Development of an Automated Clothesline System

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***Abstract** — This presents the design, fabrication, and integration of various sensors and actuators to solve the problem of drying clothes outside. This design mainly aimed to overcome challenges related to unexpected rain, getting clothes in when it's dark, and remote controlling capabilities. Traditionally, the method of drying clothes outdoors requires manpower, to put the clothes and to get them in. This causes various inconveniences to people. The proposed system addresses many of those concerns and gives positive feedback. By detecting the change in weather and darkness, this system will automatically shelter the clothes in a sheltered area ensuring the clothes are dry and undamaged. In addition, this system possesses the ability to control remotely and manually making it user-friendly. Additionally, this will help positively with domestic chores and demonstrate the advantages of using technology to overcome day-to-day activities. Further, this paper explains the detailed methodology, conceptual designs, and results.*

Keywords— **Fabrication, Automatically, User-friendly**

I. INTRODUCTION

In the current world, when convenience and efficiency are of the utmost importance, automation is increasingly becoming a part of daily life. Automated technologies today commonly complete domestic jobs that were formerly completed by hand, greatly enhancing lifestyle, and freeing up time for other pursuits.

One such routine task that is considered to be boring and time-consuming is doing the laundry, particularly the task of drying the garments. Since ancient times, the process has largely remained unchanged, relying solely on the sun and wind as natural forces. Despite being effective, the conventional technique has several disadvantages. Clothing that is dried outside may be subjected to unanticipated weather conditions like dust storms or rain, which adds more work and could damage the garments.

In our rushed life, we typically multitask, juggling multiple responsibilities and jobs, which frequently leaves little time for home chores like laundry. It's normal to worry continually about needing to get clothes before they get wet in an unexpected downpour or turn dark from the night. The significance of drying clothing in this case extends beyond the act of drying itself and has to do with efficient time and resource management.

It is puzzling that despite innumerable developments in automation, the process of drying clothes has virtually remained unchanged. Existing automated methods have not been widely adopted due to a number of reasons, including cost, energy use, and dependability in a variety of weather conditions. It follows that there is a clear need for a more automated, more useful, and more affordable system that can adapt to changing weather conditions.

This paper outlines a cutting-edge method for automating textile drying to address the problem. The suggested solution creates a system that automatically shields garments from the elements while adapting to changing weather conditions by combining automation and sensor technology.

The purpose of this study is to design, develop, and test an automated clothesline system that efficiently dries clothes and protects them from bad weather. We wish to offer a service that can put people's minds at ease about drying clothes outside while also making the procedure quick and easy. The details of the proposed system, as well as the methodology, outcomes, and conclusions, will all be thoroughly covered in the parts that follow.

II. LITERATURE REVIEW

Automating clothesline is not a new concept to the world and few people have implemented many designs to optimize this work. The automated clothesline system is one such attempt to detect rain and automatically bring clothes to a sheltered place. (Mohamad, 2008). This employs sensors, a microcontroller, and a motor in design. A water sensor was used to detect rain and the microcontroller used was PIC16F877 and a DC motor. This system is able to pull the clothesline hand free by integrating the above-mentioned components.

The "Design and Development of Smart Automated Clothesline " project also has the same aim to elevate the idea of automating clothesline (Abd Latif et al., 2021). This project have three main objectives and mainly focusing on developing and automated clothesline. This system also use rain sensor module, to get the clothes inside when there is rain (Abd Latif et al., 2021).

These initiatives mark significant advancements in the creation of intelligent, automated devices for commonplace jobs like drying clothes. They develop systems that react to environmental changes and run without human intervention by utilizing contemporary sensor technologies and automation ideas. The sophistication and amount of complexity required to develop such systems is demonstrated by the usage of a microcontroller and motor circuit in these designs.

To fully comprehend the ramifications of above-mentioned projects including their possible advantages and downsides as well as their scalability for bigger applications, additional research would be required given the paucity of the material now accessible. Additionally, research into alternative technologies and approaches that can be used to automate the drying of clothing could be useful in the future (Mohamad, 2008).

III. EXPERIMENTAL DESIGNS

Before designing the final design and the final mechanism, we came up with some conceptual designs.

Figure 1: Conceptual design

Figure 2 can be manufactured using less materials than figure 1 and get the same stability. Therefore figure 1 design was rejected.

IV. SYSTEM OVERVIEW

The Automated Clothesline System is a creative, user-friendly system created to handle typical issues related to drying outdoor laundry. The Arduino Uno microcontroller, an LDR (light dependent resistor) sensor, a YL-83 rain sensor, an HC-05 Bluetooth module, a gear motor, and an L298D motor controller are the main parts of the system. To speed up the drying process, this system integrates sensing technology, automation, and remote-control capabilities.

