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Easy-Erase for Whiteboard Prototype

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Abstract

This thesis addresses the need for efficient maintenance of traditional whiteboards in educational and professional settings, proposing an automatic cleaner that integrates advanced technology to streamline the cleaning process, reduce manual effort, and enhance overall efficiency. The study emphasizes the limitations of manual cleaning methods and the adverse health effects of common cleaning agents. Through a detailed design process, the development involves an Arduino Uno microcontroller, motor driver, DC motor, ultrasonic sensor, and push button, with evaluation criteria covering cleaning efficiency, speed, user-friendliness, maintenance, durability, user satisfaction, compatibility, and environmental impact. The mechanism system utilizes smart algorithms and a schematic diagram, demonstrating the device's ability to navigate and clean thoroughly. Time analysis data confirm the significant reduction in cleaning time compared to manual methods, making the proposed time in value second whiteboard cleaner a promising solution for maintaining clean and functional whiteboard surfaces.

1. Introduction

The widespread use of whiteboards in various professional settings has increased due to their affordability, mobility, and ease of use. Despite advancements in technology, whiteboards remain a preferred tool for education, presentations, and collaborative workspaces. However, the frequent cleaning required for large whiteboards poses a challenge, leading to the development of automated cleaning solutions. Modern meeting spaces and classrooms rely on whiteboards for efficient knowledge exchange, but the accumulation of marker residue necessitates regular cleaning. Traditional manual cleaning processes using agents or erasers can be time-consuming and inefficient, especially in large contexts. The unique advantages of whiteboards, such as their dust-free nature and compatibility with colored markers, make them indispensable. The automation of cleaning processes through micro-controlling systems minimizes human labor and simplifies maintenance tasks, ensuring clear and functional whiteboard surfaces in diverse environments [1].

Whiteboards are essential in modern spaces for exchanging ideas but cleaning them manually can be laborious and inefficient. Dry erase marker residue and stains are persistent issues requiring regular cleaning. Traditional methods involve time-consuming processes with cleaning agents or erasers, especially challenging in large educational or corporate settings. Automation systems, facilitated by micro-controlling systems, offer a solution by minimizing human labor and simplifying the cleaning process, making whiteboards more convenient and efficient [2].

Frequent manual erasing of the whiteboard during lectures poses challenges for instructors, especially for those of shorter stature who struggle to reach the top. This process requires physical effort and time, potentially

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impacting health in the long run. Additionally, the risk of losing the eraser due to the open classroom door adds to the inefficiency. Automating the erasing procedure is deemed essential to address these issues and streamline the whiteboard maintenance process.

Whiteboards are integral in modern spaces for collaborative work, but they face challenges such as marker residue buildup. Regular cleaning is essential, traditionally a laborious manual process. The new automation system, facilitated by micro-controlling systems, minimizes human labor, simplifies setup, and enhances efficiency. It addresses the challenges of manual cleaning in large educational or corporate settings, providing a convenient and effective solution for maintaining clear and functional whiteboard surfaces.

The easy-erase prototype offers significant time-saving benefits, especially for large or frequently used whiteboard surfaces. Automation eliminates the need for manual labor, enabling swift and effective cleaning, enhancing overall productivity. The automatic cleaner allows users to quickly switch between tasks, meetings, or lectures without spending time on manual erasing. The prototype's convenience, achieved through a push-button cleaning plan, makes it particularly useful in crowded spaces such as offices, meeting rooms, and schools.

Regular whiteboard markers, despite being labeled as non-toxic, can lead to common side effects like headaches and respiratory issues due to the presence of the solvent xylene [4]. Xylene, a clear liquid with a distinct aromatic smell, is commonly used as a solvent in various industries [3]. Inhalation of xylene vapours, even in small amounts, may cause health problems. Table 1 outlines the effects of xylene on human health [5] [6].

Table 1 *Effect of xylene on human health*

Effect	Explanation
Inhalation Exposure	High amounts of xylene vapour can cause symptoms like headaches, nausea, and respiratory irritation when inhaled for a brief period.
Skin Contact	Dermatitis, skin rashes, and skin irritation can all result from direct contact with xylene.
Eye Contact	Inflammation, redness, tearing, and discomfort might result from coming into contact with xylene.
Central Nervous System	When inhaled or absorbed over an extended period in high amounts, xylene can have an impact on the central nervous system.
Reproductive and Developmental	The development of the foetus and reproductive health may be negatively impacted by xylene.

