AUTOMATIC BLACKBOARD ERASER ROBOT

S Deepti*[1] | T Vandana[2] | K Navya[3] | K Spandhana[4]

1 Associate Professor & HOD-EEE Department, Bhoj Reddy Engineering College for Women, Hyderabad, Telangana, India.

2, 3&4 Undergraduate Students, Bhoj Reddy Engineering College for Women, Hyderabad, Telangana, India.

Abstract:

Manual blackboard cleaning is a repetitive and time-consuming task in educational institutions, often interrupting the teaching process and causing inconvenience. This proposed paper introduces an Automatic Blackboard Eraser Robot, designed to efficiently clean the board with minimal human effort. The system is equipped with a geared DC motor and a microcontroller based control unit, allowing it to move smoothly across the board and erase content uniformly. It offers three modes of control—Bluetooth via smartphone, RF remote control, and manual switch operation, giving users flexible control over its functions. The robot features four directional keys: two for high-speed left and right movement, and two for low-speed left and right movement. Powered through a regulated power supply with components such as a voltage regulator, relay module, and RF transmitter/receiver (433 MHz), the system ensures safety and reliability. This smart solution not only improves classroom cleanliness but also introduces automation concepts to students, making it both practical and educational

Keywords: *Arduino, Bluetooth, RF Remote, Manual Switch, Wireless Control, Speed Control, Microcontroller-based Control*

1. INTRODUCTION

The manual cleaning of blackboards in classrooms is often time-consuming and physically demanding for teachers, impacting their efficiency. Traditional methods of erasing chalk marks may also leave residues, reducing the clarity of the board and affecting the learning environment. In response to these challenges, automating the blackboard cleaning process has become essential to improve classroom hygiene and support educators. Implementing a controlled robotic system allows for consistent, quick, and effective erasing, enhancing overall classroom productivity.

A. S. Rajput and P. V. Sutar [2017] proposed an automated blackboard cleaner using a basic microcontroller-based approach. Their system was designed to move a foam-based erasing mechanism horizontally across the board using a DC motor controlled by an 8051 microcontroller, the system lacked wireless control options such as Bluetooth or RF, making it less flexible. Additionally, there

were no limit switches to detect the board edges, which increased the risk of motor overshoot.Despite these drawbacks, their work served as a foundational concept for later designs. [1]

Patil Mayuri.S ,Tamboli Snehal.R, Dunke Pooja.R and Batwal Namrata.D (2018)this literature review aims to inform “Automatic Blackboard Cleaner”,This is the method in which two dc motor to move the strip horizontally on the blackboard to this strip we will stick the sponge which will clean the board as soon as it moves horizontally from left to right and again from right to left. An automatic blackboard cleaner comprises of blackboard plate including plate upper edge and lower edge which are arranged in spaced in parallel relationship on which rack is arranged and through the motor will move pinion on the rack horizontally in forward and backward direction.[2]

S. Vignesh K, Vinith, K, Mouleswaran, H. M. Sanjay(2021) focused on making This paper is helpful in the cleaning of the board along with various positive impacts and it will reduce various health hazards to a user which they encountered during cleaning, the tiny dust particles from the board that comes in direct contact with eyes nose, skin. The main objective of the present automatic blackboard duster is to provide an attachment for blackboards in the form of a power-driven erasing apparatus which can be set in operation by a switch, thus eliminating the drudgery of manually cleaning blackboards.[3]

Sanjay S Tippannavar and Preethi G (2023) introduced the concept on "Design and Implementation of a Dust Remover from a Conventional Blackboard Duster to Prevent Respiratory Problems." The information on product development, automation, and numerous components.The primary goal of this paper is to automatically remove the chalk dust from a traditional blackboard duster where the dust is collected after removal, protecting neither the instructor nor the pupils from dangerous dust particles [4]

Dr.Rangarajan(2023) advanced the idea by developing an "Design and Fabrication of Automated Board Cleaner ." the construction and model of automated board cleaner is done through manual & Auto cad software and validated for the dimensional accuracies for each component. The fabrication process is initiated through the designed Auto cad model.The "Automated Board Cleaner" is a superb alternative to the "Manual Duster" with an automation system that further enhances the quality of smart classrooms. [5]

