MULTIDISCIPLINARY APPLIED RESEARCH AND INNOVATION
e-ISSN: 2773-4773

MARI

Vol. 5 No. 3 (2024) 238-243
https://publisher.uthm.edu.my/periodicals/index.php/mari

Whiteboard Smart Wipe with Ethanol Spray using Linear Rod and DC Gearmotor

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DOI: https://doi.org/10.30880/mari.2024.05.03.033

Article Info

Received: 31 March 2024
Accepted: 31 July 2024
Available online: 31 December 2024

Keywords

Smart whiteboard, spray mechanism, Arduino UNO

Abstract

In modern and professional environments, maintaining clean whiteboard surfaces is essential but often challenging and time-consuming. This project addresses this issue by developing an automated whiteboard cleaning system that combines mechanical structure, electrical components, and ethanol spray features. The primary objective is to design and implement a mechatronic system driven by a lead rod coupled with DC gearmotor and controlled by an Arduino Uno microcontroller to facilitate the systematic cleaning of whiteboards. Additionally, an ethanol spray system powered by DC water pump is integrated to efficiently remove stubborn ink. The system's effectiveness was validated through simulations and practical tests, demonstrating its ability to clean whiteboards thoroughly and automatically. The results indicate that the system is user–friendly for all consumers. Almost 70% of the whiteboard ink has been efficiently removed. In conclusion, this project provide solution for maintaining whiteboard cleanliness in shared space.

1. Introduction

Education is the backbone of a nation. Education comprises of teaching and learning. The resources materials used in teaching are becoming updated along with the teaching and learning techniques. Writing was earlier done on sand, walls, slates made of wood, chalkboards and in recent times on white boards and electronic boards. Chalk dust scatter causes serious health problems. Because of these reasons whiteboard has been widely implemented into many other sectors of human endeavor besides teaching [1]. Nowadays, whiteboards are used widely in classrooms and higher education centers for teaching and learning purposes. Whiteboards also support two-way communication meetings or lectures by facilitating the sharing of ideas, focusing attention, and summarizing [2]. Many variations and improvisations have been done on automated whiteboard wipers. To address this limitation, rolling whiteboard surfaces with fixed dusters were introduced, where the whiteboard surface moves around rollers to create sufficient friction and pressure to erase the written data [3]. Although effective, this process is time-consuming. Further improvements included using microcontrollers and sensors to enhance cleaning efficiency, but these methods often faced issues with durability due to the use of flat belts that wear out quickly [4].

Several design of smart whiteboard wipers have been found in the literature. In [4], a smart whiteboard cleaner has been developed, controlled by a double pole double throw button (DPDT) to move the wiper. A 12V

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DC motor was used to move the wiper with two limit switches at the edge of the whiteboard. S. Akhter et. al [5] developed an automatic whiteboard cleaner by implementing rack and pinion mechanism. The mechanism movement was driven by a DC geared motor controlled by using Arduino UNO. In [6], War, N.Y.W. and Tun, Z.M developed a remote-controlled whiteboard using IR remote, equipped with two types of motor; servo motor to press and release the duster, and stepper motor to move the direction of the duster.

In this project, it is focuses on upgrading the exising design of automated whiteboard wiper frequently used in classes and meeting purposes called Whiteboard SmartWipe. The project equipped with an ethanol spray using linear rod and DC gearmotor. The proposed design in this paper overcomes these limitations by employing a linear rod driven by a DC gearmotor, controlled by an Arduino UNO. This system equipped with an ethanol spray ensures systematic and efficient cleaning of ink on whiteboard surfaces. The linear rod acts as a path for wiper to move, cleaning without the noise and wear issues associated with chains and belts that have been used from past projects. By automating the cleaning process, the system reduces physical effort and ensures consistent results, enhancing the usability and hygiene of whiteboards in educational and professional settings. This innovative approach making the cleaning process quick and reliable.

2. Methodology

This section delves into the methodology adopted in developing the automated whiteboard cleaner with ethanol spray system. The primary aim of this methodology is to provide complete description about the project's design. The key components covered in this section encompass the project design, materials and equipment used, flowchart and block diagram

2.1 System Components

Several materials and equipment were used in this project to design and develop the Whiteboard SmartWipe using Linear Rod and DC gearmotor. These materials and equipment are listed in Table 1 together with their functionality in the system.