The whiteboard on the UTHM campus was cleaned with paper, as seen in Fig. 1. This is the justification for carrying out this undertaking. The whiteboard cannot be cleaned in a proper manner. This procedure should not be used to wipe the whiteboard because of the potentially harmful compounds found in whiteboard's ink.

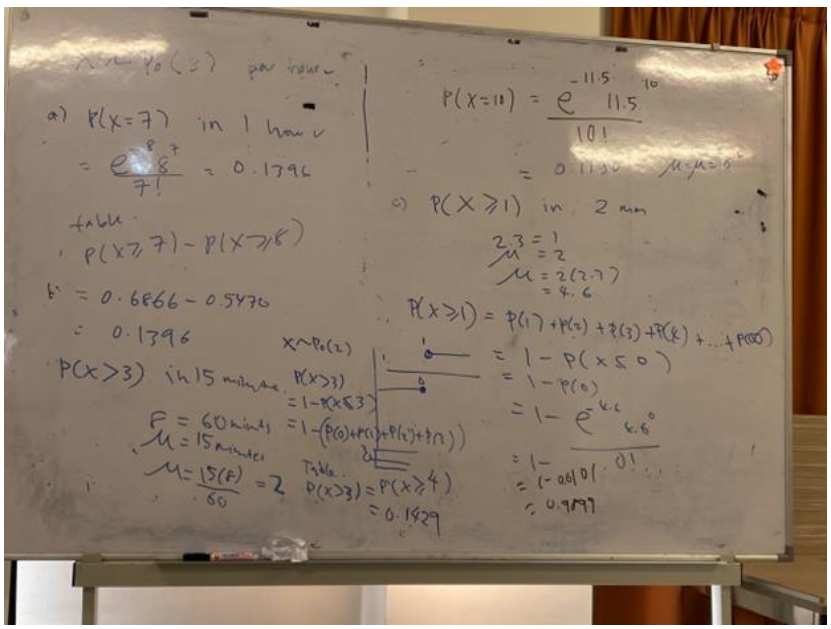

Fig. 1 *Use paper to clean the whiteboard.*

1.1 Patent Search

Patent 1: Non-permanent marker board eraser apparatus

The whiteboard cleaner depicted in Fig. 2 features a simple design with minimal moving parts for effective erasing. It includes two u-shaped, horizontally spaced guiding rails that extend outward. Motorized vertical rubber parts are driven by a rubberized wheel within the upper or lower guide rail, allowing selective contact with the marker board through control buttons. Automatic rubber return accompanies every board movement, ensuring cleanliness. Additionally, the eraser releases cleaning fluid during operation [8].

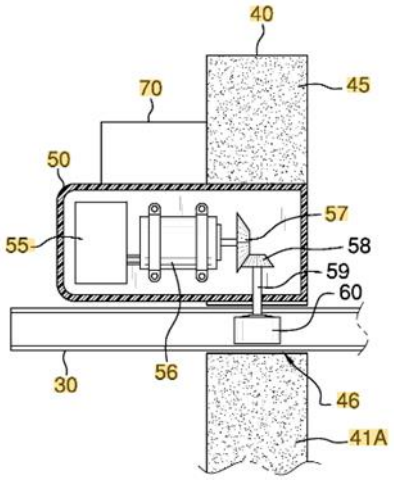

Fig. 2 *Patent 1*

Patent 2: Automatic whiteboard eraser

Fig. 3 depicts an automatic whiteboard eraser invention comprising a driving module with two side ends connecting to a single-wing board eraser, and the front side end linking to a touch device through a connecting rod. The driving module features a motor connected to a universal wheel and a power supply module, with its four legs attached to the four legs of the touch device [7].

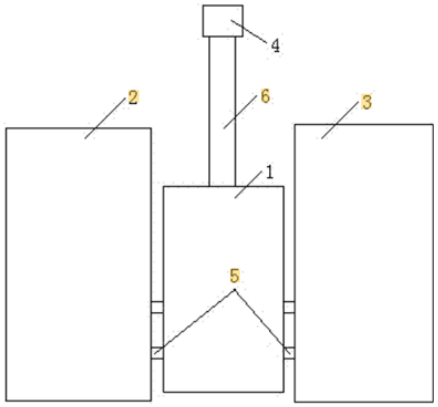

Fig. 3 *Patent 2*

Patent 3: Whiteboard eraser

The Fig. 4 innovation features a whiteboard eraser with an eraser box, sponge, and internal hydraulic mechanism, combining a cleaning agent. The button on one side of the box releases the agent through a connected liquid storage tube, providing a simple and efficient cleaning process [9].