The main limitation of current blackboard cleaning practices is their reliance on manual effort, which can be physically exhausting and time-consuming for teachers. Most existing solutions do not integrate automation, wireless control, or adaptive features that can streamline the process effectively. To overcome these limitations, an Automatic Blackboard Eraser System is proposed as a microcontroller-based hardware solution that enhances classroom maintenance by automating the erasing process. The system ensures consistent cleaning, reduces the physical burden on teachers, and supports a more efficient learning environment.In the proposed system, the blackboard eraser is

mounted on a motorized frame that moves horizontally across the board. The blackboard used in the project has a length of 22 cm and a breadth of 14 cm. Based on this, the duster was designed with an estimated length of 10–12 cm and a breadth of 4–5 cm, making it suitable for effective cleaning and easy movement across the board.This paper introduces an advanced classroom automation solution. It utilizes embedded systems technology and wireless communication to provide a user-friendly, efficient, and reliable blackboard erasing mechanism.

2. BLOCK DIAGRAM

The block diagram For Automatic Blackboard Eraser Robot as shown in Fig.1 and Fig.2

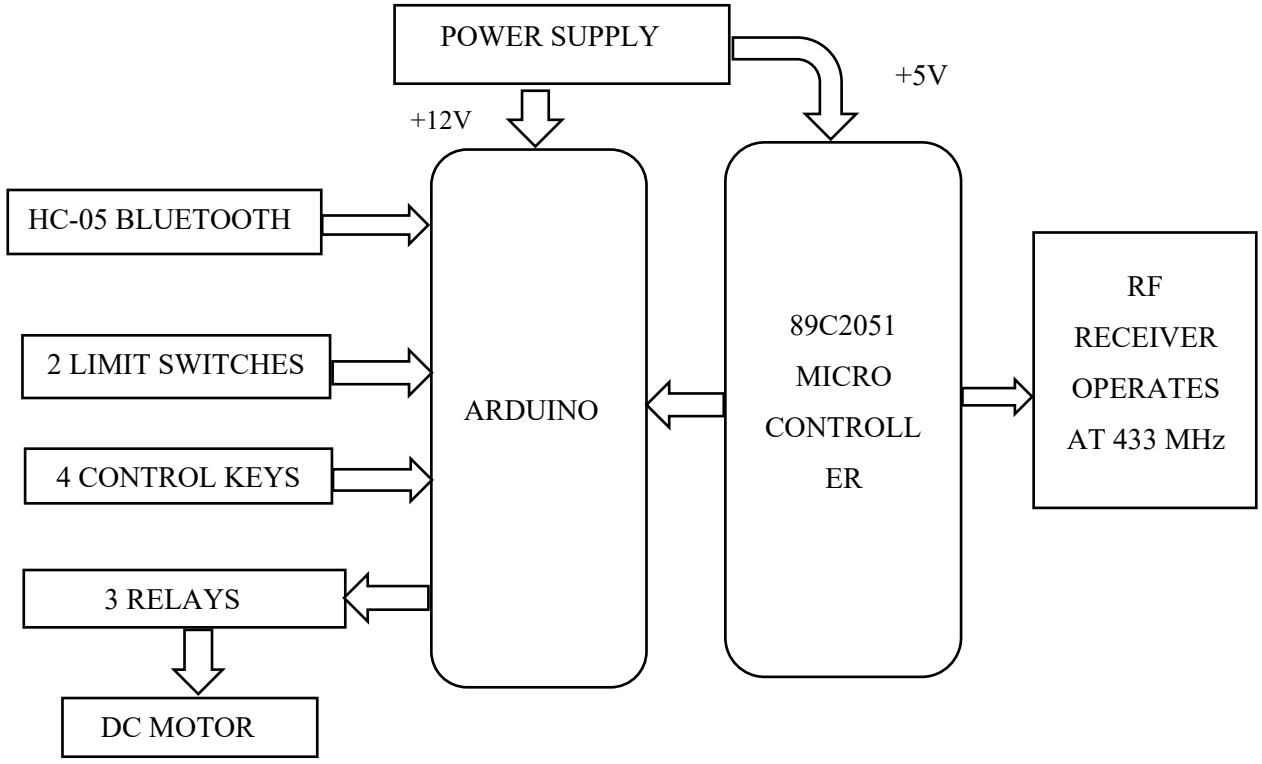

