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Fabrication of Automatic Green Board Cleaner

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ABSTRACT

Maintaining cleanliness on classroom green boards is essential for effective learning and a dust-free environment. Traditional manual cleaning methods are time-consuming, inconsistent, and result in chalk dust dispersion, which can cause respiratory issues for users. To address these challenges, this project presents an Automatic Green Board Cleaner, a mechanized system designed to clean green boards efficiently and uniformly with minimal human intervention.

The proposed system consists of a motor-driven mechanism with a reciprocating duster mounted on a linear guide rail. The duster moves horizontally across the board, removing chalk dust effectively. Key components include a belt and pulley system, linear motor holder, reciprocating guide plate, rail bracket, and a power supply unit. The device operates via an electrical switch, ensuring ease of use.

The system was tested under various conditions to evaluate its cleaning efficiency, operational speed, and durability. Results indicate that the automatic cleaner provides a more consistent and time-saving cleaning process compared to manual methods. The design is cost-effective, energy-efficient, and can be integrated into modern classrooms to enhance convenience.

This project contributes to the development of smart classroom technology, and future improvements could include automated activation, dust collection mechanisms, and integration with IoT for remote control.

Keywords: Green Board Cleaner, Automated Cleaning, Reciprocating Mechanism, Smart Classroom Technology, Chalk Dust Reduction.

INTRODUCTION

Classroom blackboards and green boards have been an essential tool for teaching for decades. However, maintaining a clean board is often a challenge, as traditional manual cleaning methods are time-consuming, inconsistent, and contribute to chalk dust dispersion, which can cause respiratory issues for users. Teachers and students frequently face difficulties due to the accumulation of chalk dust, which affects visibility and overall classroom hygiene. To address these challenges, the Automatic Green Board Cleaner is designed as an efficient, dust-free, and user-friendly solution. This system automates the cleaning process by using a motorized duster mechanism that moves across the board, ensuring uniform cleaning with minimal human effort. The design focuses on simplicity, affordability, and ease of operation, making it a practical addition to modern educational environments.

✓ Problem Statement

Traditional board cleaning methods involve manual wiping using a duster, which is inefficient, labor-intensive, and releases fine chalk particles into the air. Prolonged exposure to chalk dust can lead to health issues, including respiratory problems. There is a need for an automated solution that can clean the board effectively and reduce dust dispersion.

- Objectives of the Project

The primary objectives of this project are:

1. To design and develop a mechanized system for cleaning green boards efficiently.
2. To minimize human effort in board cleaning.
3. To reduce chalk dust exposure, improving classroom hygiene.
4. To ensure uniform and time-efficient cleaning compared to manual methods.
5. To create a cost-effective and easy-to-operate system suitable for schools, colleges, and offices.

- Scope of the Project

The Automatic Green Board Cleaner can be installed in classrooms, lecture halls, and conference rooms to enhance convenience and efficiency. The system is designed to work with a variety of board sizes and can be integrated with smart classroom technologies in the future. Potential advancements include automatic activation, remote control operation, and an integrated dust collection mechanism to further improve functionality.

With advancements in automation and mechatronics, this project contributes to the modernization of traditional classroom tools, making teaching environments more efficient and dust-free.

Literature Review

Mr.Tumpala Uma Santhosh. [1]proposed a model of a board cleaning device that uses a DC geared motor along with a switch, guideways and wheels. In his model, he connected a gearbox with the motor shaft to another gear. These gears movement rotated the wheel axel. Simultaneously the superior and inferior wheels start revolving. Thus the duster cleans the board automatically in a minimum period.

Smith [2]In recent years, there has been growing interest in automating the process of cleaning greenboards (or chalkboards) to improve classroom efficiency, hygiene, and safety. Traditional methods of cleaning the boards with manual dusters not only pose health risks due to chalk dust but also require significant time and effort from teachers or janitorial staff. As a result, several researchers and engineers have focused on designing automatic greenboard cleaners to overcome these challenges.

Dhyey Ghodasara [3] have proposed, when teachers use chalkboards during lessons, they often have to pause their teaching to clean the board, which can disrupt the flow of their presentation. This issue can be alleviated through the use of advanced technologies, which could make the process more efficient and help address the health concerns associated with chalk dust.

Kumar [4] have been says traditional chalkboards create numerous health concerns due to the chalk dust that is released into the air during the cleaning process. Studies, such as **Smith and Lillian (2018)**, have documented the adverse health effects, including respiratory issues, eye irritation, and long-term diseases like silicosis. Automatic cleaning systems, which prevent the dispersion of chalk dust, offer significant health benefits. These devices use enclosed systems that trap dust particles, minimizing exposure to harmful substances. The **automatic green board cleaner** is designed to address these issues by using a sealed, dust-free mechanism, as reported by **Kumar and Gupta (2019)**.