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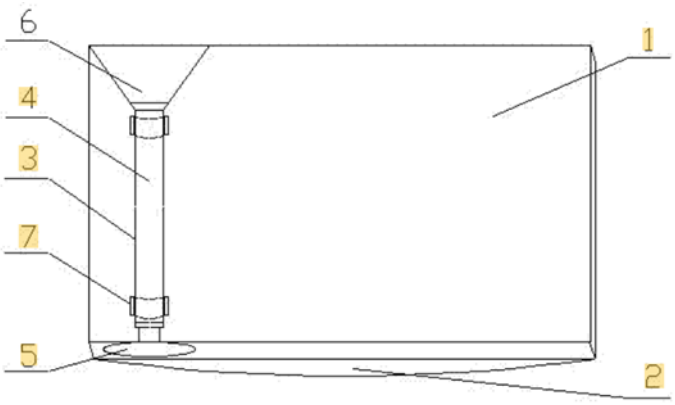

Fig. 4 *Patent 3*

Patent 4: Electric-controlled automatic erasing writing white board

Fig. 5 presents a utility model of a writing whiteboard featuring electric control and automatic erasing for smooth and rapid erasure of the writing screen. It includes a supporting frame, shim plate, composite film, driving device, erasing device, and control device. The erasing device comprises an arc-shaped erasing plate, supporting frame, and sliding rod, positioned outside a rubber roller and covered with hair felt on one side [10].

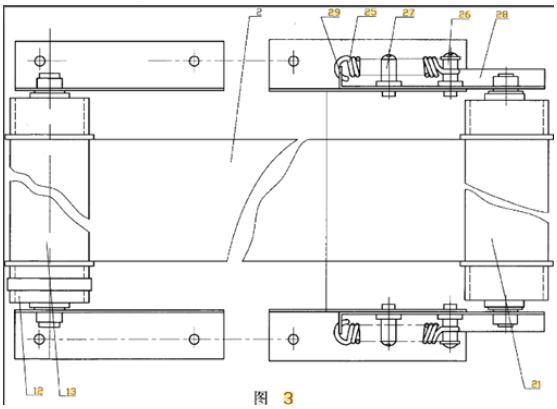

Fig. 5 *Patent 4*

1.2 Current innovation of automatic whiteboard cleaner

Innovation A: Automatic Board Cleaning system using Microcontroller.

Fig. 6 illustrates a machine designed for time and effort reduction while maintaining the board's aesthetic appeal. Built with an Arduino microcontroller, it offers simplicity in circuit construction using chips like Atmega-328p or Atmega-128p. The materials are affordable, readily available, and require basic tools for structure assembly. The machine can be enhanced with a Bluetooth remote switch for convenient operation and has the potential to transform into a smart whiteboard using infrared sensors [11].

Fig. 6 *Innovation A*

Innovation B: Automatic White Board Cleaner

In Fig. 7, the automatic board cleaner's mechanism involves horizontal movement using a duster spanning the board's breadth. When the switch is turned on, the motor powers the shaft, which drives the pulley chains, enabling horizontal cleaning. The initial command signal is sent to NODEMCU, followed by supplying voltage to a DC motor through an L298N motor driver, allowing code upload for DC motor rotation on the Arduino platform [1].

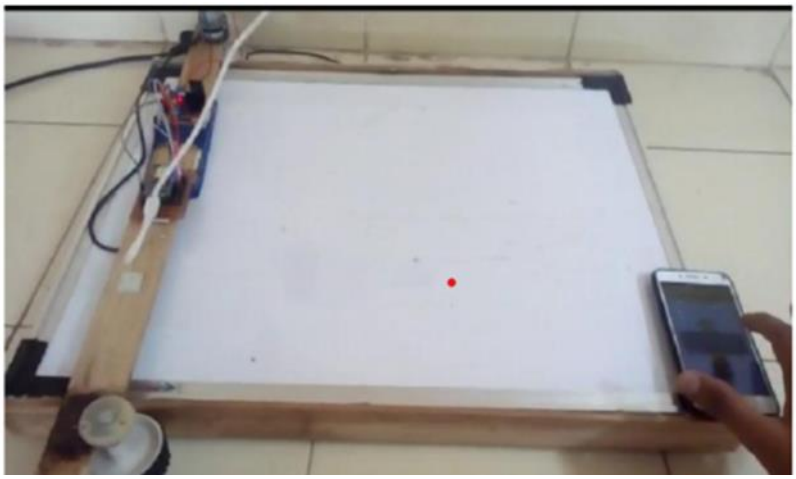

Fig. 7 *Innovation B*

Innovation C: Automatic Whiteboard Cleaner Using Microcontroller Based Rack and Pinion Mechanism