Fig.1 Block Diagram

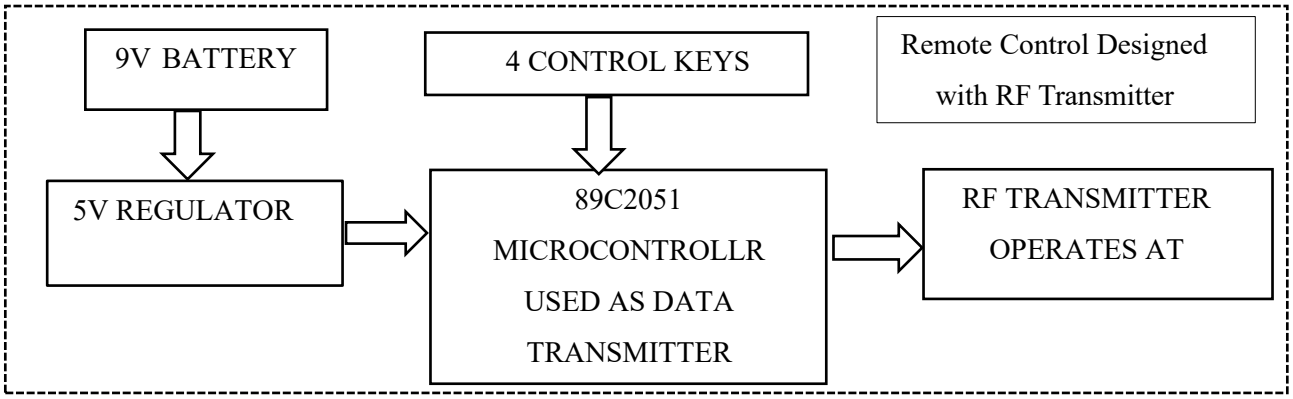

Fig.2 Remote Controller

Voltage Regulator: Supplies stable and consistent voltage to all components, preventing damage from voltage fluctuations and ensuring smooth system operation.

Arduino Uno: Serves as the brain of the system, processing input commands from various control modes and controlling the motor accordingly.

DC Motor: Provides the necessary mechanical motion to move the eraser mechanism horizontally across the blackboard.

Bluetooth Module (HC-05): Allows wireless control of the robot via a smartphone, offering flexibility and ease of use.

RF Transmitter Module: Sends control signals wirelessly from the user-operated RF remote.

RF Receiver Module: Receives wireless commands from the RF transmitter and passes them to the Arduino for action.

Manual Switches: Offer direct physical control over the motor's movement, useful in case wireless controls are not available.

Limit Switches: Detect the endpoints (edges) of the blackboard and stop motor movement automatically to avoid overrun or damage.

When the system is powered on, the Arduino microcontroller initializes all components and waits for a user command. The user can control the system through three different modes: Bluetooth, RF remote, or manual switches to move the eraser left or right with speed controls.

