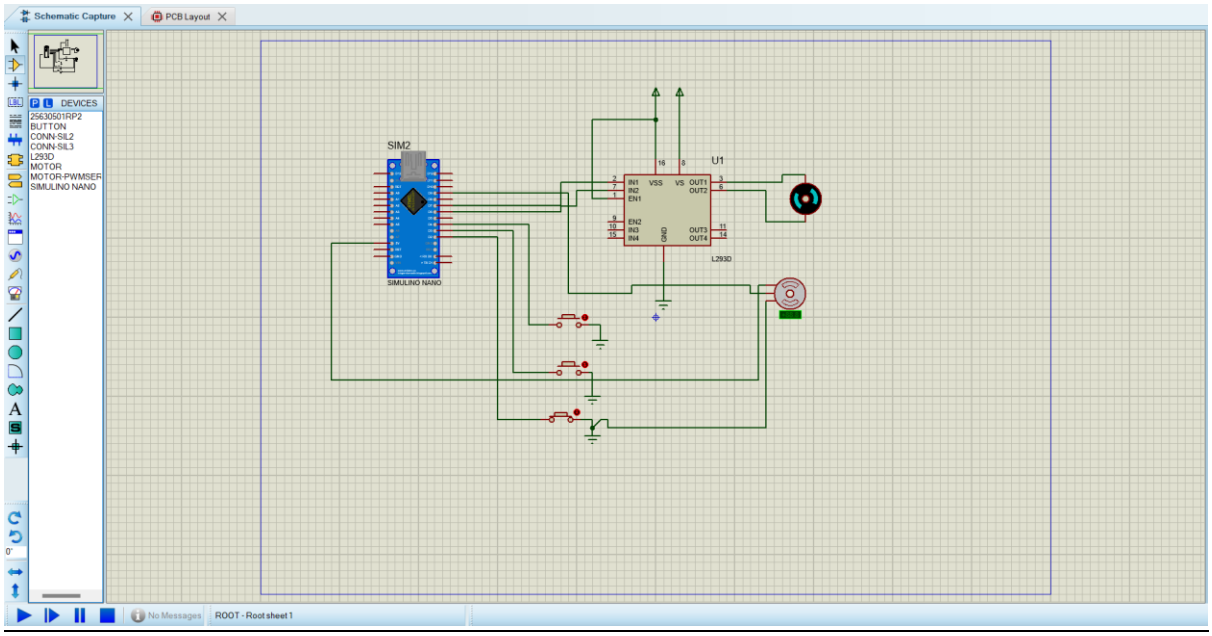


Fig – Circuit diagram of the layout created on Proteus software

5.PCB layout and Artwork

The PCB layout designed on Proteus facilitates the integration of Arduino Nano, L293D motor driver, and servo motor components into a compact and efficient circuit board. By optimizing component placement, routing traces, and ensuring signal integrity, the PCB layout enhances the overall performance, reliability, and manufacturability of the system.

PCB Layout Components and Placement:

1] Arduino Nano Placement:

The Arduino Nano is positioned centrally on the PCB to ensure easy access to its input/output pins and minimize signal routing distances.

The board's dimensions accommodate the Arduino Nano's form factor, allowing for secure mounting and alignment with other components.

Adequate clearance is maintained around the Arduino Nano to prevent interference with nearby components and facilitate heat dissipation.

2] L293D Motor Driver Mounting:
The L293D motor driver IC is strategically placed near the DC motor terminals to minimize trace lengths and reduce signal noise.
Power and ground connections are routed directly from the PCB's power supply to the motor driver to ensure stable voltage regulation and efficient motor control.
Signal traces connecting the Arduino Nano to the motor driver's input pins are routed in close proximity to minimize signal delay and optimize performance.

3] DC Motor and Servo Motor Connection:
The DC motor and servo motor terminals are located adjacent to the L293D motor driver for easy connection and cable management.
Signal traces from the motor driver's output pins to the motor terminals are routed to minimize signal interference and maximize motor performance.
The servo motor's signal wire is routed separately from the DC motor's wires to prevent crosstalk and ensure precise servo motor control.

4] Switches Integration:
The switches for controlling the DC motor rotation and servo motor movement are mounted on the PCB within reach of the user interface.
Traces connecting the switches to the Arduino Nano's digital input pins are routed efficiently to minimize signal delay and ensure responsive user interaction.
Debouncing circuits may be implemented near the switches to eliminate contact bounce and ensure reliable switch operation.

PCB Layout Design Considerations:

1] Signal Tracing and Routing:
Signal traces are routed to minimize electromagnetic interference (EMI) and maintain signal integrity.
Differential pair routing techniques may be employed for high-speed signals to minimize signal skew and reduce noise.
Ground planes are utilized to provide low-impedance return paths for signal currents and minimize ground loops.

