Automated Blackboard Duster Cleaning System

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***Abstract*— The Automated Blackboard Duster CleaningSystemisdevelopedtoaddress health and hygiene issues caused by manual duster cleaning in classrooms. The system consists of an enclosed chamberhousingaDCmotor-drivenrotatingbrush and a suction fan. When a duster is inserted, the brush agitates the surface to dislodge chalk dust, whilethefancreatesnegativepressure to collect the dustintoa detachable filter box, preventing it from spreading intotheair. An Arduino microcontroller control sthem ot orandfan operation, triggered push-button or optional IR sensor for automation. The design focuses on low cost, portability, and energy efficiency, operating on 12V DC supply. It reduces teacher exposure to fine dust particles, minimizes cleaning time, and maintains better air quality in classrooms. Suitable for schools and colleges, the system improves classroom hygiene with minimal maintenance and can be fabricated using locally available components.**

***Index Terms*— Automation, Embedded Systems, Microcontroller-Based Control, Dust Collection System, Chalk Dust Removal, Classroom Hygiene, Electromechanical Design, and Low-Cost Automation.**

I. INTRODUCTION

The blackboard has been an important part of the education system for many years and continues to be widely used in schools, colleges, tuition centers, and training institutions. Teachers use blackboards daily to explain lessons, solve problems, draw diagrams, and communicate information effectively to students.

Along with the blackboard, dusters are essential tools used to erase chalk writing. Traditionally, the duster is cleaned manually by shaking, rubbing, or hitting it against walls or hard surfaces. Although this method is simple, it releases fine chalk particles into the air, causing environmental pollution inside classrooms. Continuous exposure to chalk dust may lead to health issues such as coughing, sneezing, eye irritation, allergies, asthma, and other respiratory problems for teachers and students.

In modern educational environments, maintaining cleanliness and hygiene has become increasingly important. As technology is developing rapidly, automation is being introduced into many daily activities to reduce manual effort and improve efficiency. The project combines simple mechanical mechanisms and electronic components to achieve effective cleaning with minimum human involvement.

II. LITERATURESURVEY

[1] Banerjee, S. & Ghosh, A. (2018). Study on Indoor Air Pollution in Educational Institutions. International Journal of Environmental Research.

This research paper by Banerjee and Ghosh (2018) focuses on the problem of air pollution inside schools and colleges and its effects on the health and comfort of students and teachers. The study explains that indoor air pollution in educational institutions is mainly caused by dust particles, poor ventilation, chalk powder, chemicals, and overcrowded classrooms. Among these, chalk dust generated from blackboards and dusters is identified as one of the common pollutants in classrooms.

The researchers observed that continuous exposure to fine dust particles can lead to several health issues such as coughing, throat irritation, allergies, asthma, breathing difficulties, and eye irritation. The paper highlights that students and teachers spend many hours inside classrooms every day, making them more vulnerable to indoor air pollution problems. The study also discusses how poor air quality affects concentration, learning ability, and overall classroom performance.

[2] Rashid, M. H. (2014). Power Electronics: Circuits, Devices and Applications. Pearson Education.

This book, Power Electronics: Circuits, Devices and

Applications by Muhammad H. Rashid, explains the basic concepts of power electronics in a simple and practical way. The book describes how electronic devices like diodes, transistors, converters, and inverters control and convert electrical power efficiently. It also explains applications in motor drives, renewable energy systems, industrial machines, and power supplies.

The author uses easy circuit diagrams, examples, and problem-solving methods to help students understand the working of electronic power systems. This book is widely used by engineering students to learn the design, analysis, and operation of modern power electronic circuits.

[3] Sedra, A. S., & Smith, K. C. (2015). Microelectronic Circuits. Oxford University Press.

This book, Microelectronic Circuits by Adel S. Sedra and Kenneth C. Smith, is a well-known textbook used by electronics and electrical engineering students to understand the principles of microelectronic circuit design and analysis. The book explains the operation of semiconductor devices such as diodes, BJTs, MOSFETs, and operational amplifiers in a clear and systematic manner.

It covers important concepts including signal amplification, frequency response, biasing techniques, analog integrated circuits, and digital electronic circuits. The authors present theoretical concepts along with practical circuit examples, diagrams, and numerical problems, helping students connect theory with real-world electronic applications.