3. HARDWARE MODULE

The hardware module is shown in the Fig.3, Fig.4 and Fig.5

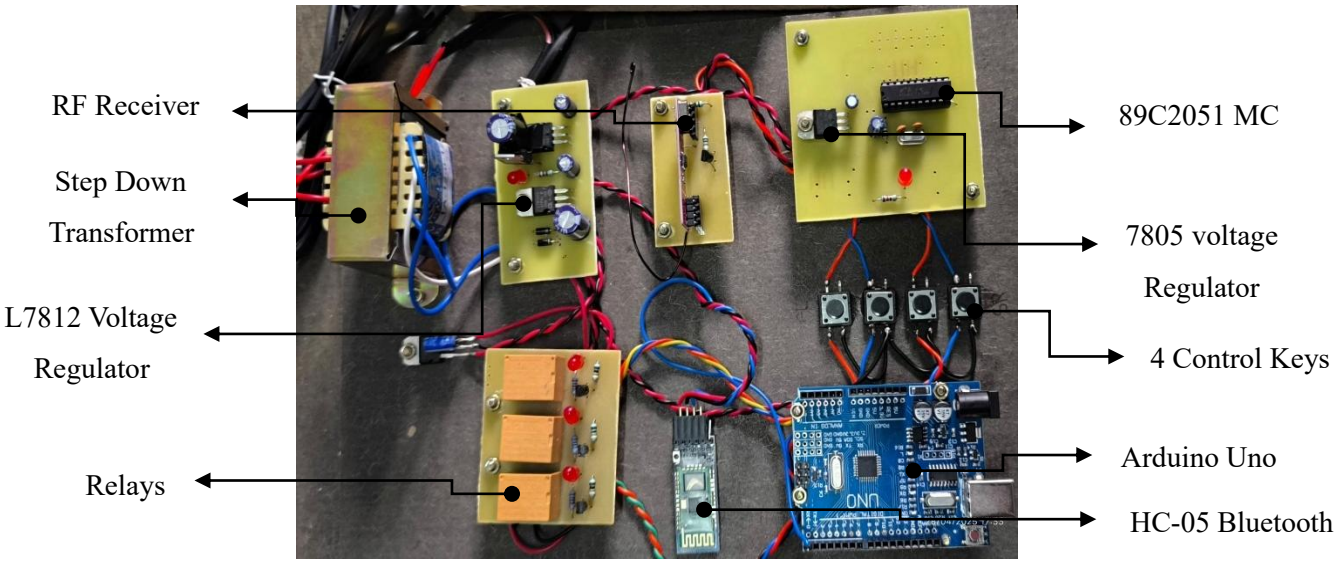

Fig.3 Hardware Module

Fig.4 Top view of Hardware Module

A single-phase 230V, 50Hz AC power supply is used to operate the system, which is stepped down using a transformer and converted to a stable 5V DC through a voltage regulator. This regulated voltage powers the Arduino Uno and all connected components including the Bluetooth module, RF receiver, manual switches, limit switches, and the DC motor. The system is designed to automate the blackboard cleaning process using three modes of control—Bluetooth, RF remote, and manual switches.

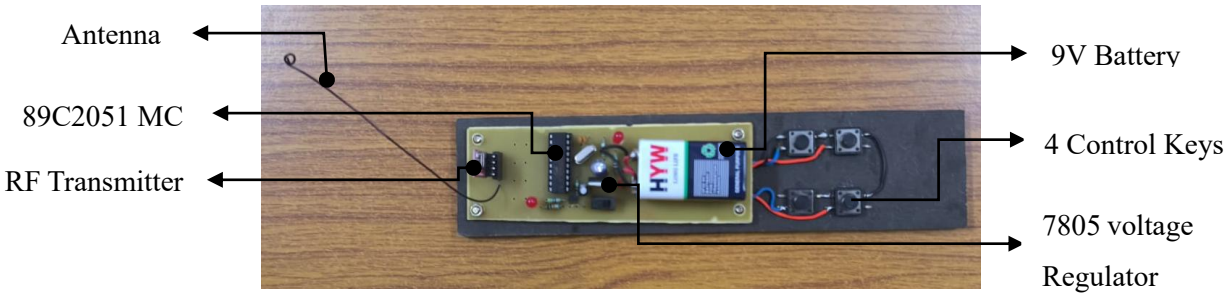

Fig.5 Remote Controller

The Arduino receives commands from any of these input methods and drives the DC motor, which moves the erasing mechanism horizontally across the board. Limit switches installed at both ends of the blackboard to detect boundaries and stop the motor automatically.

4. TESTING AND RESULTS

The hardware was tested for different cases to observe its operation

4.1 Testing With Manual Control

During manual control testing, physical push-button switches were directly connected to the Arduino to operate the robot without any wireless communication. One switch controlled the left movement of the DC motor, and the other controlled the right movement. When a switch was pressed, the eraser moved across the blackboard in the respective direction.Limit switches were also tested to ensure the motor stopped safely at the board edges, preventing the eraser from going beyond the blackboard area. This ensured safe operation within defined boundaries.

