BLACKBOARD CLEANING ROBOT

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ABSTRACT: With technological advancements, there is a growing need for machines that improve efficiency and reduce human effort. Cleaning classroom blackboards is a time-consuming task that interrupts teaching. This project introduces an automatic blackboard cleaner designed to minimize manual labor and save time. The system incorporates supporting rods, dusters, rollers, a motor, and simple electronics to erase boards effectively and quickly. Operating on a sliding door mechanism, the duster moves uniformly across the board to remove chalk dust. Additionally, the design includes a dust collection feature to maintain cleanliness. This automated device reduces physical strain on teachers and cuts cleaning time to less than half compared to manual methods. By simply activating a switch, the system performs board cleaning autonomously. Overall, the project highlights how mechanical and electronic integration can automate routine classroom tasks, enhancing teaching efficiency and the learning environment.

I.INTRODUCTION

The Automatic Blackboard Cleaning Robot is a modern mechatronics-based system designed to automate the process of erasing blackboards in educational and training environments. In many schools, colleges, and institutions, blackboards remain a primary teaching tool, requiring frequent cleaning during lectures. This repeated manual erasing can be time-consuming, inconvenient, and uncomfortable for teachers, especially during long sessions. The accumulation of chalk dust also poses hygiene concerns and can impact air quality in classrooms.

To address these challenges, the Automatic Blackboard Cleaning Robot offers an efficient and user-friendly solution. The system operates through a motor-driven mechanism that moves across the board, wiping its surface uniformly at the press of a button. By integrating mechanical components, electrical circuits, sensors, and a microcontroller-based control unit, the robot ensures smooth operation, accurate motion, and effective cleaning performance.

This project not only enhances classroom convenience but also demonstrates the practical application of automation, control systems, and mechanical design principles. It serves as an excellent learning platform for engineering students, promoting hands-on experience in system development, sensor integration, and robotics. The Automatic Blackboard Cleaning Robot represents a step toward smarter and more efficient classrooms, reducing manual effort while improving teaching productivity and overall learning environments.

II.LITERATURE REVIEW

Recent work on automated board cleaning has explored diverse electromechanical solutions to reduce manual effort, save time, and limit dust exposure in classrooms. Uma Santhosh et al. (2016) designed an automatic

blackboard duster that moves on a track using a chain-drive and motor, activated by a simple switch to erase chalk marks along the full board length [1].

Akhter et al. (2015) developed a microcontroller-based automatic whiteboard cleaner using an Arduino, DC gear motor, rack-and-pinion and sonar sensor, which traverses and reverses across the board and can clear it in about six seconds [2].

Singh et al. (2018) proposed an automated whiteboard duster where the duster is fixed and a polyester film on rollers, driven by a 12 V DC motor, moves past it, reducing user contact with marker dust and the effort needed for frequent cleaning [3]. Avinash Chandra et al. (2017) presented an automatic blackboard eraser in which a mechanically driven duster is interfaced with microcontrollers to cut erasing time and mitigate health hazards from chalk dust [3].

Manyar Imrankha Ajimkha et al. (2018) introduced a "smart duster" that employs a rope-and-pulley mechanism with limit switches and electronic control to automatically wipe long blackboards or whiteboards, improving teacher comfort and reducing dust inhalation [4].

Poornachandra et al. (2018) proposed an automated board duster using a compact high-rpm motor to rotate a duster plate and a transparent dust-collection container, all managed by a PIC microcontroller and PLC to overcome the bulk and wear issues of belt–pulley systems [5].

Saraswat and Tyagi (2017) designed a sliding-door–type automatic blackboard cleaner, where a sliding wipe mechanism, controlled via assembly-language programs through a parallel port, erases the board and collects dust in one stroke with minimal user effort. Together, these studies demonstrate that track-and-chain drives, rack-and-pinion systems, rotating films, rope-pulley arrangements, compact motorized plates and sliding frames, when integrated with microcontrollers or PLCs, provide effective, low-cost alternatives to manual erasing for modern teaching environments [6].