2] Power Distribution and Decoupling:
Power distribution traces are designed to handle the current requirements of each component and minimize voltage drop.
Decoupling capacitors are placed near each component's power supply pins to filter noise and provide stable voltage regulation.

3] Component Footprint Selection:
Component footprints are chosen to match the specifications of each component and ensure proper mounting and soldering.
Through-hole components may be used for high-current connections, while surface-mount components are preferred for compactness and ease of assembly.

4] PCB Layer Stack up:
The PCB may utilize a multi-layer stack up to accommodate complex signal routing and reduce signal crosstalk.
Signal layers are arranged to minimize coupling between adjacent traces and provide shielding for sensitive signals.

PCB layout:

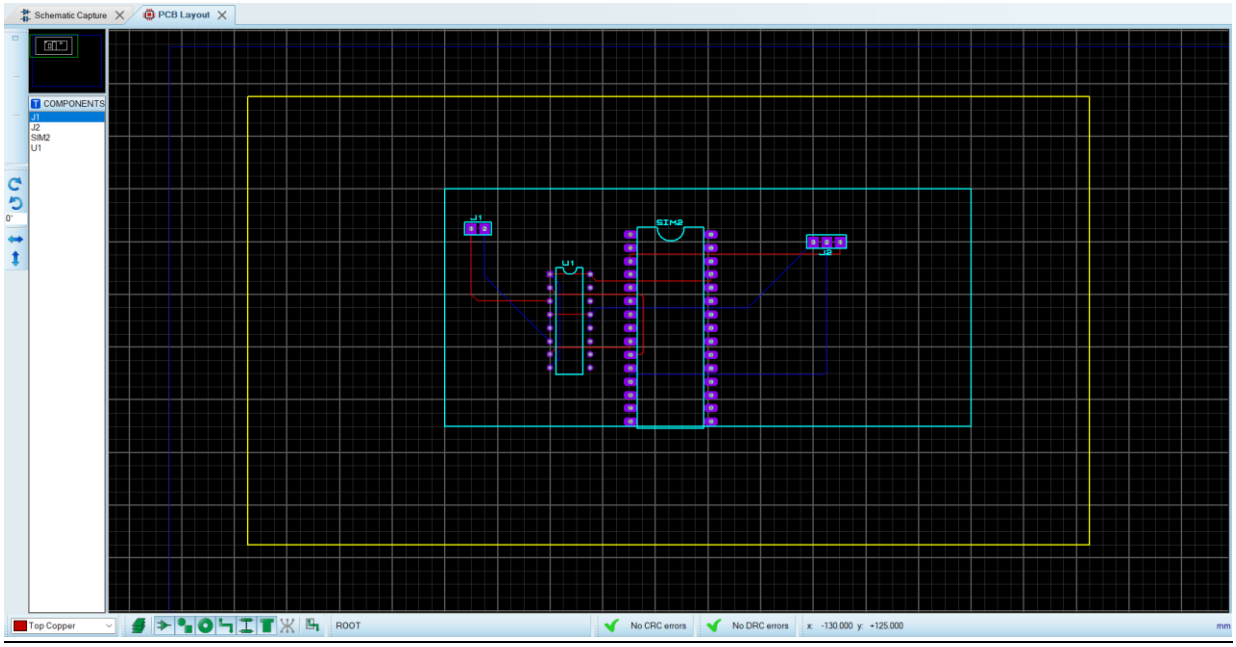


Fig – PCB layout of the schematic capture created on proteus software

6. Working of Project

In the development of our rotating blackboard featuring an automatic erasing system, we've meticulously engineered and integrated several critical components to ensure optimal functionality and efficiency. At the core of our design is a sophisticated conveyor belt system, meticulously controlled by an Arduino microcontroller in tandem with a high-performance DC motor. This dynamic duo orchestrates precise and synchronized movement of the conveyor belt, facilitating smooth and uninterrupted rotation of the blackboard.

Complementing the conveyor belt system is a precision-engineered brush mechanism strategically positioned at the rear of the blackboard. This mechanism incorporates a servo motor renowned for its exceptional accuracy and control. Through meticulous calibration and programming of the servo motor, we achieve precise manipulation of the brush's movements, enabling efficient and thorough erasure of markings on the blackboard surface.

Utilizing the frictional forces generated by the brush, our system effectively removes letters and markings from the blackboard surface without requiring manual intervention. This friction-based erasing method ensures comprehensive

removal of content, maintaining the blackboard's pristine condition and readiness for new input.