The motor's speed was tested in two modes:

- **Low Speed – 30 RPM**: Suitable for slow and controlled erasing.
- **High Speed – 60 RPM**: Used for fast and efficient cleaning.

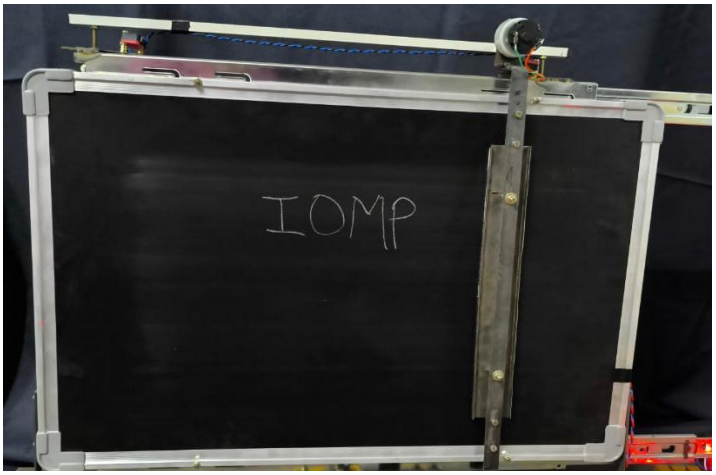

Fig.6 By pressing the Control Key Duster Moves in the Right direction

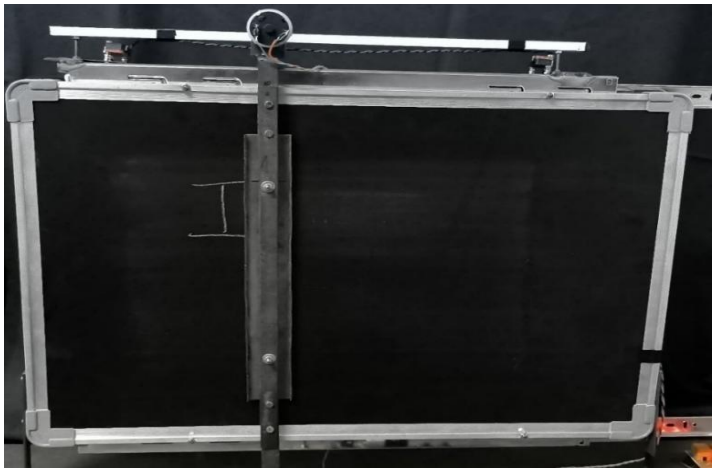

Fig.7 By pressing the Control Key Duster Moves in the Left direction

4.2 Testing with Remote Control

In the remote control mode, the operation of the blackboard eraser robot is managed using an RF (Radio Frequency) transmitter and receiver pair. The user controls the robot by pressing one of the four buttons on the RF transmitter, each corresponding to a specific command. These signals are wirelessly transmitted and received by the RF receiver module connected to the Arduino. Upon receiving the signal, the Arduino decodes the command and performs the assigned function: Command 1 moves the eraser to the left at high speed(60rpm), Command 2 moves it to the right at high speed, Command 3 moves it to the left at low speed(30rpm), and Command 4 moves it to the right at low speed. This wireless communication system allows the user to operate the robot from a distance, enhancing convenience and flexibility in controlling the eraser without physical connection.