Table 1 *List of components*

Materials	Picture	Function
Arduino UNO		Act as controller to read input and determine output process.
Motor Driver L298N		Drive DC motor to rotate clockwise and anti-clockwise
Battery 9V		Supply DC power to the system
12V DC Gearmotor		Drive wiper to move horizontally.

3V – 5V DC Waterpump		Pump ethanol for spray system.
Push Button		Use to start the system operation.
Limit Switch		To cut-off the movement of wiper.
Lead Rod		To lead the movement of the wiper.

2.2 Block Diagram

Figure 1 shows the block diagram of the Whiteboard SmartWipe with ethanol spray system using linear rod and DC gearmotor. This system is designed considering the present scenario of automatic whiteboards cleaner. It consists of nine main components: DC gear motor, Arduino UNO, motor driver L298N, push button, battery, limit switch, linear rod, DC water pump. The input of the system includes push button and limit switch. The limit switch is used to limit the movement of the wiper. The battery provides power to the system, while Arduino UNO controlled the system operation. The motor driver, DC gearmotor, linear rod and DC water pump will serve as the outputs for the system.

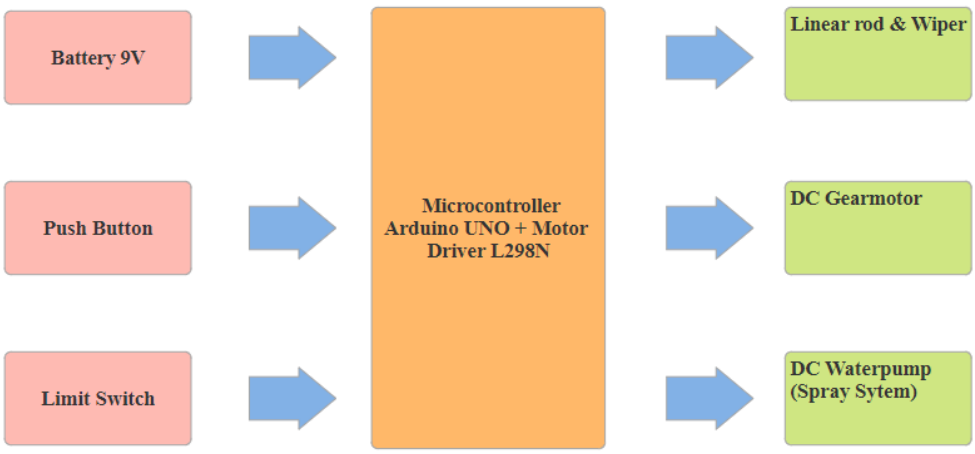

Figure 1 *Block diagram of the system*

2.3 Flow Chart

Figure 2 illustrates a flowchart diagram for the Whiteboard SmartWipe with ethanol spray system using rack and pinion mechanisms and DC gearmotor. If either switch 1 or switch 2 is pressed, Arduino reads and sends signals to the motor either will move clockwise or counterclockwise based on switch pressed. Then, when the limit switch is pressed, the Arduino reads and sends signals to stop the movement of the motor.