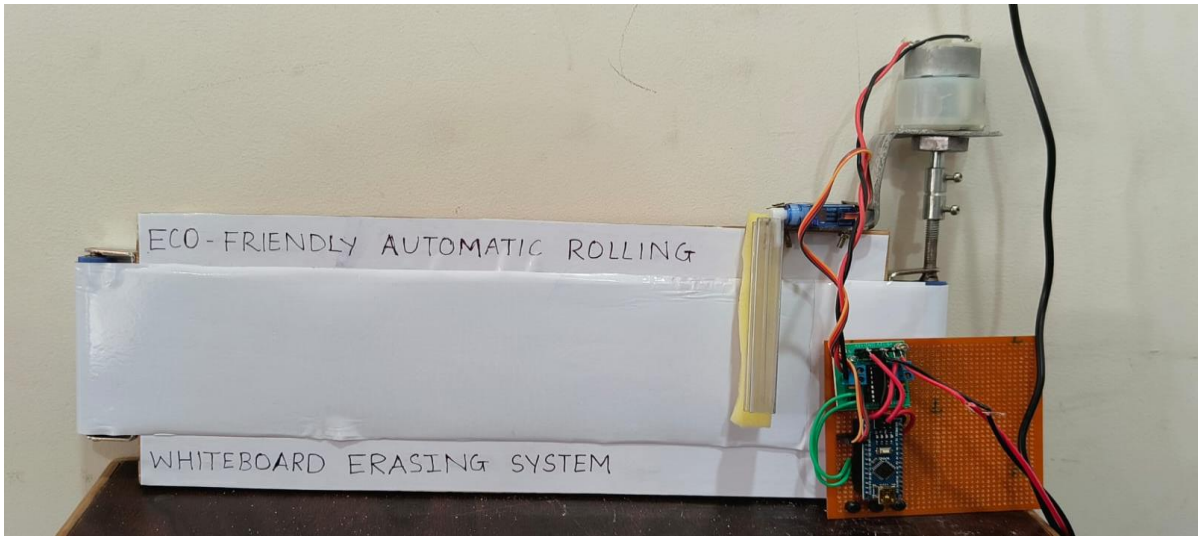
Enhancing user control and interaction, our system features three strategically placed switches. The first switch initiates clockwise rotation of the board, providing users with versatile positioning options. Conversely, the second switch activates anticlockwise rotation, facilitating optimal viewing angles and user convenience.

The third switch represents a significant innovation in blackboard technology, seamlessly integrating the servo motor into the erasing process. When activated, this switch synchronizes the servo motor's movements with the clockwise rotation of the board, initiating the erasing mechanism. This innovative feature streamlines the erasing process, ensuring precision and efficiency while enhancing user experience.

Furthermore, our system incorporates advanced features such as customizable rotation speed settings, robust safety mechanisms to prevent unintended activation, and compatibility with various writing utensils for maximum versatility. With meticulous attention to detail and innovative engineering, our rotating blackboard with an automatic erasing system sets a new standard in educational and creative environments, promoting productivity, innovation, and sustainability.

7.Result and Future Scope

In summary, the rolling blackboard with automatic erasing system has been successfully developed, offering innovative features to streamline teaching processes and enhance classroom efficiency. This technology presents significant advantages for educational institutions, as it not only reduces manual effort but also fosters student engagement through the integration of advanced technology.



The system's construction utilizes affordable and easily accessible materials, with minimal tool work required for assembly. The incorporation of an Arduino

microcontroller ensures user-friendly programming, while the integration of a servo motor facilitates precise control over the erasing mechanism.

Circuit Advantages:

Our circuit design offers several distinct advantages over traditional methods and similar projects:

1] Integrated Functionality: Unlike traditional methods that may require separate setups for the conveyor belt and erasing mechanism, our circuit integrates both functionalities into a single system. This streamlined approach reduces complexity and simplifies operation.

2] Innovative Integration: Our circuit design stands out for its innovative integration of technology, combining traditional classroom tools with modern automation. By seamlessly merging the conveyor belt system with the automatic erasing mechanism, we offer a comprehensive solution that addresses the needs of educators for efficient teaching tools.

3] User-Friendly Controls: Our circuit design incorporates user-friendly controls, such as responsive switches and intuitive operation, making it accessible and easy to use for educators and students alike. This simplifies the teaching process and promotes a more engaging learning environment.

4] Precise Motor Control: The circuit design enables precise control over the motors driving both the conveyor belt and the automatic erasing mechanism. This precision ensures smooth and accurate movement, enhancing the effectiveness of the system in maintaining a clean blackboard surface.