The system in Fig. 8, designed for whiteboards, consists of two main units: the cleaning system, responsible for removing writing, and the controlling system, managed by a microcontroller to regulate the motor's speed, rotational time, and rpm [12].

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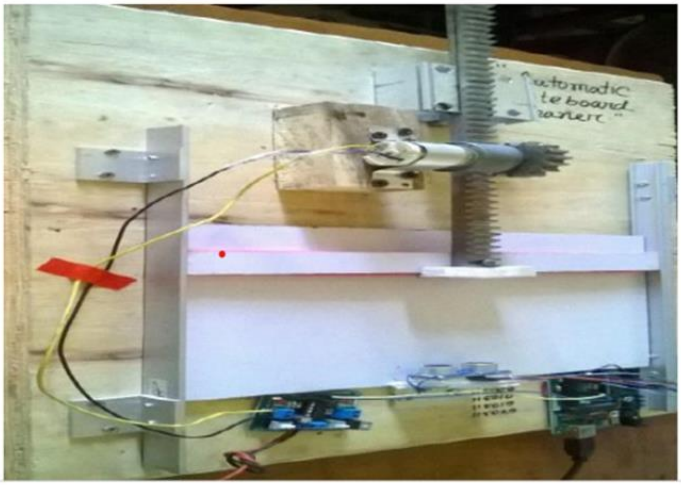

Fig. 8 *Innovation C*

Innovation D: Automatic White Board Cleaner Using Arduino Uno

Fig. 9 displays the layout of an automatic whiteboard cleaner, featuring components like an Arduino UNO microcontroller, a driver module, a DC accessory motor, a support system, an arbor and adhere mechanism, and a cleaning bar. The cleaner, activated when the switch is on, moves across the entire width of the board, offering an efficient replacement for a duster and introducing automation to the classroom [13].

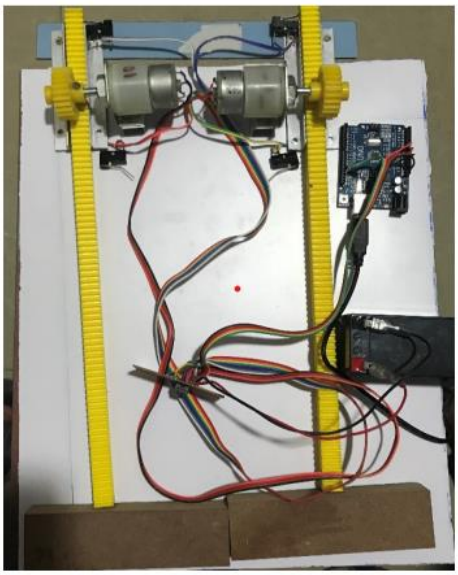

Fig. 9 *Innovation D*

1.3 Comparison of current innovation of automatic whiteboard cleaner

In Table 2, it can be seen that the inventor for innovation A using a simple system for the automatic whiteboard cleaner and the productivity for one cycle can reach minimum 8.04 second. The system that has been used is using Arduino UNO and the inventor design the duster in horizontal position. Meanwhile, for innovation B, the inventor also using a simple system but the productivity for the system more efficient which can reach minimum 5.975 second for one cycle. Mert-Arduino has been used in the system and the inventor design the duster in vertical position.

Table 2 *Comparison of current innovation of automatic whiteboard cleaner*

	Innovation A	Innovation B	Innovation C	Innovation D
Author	Imam-Ul Ferdous	Sumit Chavan	Sonia Akhter	Mrs.B.Lakshmi Prasanna
System	Simple	Simple	Complex	Complex
Productivity	8.04sec	5.975 sec	5.975 sec	-
Arduino	Arduino UNO	Mert-Arduino	Arduino UNO	Arduino UNO
Duster position	Horizontal	Horizontal	Horizontal	Vertical

2. Methodology

The design process, often seen as a problem-solving method, involves defining the problem as the initial step. It allows designers to address issues, achieve objectives, or create specific items, emphasizing that there is no rigid right or wrong way. The process serves as a tool for enhancing creativity, effectiveness, and precision, following the designer's guidance rather than imposing strict instructions.