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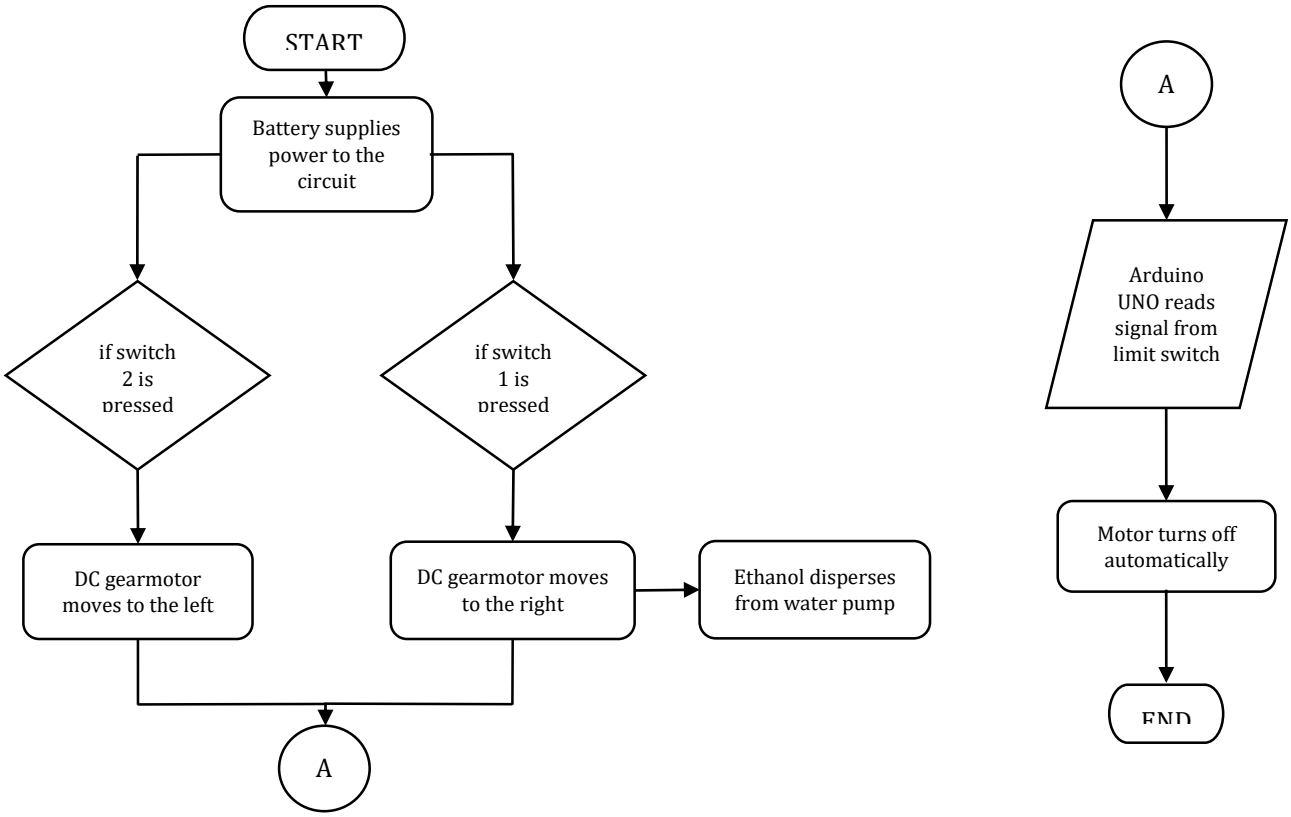

Figure 2 *Flowchart of the system*

3. Results and Discussions

The electrical component in this project acts as the controlling unit, utilizing an Arduino Uno microcontroller built on the ATmega328 chipset, providing various input/output pins and precise timing features. DC gear motors (model: SPG30) operating at 12V and 66 RPM are used for driving the cleaning mechanism, while an L298N motor driver ensures precise control over motor speed and direction. Additionally, a submersible DC water pump rated for 3V to 5V is integrated to efficiently spray an ethanol solution. All components are lightweight, compact, and efficient, making them ideal for this application. A brush is added to ensure smooth and efficient cleaning of the whiteboard surface. This brush is securely attached to the lead rod using adhesive, while the rod is being held by ball bearings on both ends. Figure 3 shows the developed whiteboard system and the location of the components, and Figure 4 shows the wiring diagram connection.