5] Customization and Scalability: Our circuit design allows for customization and scalability, enabling educators to tailor the system to their specific classroom requirements. Whether it's adjusting motor speeds, incorporating additional features, or expanding the system's capabilities, our design offers flexibility to adapt to diverse teaching environments.

Circuit Limitations:

1] Limited Range: The control functionality may have a limited operating range. Users must ensure they are within the specified range for effective operation.

2] Power Dependency: The system relies on a power source, whether it be batteries or mains electricity. In the event of power failure or depletion, the system may become non-functional until power is restored or batteries are replaced.

3] Maintenance Requirements: Like any electronic system, our circuit design requires periodic maintenance to ensure optimal performance. This may include cleaning, inspection of components, and potential replacement of worn-out parts over time.

4] Mechanical Wear and Tear: The moving parts of the system, such as the conveyor belt and servo motor, are subject to mechanical wear and tear over time. Regular inspection and maintenance are necessary to address any issues and ensure the longevity of the system.

Economics and Cost Analysis:

The economics and cost analysis of the project demonstrate its affordability and value proposition. With a total cost of 2700 rupees, inclusive of components and hardware, the project offers a cost-effective solution for implementing a rotating blackboard with an automatic erasing system.

Advantages of the System:

1] Efficiency: The automatic erasing system eliminates the need for manual erasing, saving time and effort for users. This efficiency is especially beneficial in educational settings, where instructors can quickly clear the board between lessons, maximizing teaching time.

2] Precision: The servo motor-controlled brush mechanism ensures precise and thorough erasure of markings on the blackboard surface, leaving behind a clean slate for new content. This precision contributes to improved readability and clarity of information presented on the blackboard.

3] Versatility: The ability to rotate the blackboard in both clockwise and anticlockwise directions offers enhanced flexibility in presentation and viewing angles. Users can easily adjust the orientation of the blackboard to suit their preferences, optimizing engagement and interaction.

4] Durability: The robust construction of the system's components ensures durability and longevity, reducing maintenance and replacement costs over time. This durability makes the system a sustainable investment, offering long-term value for educational institutions and businesses.

5] Eco-Friendly: By eliminating the need for disposable erasers and reducing paper waste associated with traditional whiteboards, the system promotes environmental sustainability. This eco-friendly approach aligns with modern principles of green technology and conservation.

In summary, the rotating blackboard with an automatic erasing system offers a cost-effective, efficient, and versatile solution for educational and professional environments. With its precise erasing capabilities, flexibility in orientation, durability, and eco-friendly design, the system provides significant advantages over traditional whiteboards, enhancing productivity and sustainability.

Applications:

While the project focuses on the development of a rolling blackboard with automatic erasing for educational settings, its innovative features and functionalities have potential applications in various other areas:

1] Business Presentations: Our system, adaptable for business settings, aids dynamic presentations and brainstorming. With automatic erasing, presenters swiftly update content, boosting collaboration.

2] Retail Displays: Retail stores can use our system for dynamic product displays and promotions. The rolling blackboard can be used to showcase product features and pricing information, with the automatic erasing feature allowing for timely updates and changes.

3] Hospitality Industry: Hotels and event venues can incorporate our system into conference rooms and event spaces for presentations and meetings. The rolling blackboard provides a versatile platform for communication and engagement during corporate events and conferences.

4] Training Facilities: Training facilities can benefit from our system for interactive training sessions and workshops. Trainers can easily illustrate concepts and ideas on the rolling blackboard, with the automatic erasing feature enabling seamless transitions between topics.

Future Scope:
The project presents several exciting opportunities for future development and enhancement:

1] Gesture Recognition: Utilizing sensors, such as touch sensors, proximity sensors, and gesture recognition technology, instead of switches can enhance user interaction. This approach eliminates the need for physical switches, making the system more intuitive and accessible to users.

2] Enhanced User Interface: Implementing a more intuitive and interactive user interface, possibly through touchscreen technology or voice commands, can improve user engagement and ease of use. This could include features such as voice-activated commands for controlling the conveyor belt movement and erasing functions.

3] Energy Efficiency and Sustainability: Implementing energy-efficient components and power management techniques reduces energy consumption and environmental impact. Integration of renewable energy sources, such as solar panels or kinetic energy harvesting, can further enhance sustainability and reduce operational costs.

4] Cloud Connectivity: Adding cloud connectivity capabilities enables remote access to the rolling blackboard system from any location. Users can access and control the blackboard, upload content, and monitor usage metrics remotely, fostering collaboration and flexibility in educational settings.

5] Modular Design for Scalability: Designing the system with a modular architecture allows for scalability and customization to meet evolving needs. Additional modules or accessories, such as document cameras, interactive projectors can be seamlessly integrated to extend the functionality of the rolling blackboard.

8.References/ Citations

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