2.1 Identification of Need

Designers must identify a need before they begin their work. This is crucial because without a need, there would be nothing on which to base the original design. It can be difficult to pinpoint a desire because it may originate from an ambiguous resentment, a general sense of unease, or even a sense that something isn't quite right. Do these facts a need is frequently not at all obvious but is instead prompted by some specific unfavorable scenario or potential a collection of random circumstance that could have happened virtually simultaneously [14].

2.2 Definition of Problem

Defining a problem in greater detail than identifying a requirement is crucial, necessitating the inclusion of all specifications in the design. Further needs may emerge during this process, prompting continuous identification until all specifications are met. The designer must thoroughly study the problem to devise a solution, considering its potential impact on user experience and productivity. Users, including teachers and professionals, often spend valuable time cleaning whiteboards, hindering their ability to create material or collaborate. The accumulation of marker residues can also compromise visibility and legibility, hampering effective communication.

2.3 Synthesis

A block diagram visually represents a system with blocks representing main components connected by lines to depict their relationships. It is employed to illustrate how a system functions, especially in process flow charts or software design. Block diagrams are particularly useful when clarity in representing information or control flows is essential, as showcased in Fig. 10.

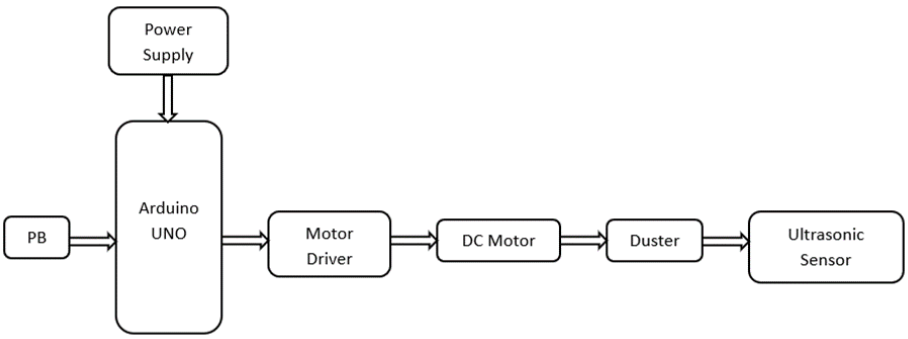

Fig. 10 *Block diagram for Automatic White Board Cleaner using Arduino Uno*

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2.4 Evaluation

Evaluation is an essential aspect of project management, offering insights into performance and areas for improvement. It systematically examines a project's efficiency and outcomes, aiding in resource optimization and effectiveness assessment. Table 3 presents the selected evaluation criteria for the automatic whiteboard cleaner.

Table 3 *Evaluation criteria for automatic whiteboard cleaner*

EVALUATION CRITERIA	• Cleaning Efficiency • Speed and Time Efficiency • User-Friendliness • Maintenance Requirements • Cost

2.5 Mechanism System

The automatic whiteboard cleaner integrates a power supply, motor driver, DC motor, and ultrasonic sensor to achieve precise and effective cleaning. The power supply, powered by rechargeable batteries, serves as the energy source for the system, providing mobility during operation. The DC motor is central to the cleaning system, driving the cleaner's movement with attached wheels or tracks. The motor driver acts as an interface between the microcontroller and the DC motor, controlling speed and direction.

The ultrasonic sensor, a key component, gathers real-time data on the whiteboard's dimensions and detects boundaries. It emits motion waves, measures their return time, and uses the information to map the whiteboard, enabling systematic navigation. The DC motor, controlled by the motor driver, ensures accurate and smooth movement along with the tread shaft.

The cleaning tools, such as brushes or microfiber towels, are strategically positioned to interact effectively with the whiteboard surface, removing dry-erase marks and residues. Smart algorithms optimize performance by determining the cleaning path based on ultrasonic sensor input. These algorithms ensure comprehensive coverage of the whiteboard and adapt the cleaner's path to navigate around obstacles. The integrated system creates a unified and efficient solution for the automatic whiteboard cleaner, enabling autonomous, adaptive, and thorough cleaning. Fig. 11 shows the schematic diagram for the system.