The Arduino Uno microcontroller, which is set up to analyze data from the LDR and YL-83 rain sensors, is the brains of the system. The YL-83 rain sensor detects rainfall, while the LDR sensor monitors ambient light to indicate the beginning of darkness. The Arduino Uno activates the gear motor to retract the clothing into a protected area when one of these circumstances is recognized.

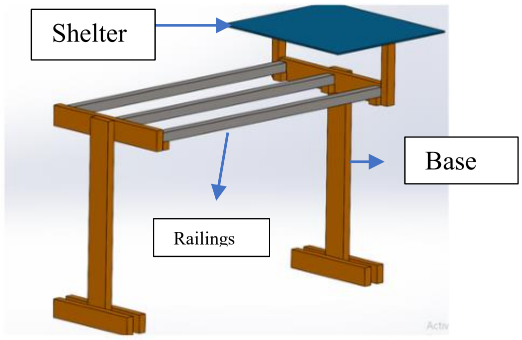

Figure 2: Final design

Figure 3: Final Prototype

The gear motor is driven through a unique gear mechanism, facilitating the movement of the clothes between the drying area and the shelter. The speed and direction of the gear motor are controlled by the L298D motor controller, ensuring precise movement of clothes based on the environmental conditions.

The transfer of the clothing between the drying area and the shelter is made easier using a special gear system to drive the gear motor. The L298D motor controller regulates the gear motor's speed and direction to ensure that the clothing moves precisely in response to the environment.

The Automated Clothesline System is now a complete management tool for managing outdoor clothing drying thanks to the addition of the HC-05 Bluetooth module, which enables remote control of the system and gives users the ability to control the system.

In conclusion, the Automated Clothesline System offers an innovative, user-friendly method for drying outdoor laundry. It significantly minimizes the human effort and ongoing monitoring that is often associated with this work by intelligently integrating sensors, motor control, and remote-control features.

V. MATHEMATICAL MODEL

The following section will describe the forces and torques involved in the operation for the prototype of the Automated Clothesline System, under the assumptions provided.

1. Assumptions:

The maximum wet mass of clothes on each hanger is 0.4 kg.

The mass of the hanger itself is negligible.

Air resistance is negligible.

The railing is made of aluminum and mild steel.

2. Force Calculations:

The maximum wet load, which is the force exerted by the maximum wet mass due to gravity.

Load = mass * acceleration due to gravity

= 0.4 kg * 9.81 m/s²

= 3.924 N

This is the normal reaction force per hanger.

The frictional force generated between the hangers and the railing is given by:

$F = \mu R$

where μ is the static coefficient of friction between aluminum and mild steel (μ static = 0.61, according to Engineering Toolbox) and R is the normal reaction force. Therefore,

F = 0.61 * 3.924 N

= 2.393 N

Given there are 15 hangers, the total force required to move all the hangers simultaneously is:

Total force = 15 * 2.393 N

= 35.904 N

3. Torque Calculations:

The torque required to drive the gear motor can be calculated using the formula:

Torque(T) = Force (P) * radius

Where P is the force required (total force calculated previously) and r is the radius of the shaft or pulley, which is 0.06 m. Therefore:

T = 35.904 N * 0.06 m

= 2.154 Nm

These calculations were done accordingly to select the most suitable components in order to handle the forces and torques without failing. It's very important to select suitable components to run the system smoothly and reliably.

VI. CONTROL SYSTEM

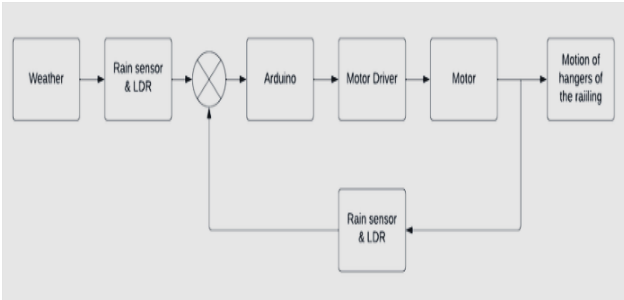

Figure 4: Control System

VII. WORKING PROCEDURE

To give the user flexibility, the Automated Clothesline System uses a combination of automated and manual controls. The sensors, the Arduino Uno microcontroller, the L298D motor controller, and the DC gear motor all interact in various ways during the process.

The system is operational once the main switch is turned on. The Arduino Uno continuously monitors the LDR sensor and the YL-83 rain sensor, which alerts them to changes in the environment. Both rain and variations in light intensity are detected by these sensors. Both sensors provide a signal to the Arduino Uno whenever they detect a trigger condition, such as darkness or rain.

When one of the sensors sends a signal, the Arduino Uno controls the L298D motor controller to turn the DC motor in a clockwise manner. Through the gear and belt mechanism, this motor movement causes the roller hangers holding the garments to withdraw toward the covered area.

To manage the movement of clothing regardless of the environment, the system includes a manual override option. The clothing moves toward the shelter when this switch is turned ON, and away from the shelter when it is turned OFF.