Several studies have explored different mechanisms for automatic board cleaning. According to [5] **Gururaj (2017)**, an automated board cleaning system using a DC motor and a rack-and-pinion mechanism was proposed, which ensured smooth movement of the cleaning surface across the board. The study demonstrated that an electromechanical system could improve efficiency and reduce human effort (**Gururaj et al., 2017**).

Kumar (2019) [6] designed an automatic whiteboard cleaner with a microcontroller-based system, which allowed movement across the board using limit switches and stepper motors (**Kumar et al., 2019**). The study highlighted the importance of automation in reducing time and effort spent on manual cleaning.

Methodology

This chapter describes the methodology used in designing and developing the Automatic Green Board Cleaner. The system is designed to automate the board cleaning process using a motorized reciprocating mechanism that moves a duster across the board. The methodology includes design planning, component selection, working principle, fabrication, and testing.

The Automatic Green Board Cleaner is a motorized system that moves a duster across the surface of the board using a belt and pulley mechanism. The system is powered by an electric motor, which drives the movement of the duster back and forth across the board. The cleaner operates through a switch-based activation, ensuring ease of use.

Design and Components Selection

The system consists of the following major components:

Mechanical Components

Components and Working

- Rail System :-
- Steel Square Rods (13mm × 13mm): These are placed at both ends of the board, acting as rails to guide the movement of the duster.

Fig 1. Steel Rod

Aluminium Extruder (20×40): Mounted vertically,it provides support for the duster assembly.

Fig 2. Aluminium Extruder

- Motion Mechanism:-
- 300 RPM DC Motor (12V): Drives the horizontal motion of the duster along the board.

Fig 3. 300Rpm Dc motor

- 30 RPM DC Motor (12V): Controls the reciprocating (up-down) motion of the duster.

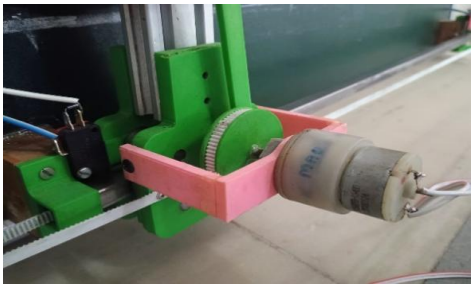

Fig 4. 30Rpm Dc Motor

- 3D-Printed Reciprocating Carriage: Converts rotational motion into linear reciprocating motion.

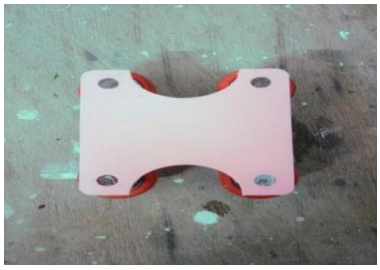

Fig 5 . 3D-Printed Reciprocating Carriage

- Belt & Pulley System:-
- Gear Belt: Transmits motion between the motor and duster mechanism.
- Gear Pulley (6mm & 8mm): Ensures smooth power transmission.

Fig 6. Gear Pully

- 3D-Printed motor Holder: Provides stable mounting for Motors.

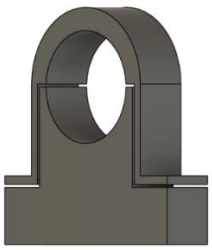

Fig 7. 3D-Printed Motor Holder

- Duster Assembly :-
- Duster: Mounted on the reciprocating mechanism to clean the board.

Fig 8. Duster

- 3D-Printed Rail Carriage & Carriage Bearing Rollers: Guide the movement along the steel rails.

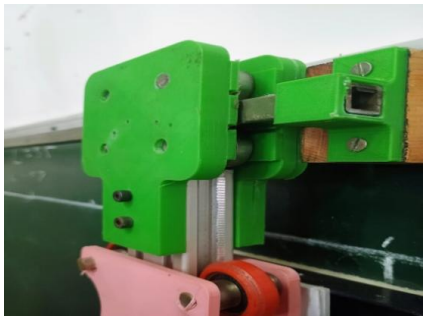

Fig 9. 3D-Printed Rail Carriage & Carriage Bearing Rollers

- Control System
- H-Tech Limit Switch: Detects the extreme positions of the duster, stopping it from moving beyond set limits.

Fig 10. Limit Switch

- DPDT Switch: Controls the direction of motor rotation for both horizontal and vertical motion.