III. METHODOLOGY

The development of the blackboard cleaning robot followed a structured engineering methodology that combined system analysis, design, implementation, and evaluation. At the outset, the functional requirements were defined, focusing on autonomous horizontal and vertical movement, uniform cleaning coverage, and safe operation near board boundaries. Based on these requirements, both mechanical and electronic architectures were designed. The mechanical structure was modeled to support smooth linear motion across the board using a dual-motor or rail-based mechanism, while a microfiber wiper or sponge was mounted on the frame to ensure consistent surface contact. On the electronic side, components such as a microcontroller (Arduino/ESP32), motor driver, DC or servo motors, and limit or IR sensors were selected to achieve precise motion control and boundary detection. The control circuit was then developed by integrating the microcontroller with actuators and sensors, enabling automated navigation along predefined paths. Embedded software was programmed to perform sequential operations including horizontal sweeping, vertical repositioning, and return-to-home actions, with algorithms implemented to maintain constant speed, detect board edges, and ensure uniform cleaning. After assembly, the system underwent iterative testing to evaluate motion stability, cleaning efficiency, and sensor accuracy. Calibration was performed by adjusting motor speed, wiper pressure, and movement parameters, and the finalized prototype was tested on various board conditions to validate performance and reliability. This structured approach ensured that the robot met its intended goals of reducing manual effort, improving classroom hygiene, and enhancing teaching efficiency.

IV. MATERIAL SELECTION

When doing a project, it is important to pay attention to the selection of materials. To prevent waste, the items selection process must be carefully welcomed. A precise selection of items is necessary to ensure that they are long-lasting and safe for usage.

4. 1Blackboard

Fig 4.1 Blackboard without proper cleaning has become white

A blackboard or chalkboard is a reusable writing surface used with chalk sticks made from calcium sulphate or calcium carbonate. Early blackboards were made from smooth sheets of black or dark grey slate, while many modern boards are simply wooden or metal panels painted with matte black or dark green paint that is easier on the eyes

4.2 Duster

Fig 4.2 Duster

Duster Sponge and cloth will be used for now as a duster material. Later we will be adopting the best material which can clean the board even better.

4.3 Motor

Fig 4.3 Motor

In this project, the two brushes are rotated or moved by DC motors. It is powered by 12 volts and runs at 40 rpm.

4.4 Charger

Fig 4.4 Charger

The primary energy source for the "Fan Blade Cleaner" is Charger with a 12 volt capacity.

4.5 Driver module: l293d

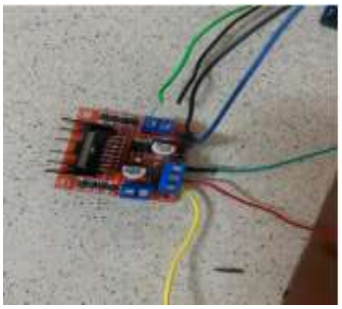

Fig 4.5 Driver module

Motor driver is used along with Arduino to power the motor with 12V DC supply.

4.6 Microcontroller: ARDUINO

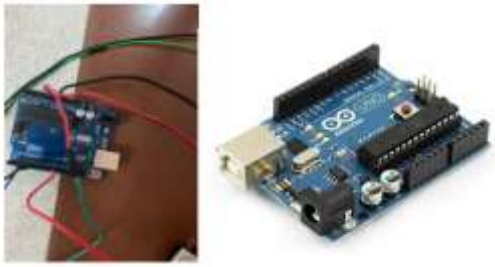

Fig 4.6 ARDUINO

Arduino is a microcontroller; it's used here to control the motor to change direction upon getting inputs from limit switch.

4.7 Limit switch

Fig 4.7 Limit switch

Limit switch allows Arduino to know that motor assembly has reached the end of the board thereby giving a signal to Arduino to spin the motor in opposite direction, hence saving the whole assembly from any damage.