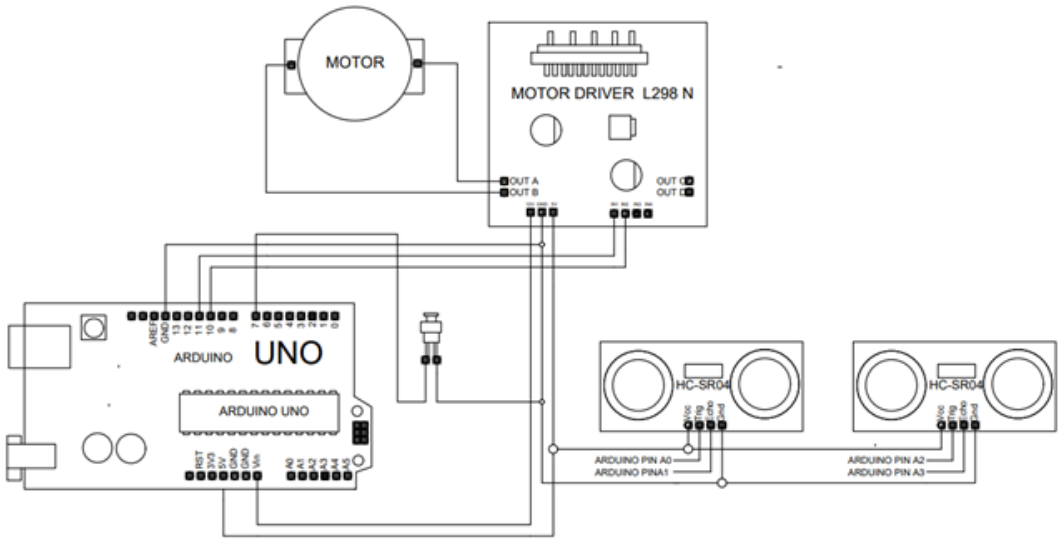

Fig. 11 *Schematic diagram for the system*

3. Result and Analysis

Result and analysis, the final stage of research, involves gathering, analyzing data, and conducting experiments to derive conclusions, apply insights, and make defensible judgments. It transforms raw data into valuable knowledge, supporting study goals, identifying patterns, trends, and implications. The analysis interprets the investigation's results using various analytical techniques.

3.1 Fabrication

The fabrication project aims to automate whiteboard cleaning using advanced technologies, including an Arduino Uno microcontroller, motor driver, DC motor, ultrasonic sensor, and push button. This initiative integrates robotics into collaborative and instructional settings, addressing the need for regular whiteboard maintenance. The goal is to enhance user experience, save time, and contribute to the sustainability of work and learning environments through automated cleaning. Fig. 12 shows the final prototype of Easy-Erase for Whiteboard.

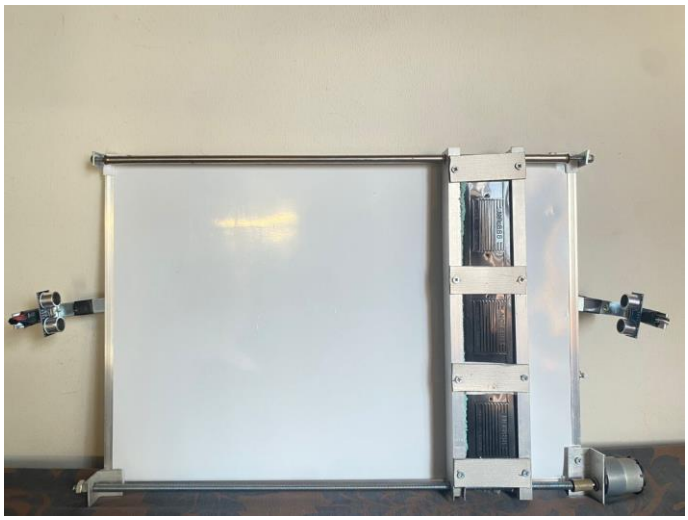

Fig. 12 *Final prototype of Easy-Erase for Whiteboard*

3.2 Circuit of Monitoring

The electric circuit, centered around the Arduino Uno microcontroller, seamlessly integrates sensor readings, user inputs, and cleaner motions. Using ultrasonic sensors for monitoring and navigation, the microcontroller acts as the brain of the system. The motor driver, analyzing signals from the microcontroller, ensures precise control over the DC motor that powers the cleaning mechanism. A push button allows users to manually input data and initiate cleaning cycles. The intricate electric circuit enables the automated whiteboard cleaner to adapt to its surroundings, efficiently clean the whiteboard, and offer a user-friendly interface. Fig. 13 shows the circuit for this project.