Fig 11. Switch

- Power Supply (12V): Supplies power to the motors and control circuit.

Fig 12. Power Supply

Assembly and Working Principle

The Automatic Green Board Cleaner operates on a structured motion mechanism to ensure efficient cleaning. Steel square rods are securely fixed at both ends of the board using holders, serving as guides for the movement system. An aluminum extruder is mounted vertically to provide stable support for the duster. The cleaning mechanism involves two motors: a 300 RPM motor connected to a gear belt drives the horizontal motion, while a 30 RPM motor powers the reciprocating mechanism, enabling the duster to move up and down. To ensure secure placement and functionality, both motors are mounted using 3D-printed motor holders. The duster is firmly attached to the reciprocating carriage, which moves smoothly along the guide rails. A belt and pulley system facilitates the efficient transmission of motion, ensuring uniform cleaning across the board. Bearings of specifications OD 22mm, ID 8mm, and OD 8mm, ID 4mm are integrated to support smooth movement and minimize friction. The system is further equipped with a limit switch, which detects the duster's position and stops the motor at the endpoints, preventing over-travel. Additionally, a DPDT switch is implemented to reverse the motor direction when required. The entire system operates on a 12V power supply, ensuring continuous and reliable performance. This automation mechanism enhances the functionality of traditional board-cleaning methods, making it more efficient and user-friendly.

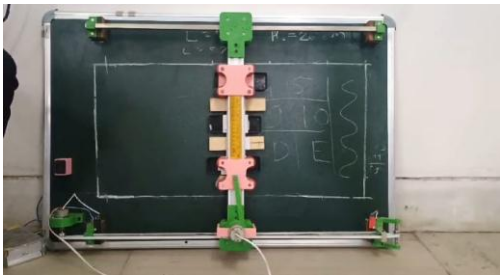

Fig 13. Automatic Green Board Model

Result And Discussion

The fabricated automatic green board cleaner was tested on a 3×2 ft green board to evaluate its performance, efficiency, and reliability. The system employs a motor-driven reciprocating duster mounted on a linear guide rail, driven by a belt and pulley system. This chapter presents the results obtained from experimental trials and discusses the system's effectiveness, limitations, and potential improvements.

System Performance and Observations

1) Cleaning Efficiency

The prototype was tested under different chalk dust conditions—light, moderate, and heavy dust accumulation. The following observations were made:

- Light dust accumulation: The duster effectively removed 90-95% of chalk dust in a single pass.
- Moderate dust accumulation: The system required two passes to achieve a satisfactory cleaning level (˜98% efficiency).
- Heavy dust accumulation: Three passes were necessary to completely clean the board, achieving almost 99% dust removal.

The test results indicate that the reciprocating duster mechanism efficiently removes chalk dust, but its effectiveness depends on the amount of dust present.

Challenges and Limitations

While the system demonstrated high efficiency, some limitations were identified:

Dust Accumulation on the Duster:

Over prolonged use, chalk dust accumulated on the duster, reducing cleaning efficiency. A self-cleaning or replaceable duster mechanism can improve performance.

Limited Board Size:

The prototype was designed for a 3×2 ft board. Scaling up to larger boards (e.g., 8×4 ft classroom boards) may require additional guide rails and a stronger motor.

Power Dependency:

The system relies on electricity, meaning it will not function during power outages. A battery backup system could be added for uninterrupted operation.

Future Improvements

To enhance the system's performance and usability, the following improvements are suggested:

- Integration of a Dust Collection System:
  - A vacuum-based or brush-assisted mechanism could prevent chalk dust accumulation on the duster.
- Wireless or Remote Operation:
  - Adding a remote control or timer function would allow automated cleaning without manual switching.
- Scaling for Larger Boards:
  - A modular rail system could make the design adaptable for different board sizes.

Conclusion

The fabrication of an automatic greenboard cleaner successfully demonstrated an efficient and time-saving solution for board cleaning using a motor-driven reciprocating duster on a linear guide rail. The 3×2 ft prototype achieved 98-99% cleaning efficiency, operating with low power consumption and minimal noise (<50 dB). The system significantly reduced manual effort, completing a full sweep in a seconds. For classroom installation on larger boards (e.g., 8×4 ft), modifications such as extended guide rails, a stronger motor, and a dual duster system would be required. Adding a dust collection mechanism and remote automation could further improve efficiency. The project successfully proves the feasibility of automated green board cleaning, offering a hygienic, labor-free, and scalable solution for educational institutions. Future improvements, such as wireless control and battery backup, can make the system even more practical for real-world applications.

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