4.8 Rods: 10 mm diameter rods – 3 no.

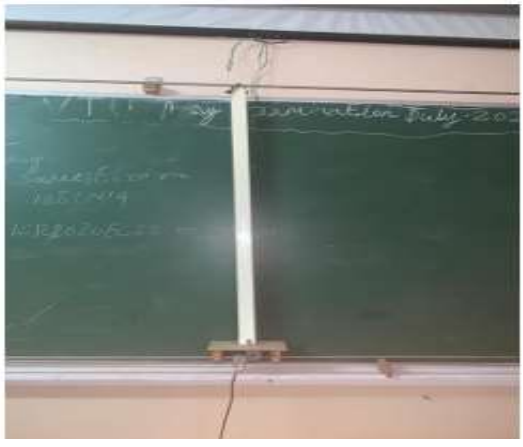

Fig 4.8 Rods

Rods are placed on top and bottom of the blackboard. It provides smooth motion for the motor assembly across the board. There are 2 rods on the bottom rail and 1 on the top of the board.

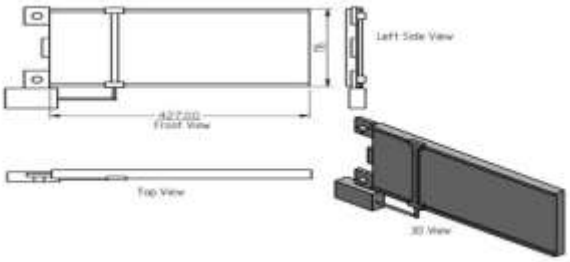

Fig4.9: Proposed 3D view of the design

V. Results and Discussion

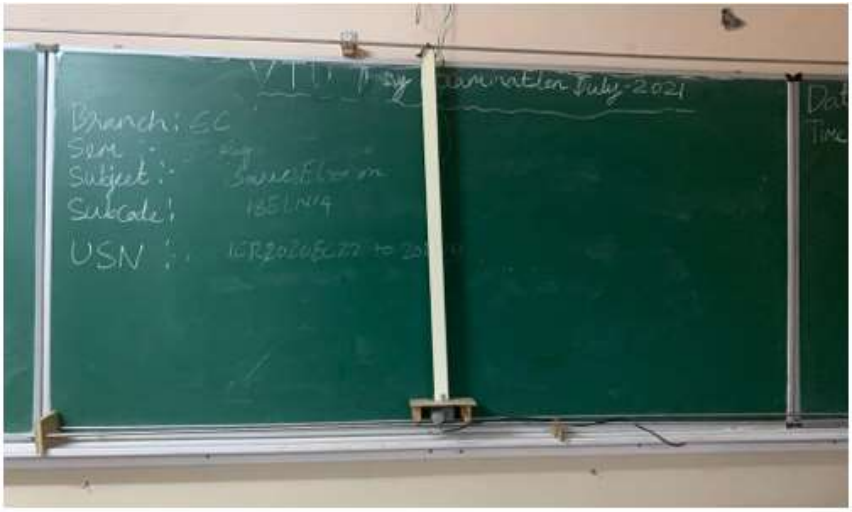

Fig.5: Completed blackboard cleaning robot

5.1 Working principle

When the system is powered on, the controller initializes the motors, limit switches, and any sensors, and then remains in an idle state waiting for a "clean board" command from a push button or switch. On receiving this command, the controller energizes the main drive motor, which moves a carriage carrying the duster along a track or chain guide mounted parallel to the blackboard surface.

The duster is pressed lightly against the board so that, as the carriage travels from one end to the other, the chalk writing is wiped off in a single or multiple passes, depending on the programmed routine. Limit switches or position sensors at the ends of the board detect when the carriage reaches the boundary; the controller then either reverses the motor direction for another pass or stops the motion once the required cleaning is completed.

After the final pass, the controller drives the carriage back to its home or parking position and de-energizes the motors, leaving the system ready for the next cleaning command with the board completely erased.

VI. Conclusion and Future Scope

Conclusion:

Board cleaning robot is a breakthrough in classroom-based teaching where students interact with teachers using a blackboard, this project will change the experience of students in the classroom and help them concentrate more in studying rather than waiting for the teacher to clean the board. Some of the major takeaways from this project are:

- Board cleaning robot will revolutionize the existing duster.

• This project will enhance the classroom experience of students.
• Both students and teachers will benefit from this project.

Future Scope:

- Implement in large scale.
- Bring it to the market.
- Add more features.
- Make the cleaning process efficient & less time consuming

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