Fig.8 Duster Moves in the Right direction

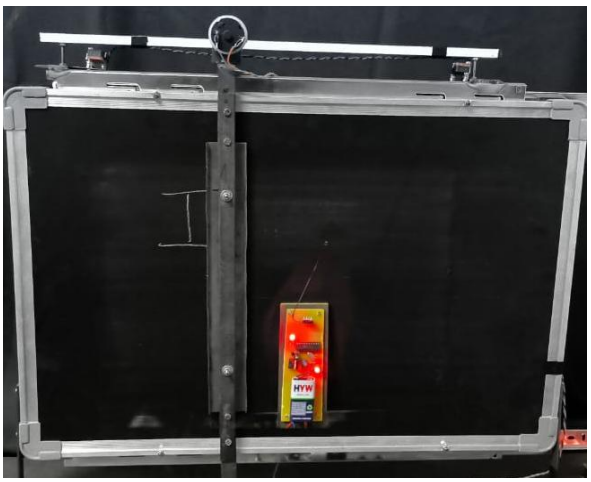

Fig.9 Duster Moves in the Left direction

4.3 Testing with Bluetooth Control

Bluetooth control testing was performed using a smartphone connected to the HC-05 Bluetooth module paired with the Arduino Uno. A mobile application with directional buttons (left, right, stop) was used to send commands wirelessly. Upon receiving a command, the Arduino processed it and activated the DC motor to move the eraser accordingly. The limit switches functioned correctly, stopping the motor when the eraser reached the board's edge. This testing verified that the Bluetooth module provided effective and convenient wireless control, making the system more user-friendly and suitable for smart classroom applications.

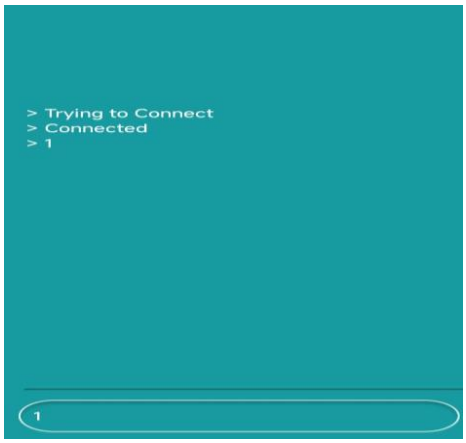

Fig.10 Type command 1

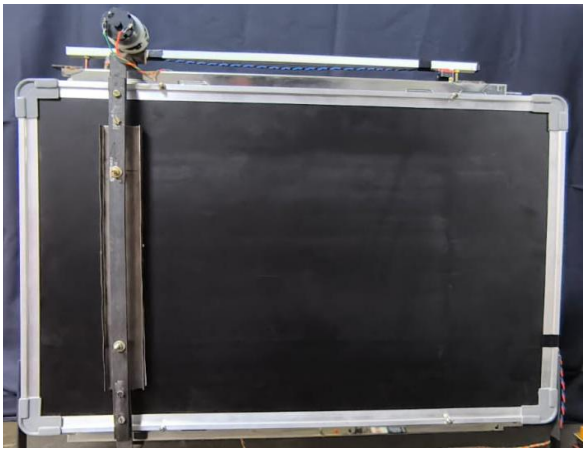

Fig.11 Duster Moves in the Left direction

The communication range of the Bluetooth module was also evaluated during testing. It provided reliable connectivity within a distance of approximately 10 meters, making it suitable for classroom environments.Even in the presence of minor obstacles, the signal remained stable. The integration between the mobile app and the Arduino through the HC-05 module ensured that commands were transmitted accurately with minimal delay.

Fig.12 Type command 2

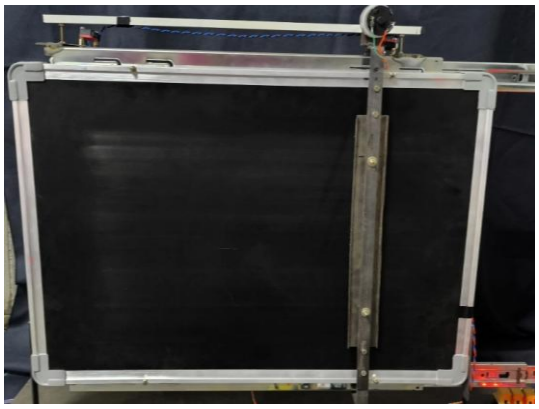

Fig.13 Duster Moves in the Right direction

In Bluetooth control mode, speed control is managed by sending specific commands from the mobile app to the Arduino.When the "Low Speed" button is pressed, a predefined character is sent to reduce the motor's speedto 30rpm.