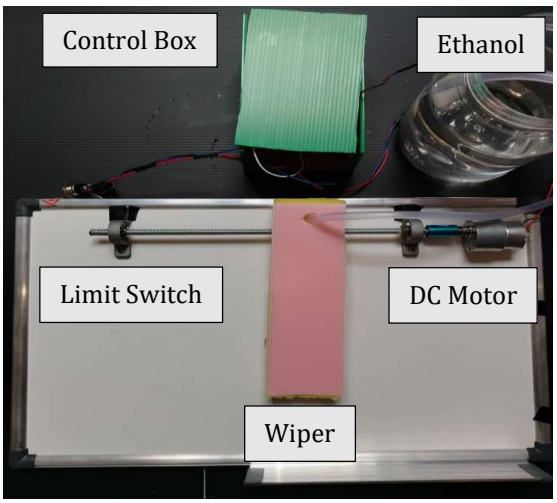

Figure 3 *Project prototype*

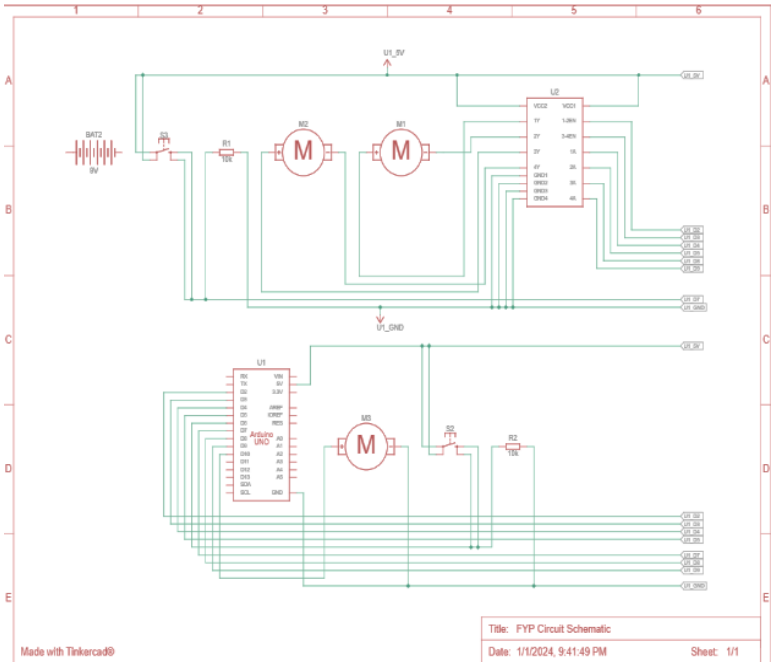

Figure 4 *Schematic diagram*

The observation involved configuring the Arduino Uno microcontroller to control the wiper movement using a DC gearmotor and lead rod for whiteboard cleaning. The system was tested for efficiency, demonstrating its ability to clean whiteboards thoroughly and automatically. The time taken for the wiper to move from one end to the other was recorded over several trials in Table 2.

Table 2 *Time taken for wiper movement*

No. of trials	Right motion	Left motion	Total time taken
1	1m 15s	1m 17s	2m 32s
2	1m 18s	1m 19s	2m 37s
3	1m 14s	1m 16s	2m 30s
4	1m 20s	1m 18s	2m 38s
5	1m 19s	1m 14s	2m 33s
Average	1m 17	1m 16s	2m 33s

Observations that can be made from the results is quite unsatisfactory. Enhancing wiper speed might be achieved by upgrading to a more durable motor and speed, which would be in line with the project's main objective of raising performance metrics and functionality. Furthermore, addressing battery wear and tear with planned actions like routine maintenance or upgrading to larger capacity batteries guarantees continued dependability and performance throughout the project's existence. Furthermore, obtaining the best possible performance and longevity requires carefully balancing the whiteboard's dimensions in relation to the motor parameters. It is possible to achieve smoother performance and possibly increase the wiper mechanism's working lifespan by carefully adjusting these parameters. The project's resilience and usefulness are improved by this simultaneous focus on durability and efficiency, which are essential components in fulfilling functional needs and surpassing user expectations. These recommendations not only help to reduce present operating concerns but also optimize resource utilization and lower long-term maintenance costs.

4. Conclusion

In conclusion, the development of this project begins by identifying the main problem, which is the conventional method using dry erasers, leading to incomplete removal of stubborn ink marks and cost times. To address these issues, the complete development of this project aligning with the project's main objectives to develop whiteboard prototype that is automated and have an ethanol spray system, but the results as mentioned are quite unsatisfactory, where only 70% of the whiteboard's ink has been removed. Recommendations for future improvements include integrating sensors, such as pressure and proximity sensors, and developing a rail slide for wiper control. This project demonstrates the potential of affordable, easily deployable technology to enhance efficiency rather than using conventional methods.

Acknowledgement

The authors would like to thank the Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia for its support.

Conflict of Interest

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

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Idham Mohd Khalil Fisal, Mohd Nurul Al-Hafiz Sha'abani;* ***data collection:*** *Muhammad Idham Mohd Khalil Fisal;* ***analysis and interpretation of results:*** *Muhammad Idham Mohd Khalil Fisal, Mohd Nurul Al Hafiz Sha'abani;* ***draft manuscript preparation:*** *Muhammad Idham Mohd Khalil Fisal, Mohd Nurul Al Hafiz Sha'abani. All authors reviewed the results and approved the final version of the manuscript.*

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