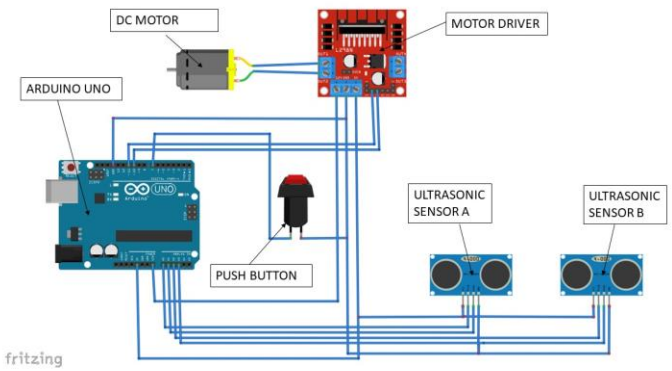

Fig. 13 *Circuit*

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3.3 Bill of Materials

Table 4 *Estimate cost for Easy-Erase for Whiteboard Prototype*

Items	Price	Quantity	Total Price
Whiteboard 50 x 35 cm	RM15.50	1	RM15.50
Thread shaft	RM8.00	1	RM8.00
Shaft	RM8.00	1	RM8.00
Aluminium	RM10.00	2	RM20.00
Duster	RM3.50	3	RM10.50
Arduino UNO	RM25.00	1	RM25.00
Motor Driver	RM5.50	1	RM5.50
DC Motor	RM30.00	1	RM30.00
Ultrasonic Sensor	RM5.00	2	RM10.00
Push Button	RM1.00	1	RM1.00

The total estimated to development of prototype of Easy-Erase for Whiteboard is RM133.50. This is an affordable price to develop a prototype.

3.4 Time Analysis

For this project, a 50 x 35 cm long prototype board was employed. The entire board was cleaned in around 45 seconds with a manual duster. The suggested automatic whiteboard cleaning cuts down on the amount of time needed. When the switch is turned on, the brush goes in two directions, which is right side and left side, completing a full cycle of movement. The suggested automatic brush requires two complete cycles to thoroughly clean the board. The amount of time needed to finish the wiping operation was ascertained by taking multiple data sets. The time for five observations is displayed in Table 4.

Table 4 *Time analysis*

Trial Number, n	Right Side Time (sec)	Left Side Time (sec)	Total Time of 1 Cycle (sec)	Average Time (sec)	Total average time for complete cleaning (Sec) Average time x cycle time
1	10.50	10.55	21.05		
2	10.51	10.55	21.06		
3	10.48	10.57	21.05	21.066	21.066x2=42.132
4	10.50	10.59	21.09		
5	10.53	10.55	21.08		

The Results and Analysis section highlights the importance of analyzing raw data for meaningful insights, while the Fabrication section details the development of the automatic whiteboard cleaner, focusing on material selection and assembly. Considerations such as durability and environmental impact are evident in the choice of materials. The System Installation and Project Component section explains the installation process, components used, coding, and data analysis. Time analysis demonstrates the cleaner's efficiency, cleaning a board in approximately 42.132 seconds, significantly faster than manual methods. Overall, the section provides a comprehensive overview of research outcomes, fabrication, and installation analysis.

4. Conclusion

In essence, this comprehensive study successfully achieved three crucial objectives in advancing whiteboard cleaning technology. The design phase focused on creating the Easy-Erase system, emphasizing features to enhance usability and simplify the cleaning process. The subsequent manufacturing phase ensured the system's durability and optimal cleaning performance. The evaluation stage thoroughly examined the system's real-world performance, considering indicators such as cleaning efficiency, time analysis, and user satisfaction, confirming the Easy-Erase system's effectiveness and user happiness.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Shazleen Azwa binti Khairullah;* ***data collection:*** *Shazleen Azwa binti Khairullah;* ***analysis and interpretation of results:*** *Shazleen Azwa binti Khairullah;* ***draft manuscript preparation:*** *Shazleen Azwa binti Khairullah, Siti Zaharah binti Kunchi Mon. All authors reviewed the results and approved the final version of the manuscript.*

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