Similarly, pressing the "High Speed" button sends another command to increase the motor's speed to 60rpm.The Arduino interprets these commands and adjusts the motor's speed accordingly, allowing smooth and controlled movement of the blackboard eraser based on user preference.

4.6 Results table and Discussion

Control Method	Key Function	Expected Output	Remarks
Manual / Bluetooth / RF Remote	Key 1 – Left High Speed	Robot moves left quickly	Robot responded accurately at high speed in all control methods
	Key 2 – Right High Speed	Robot moves right quickly	Smooth and consistent movement observed across all methods
	Key 3 – Left Low Speed	Robot moves left slowly	Low speed movement was visible and well-managed in all modes
	Key 4 – Right Low Speed	Robot moves right slowly	Accurate and stable operation within range for all controls

The automatic blackboard eraser robot system functioned effectively in all tested control modes-manual switches, Bluetooth, and RF remote. During manual testing, each switch accurately directed the motor to move the eraser left or right, with the limit switches successfully stopping the movement at both ends of the board. In Bluetooth mode, commands sent from a mobile application were received by the Arduino through the HC-05 module, enabling smooth motor control and directional movement. Speed variations high(60rpm) and low(30rpm),were also handled accurately through predefined commands. Similarly, in RF control mode, signals from the transmitter were reliably received by the RF receiver, allowing wireless operation without line-of-sight limitations.

The system's overall performance across all control modes was stable and responsive, demonstrating a successful integration of electronics and automation. This cohesive setup enables efficient blackboard cleaning, reduces manual effort, and supports smart classroom environments with reliable multi-mode control.

5. CONCLUSION

The development of an advanced and reliable blackboard erasing system addresses critical challenges related to time consumption and manual effort in traditional teaching environments, significantly enhancing classroom efficiency. By using components like DC motors, limit switches, Bluetooth and RF modules, the system ensures real-time, flexible control for automated erasing tasks. The integration of limit switches, Bluetooth module, RF receiver, and manual switches allows for prompt response and smooth operation, while features like speed control and boundary detection ensure safe and effective performance. The system operates through multiple control modes, providing convenience and adaptability for different users.

This hardware was tested in various scenarios, including left-right movement, speed variations, edge detection through limit switches, and wireless command execution via Bluetooth and RF. It met all defined functional requirements and performed efficiently under all tested conditions. It demonstrates a successful application of embedded systems and automation technology to improve classroom operations, providing educational institutions with a practical and robust solution to enhance teaching convenience and reduce physical workload.

6. ACKNOWLEDGMENT

The authors are thankful to the officials of Department of Electrical and Electronics Engineering, Bhoj Reddy Engineering College for Women, Hyderabad, India, for providing facilities required to carry out this work.

REFERENCES

[1] G. Priya, “Design and Fabrication of Automated Board Cleaner,” International Journal of Scientific Research in Science, Engineering and Technology, vol. 2, no. 3, pp. 131–133, Mar. 2015.

[2] A. S. Rajput and P. V. Sutar, “Automated Blackboard Cleaner Using Microcontroller,” International Journal of Innovative Research in Science, Engineering and Technology, vol. 6, no. 3, pp. 1234–1238, 2017.

[3] M. S. Patil, S. R. Tamboli, P. R. Dunke, and N. D. Batwal, “Automatic Blackboard Cleaner,” International Journal of Advance Engineering and Research Development (IJAERD), vol. 5, no. 16, 2018.

[4] D. Ghodasara, M. Aghera, and S. Rayjada, “Automatic Board Duster,” International Journal of Research in Engineering, Science and Management, vol. 2, no. 3, pp. 316–318, Mar. 2019.

[5] K. Yadav, S. Verma, and N. Sharma, “Automated Smart Duster Using Arduino for Teaching Boards”, vol. 7, no. 4, 2020.

[6] S. Vignesh K., Vinith K., Mouleswaran H., and M. Sanjay, “Automatic Blackboard Duster to Reduce Health Hazards,” 2021.

[7] Sanjay S. Tippannavar and Preethi G., “Design and Implementation of a Dust Remover from a Conventional Blackboard Duster to Prevent Respiratory Problems,” 2023.