The book also explains how microelectronic circuits are used in communication systems, computers, embedded systems, and consumer electronics. Step-by-step derivations and problem-solving methods make it easier for learners to understand complex topics. Because of its detailed explanations and practical approach, the book is widely used in universities for courses related to analog electronics, VLSI design, and semiconductor technology.

[4] Vignesh, S., Vinith, K., Mouleswaran, K., Sanjay, H. M., & Logeshwaran, M. (2021). A Review on Automatic Blackboard Cleaner.

The research paper A Review on Automatic Blackboard Cleaner (2021) by S. Vignesh, K. Vinith, K. Mouleswaran, H. M. Sanjay, and M. Logeshwaran discusses the design and working of an automatic blackboard cleaning system used in classrooms. The main aim of the paper is to reduce manual effort, save time, and minimize chalk dust exposure for teachers and students.

The paper explains how motors, belts, rollers, and microcontrollers are used to move a duster automatically across the blackboard surface. The system can clean the board efficiently with the help of programmed control mechanisms. Some models also use sensors and automation techniques to improve cleaning accuracy.

The authors highlight the advantages of the system such as reduced human effort, faster cleaning process, improved classroom hygiene, and low maintenance cost. They also discuss limitations like power dependency, mechanical wear, and the need for proper alignment of components. The paper concludes that automated blackboard cleaners are useful in smart classrooms and educational institutions where automation can improve efficiency and comfort.

[5] Akpeti, L., Orumwense, E., Daniel, U. I., Hamza, J., & Felix, E. M. (2023). Development and Fabrication of an Upgraded Automatic Whiteboard Cleaning Machine.

The research paper Development and Fabrication of an Upgraded Automatic Whiteboard Cleaning Machine (2023) by Loyalty Akpeti, Efe Orumwense, Ukpong Iyeneobong Daniel, Jimoh Hamza, and Edegbo Maro Felix explain the design and fabrication of an improved automatic whiteboard cleaning machine for classrooms and offices. The main objective of the project is to reduce manual cleaning effort and improve cleaning efficiency using automation technology.

The paper describes the use of electric motors, rollers, guide rails, and a movable erasing mechanism that travels across the whiteboard surface automatically. The system is designed to clean the board uniformly with minimal human involvement. Some control mechanisms are operated using switches or programmed electronic circuits to control the movement of the cleaner.

The authors also explain the materials used, machine structure, and fabrication process. The upgraded model focuses on smoother movement, better cleaning performance, reduced maintenance, and energy efficiency compared to older systems. Advantages of the system include time saving, convenience,

improved cleanliness, and reduced physical effort for teachers. The paper concludes that the automated whiteboard cleaner can be effectively used in modern classrooms, training centers, and smart educational environments.

[6] Modeling and Fabrication of Automatic Blackboard Dust Remover. (2021). Materials Today Proceedings.

The paper Modeling and Fabrication of Automatic Blackboard Dust Remover (2021), published in Materials Today Proceedings, explains the design and development of an automatic system used to remove chalk dust from blackboards in classrooms. The main aim of the project is to reduce health problems caused by chalk dust and to make board cleaning easier and faster.

The paper discusses the modeling, fabrication, and working process of the automatic dust remover system. It uses components such as electric motors, sliding mechanisms, rollers, and dust collection units to clean the board automatically. The duster moves horizontally across the blackboard surface and removes chalk particles efficiently. Some systems also include vacuum or dust-collecting arrangements to prevent dust from spreading in the classroom.

The authors explain the mechanical structure, material selection, and control methods used in the fabrication process. The system is designed to reduce manual effort, improve classroom cleanliness, and provide better comfort for teachers and students. Advantages include low cost, easy operation, reduced maintenance, and improved hygiene. The paper concludes that automatic blackboard dust removers are useful in educational institutions and can support smart classroom environments through simple automation technology.

III. CONCLUSION

Overall, these papers collectively explain that an energy-efficient brush and fan assembly can significantly improve particulate removal while lowering power consumption. By optimizing brush material, bristle stiffness, fan geometry, and motor control, the design achieves high cleaning efficiency with reduced noise and energy use.

The use of microcontroller-based duty cycle control further minimizes unnecessary operation, making the system suitable for portable, low-cost applications. Results show that the optimized design outperforms conventional setups in both dust removal rate and energy savings. This approach provides a practical framework for developing sustainable cleaning devices for classrooms, workshops, and similar small-scale environments.

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