A Bluetooth-enabled remote-control feature is also part of the system. The user can control the movement of the garments using a smartphone that is connected to the device: hitting the number 0 button pushes the clothes in the direction of the shelter, while pressing the number 1 button moves them away from it.

An ultrasonic sensor and a traveling sheet affixed to the center railing serve as a safety precaution to prevent injury or overtravel of the clothing. The sheet follows the clothing as they make their way to the shelter. The movement of the clothing is stopped when the ultrasonic sensor determines that the sheet has reached a specific location and sends a signal to the Arduino Uno to turn off the motor.

In conclusion, the Automated Clothesline System offers a smart, engaging, and secure method for managing outdoor clothing drying. Its dual automated and manual operation modes provide practical control options, ensuring clothing is shielded from the elements while minimizing the need for ongoing human involvement.

VIII. FABRICATION AND ASSEMBLY

The manufacture of the various system components is covered in this section.

Wood was used to construct the system's main construction because of its excellent strength-to-weight ratio and economical nature. Wood's versatility and ease of use made it possible to make anything quickly and precisely. The wooden components were joined and fixed together with nuts and nails to provide stability and endurance. A glue gun was used to strengthen the joints in some places where more stickiness was needed.

The electronics were put together on a Vero board and consisted of the Arduino Uno microcontroller, the sensors, the motor controller, and the Bluetooth module. This board gives the electronic components a small, sturdy foundation and makes it simple to troubleshoot and modify it as needed.

Flexible pipes were employed as conduits to provide the orderly and secure routing of the various wires. These pipes not only helped to keep the wires safe from harm but also helped the system look organized and professional.

Last but not least, a sturdy polymer substance was used to create the tent that would preserve the clothing. This substance was picked for its capacity to withstand external elements like UV rays, rain, and wind, ensuring long-term durability and efficient clothing protection.

In conclusion, the Automated Clothesline System's production and assembly process placed a premium on robustness, effectiveness, and aesthetics. Using wood, a Vero board, flexible pipes, a polymer shelter, and using nuts, nails, and glue guns wisely led to a sturdy, economical, and aesthetically pleasing system.

IX. RESULTS AND ANALYSIS

The objective of the research was to create an effective and novel method for drying clothing outside. Modern technology was incorporated to develop a complex system that would streamline and improve the entire process.

The Arduino Uno microcontroller, which serves as the system's brain, is at its core. Data from extremely sensitive sensors, such as the YL-83 rain sensor for rainfall detection and the LDR sensor for ambient light detection, are successfully analyzed by this clever controller.

Data: - By monitoring the process 10 days

Time where clothes gets to the shelter.

Table 1: Time that clothes came to the shelter with corresponding date.

Date	Time that clothes came to the shelter
20/5/2023	6.15 PM
21/5/2023	5.50 PM
22/5/2023	6.12 PM
23/5/2023	6.23 PM
24/5/2023	6.15 PM
25/5/2023	5.56 PM
26/5/2023	6.45 PM
27/5/2023	6.34 PM
28/5/2023	6.25 PM
29/5/2023	5.45 PM
30/5/2023	6.17 PM

Average rainfall during the 10 days > 295 precipitation / rainfall(mm)

Based on the gathered data, the system autonomously initiates the necessary action to optimize the process.

Data: - By monitoring the process the team calculated the average time taken to return the clothes in seconds for 20 samples

5.225, 5.505, 4.972, 5.323, 5.380, 5.775, 4.703, 4.875, 6.004, 5.690, 4.927, 5.776, 5.988, 5.300, 5.080, 5.027, 5.970, 6.879, 4.900, 5.470.

Average time = 5.43845 seconds

The HC-05 Bluetooth module was used to improve user comfort and allow for easy system remote control. Compatible devices give users simple management and monitoring tools, providing previously unheard-of flexibility and control.

In conclusion, this research has produced a ground-breaking answer that transforms outdoor laundry drying.

The created solution considerably minimizes human work and maximizes productivity by utilizing cutting-edge technologies and implementing a user-centric design. This innovation has the potential to revolutionize conventional washing procedures, providing households with greater ease and an improved drying experience.

X. CONCLUSION

To sum up, the Automated Clothesline System is a creative way to automate a typical domestic task. In order to address problems with outdoor clothes drying, namely the protection of clothes from rain and darkness, it includes sensor technology, automation, and remote-control functions. The system's construction makes use of an original mechanical design and affordable, long-lasting materials. The current system makes a substantial contribution to the field of home automation, even though there is room for improvement. It exemplifies how technology may improve convenience and effectiveness in our daily lives.

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ACKNOWLEDGMENT

I would like to take this opportunity to express my gratitude to everyone who contributed in order to the successful completion of this study. Especially, my sincerest appreciation to my team members. And I am deeply indebted to the faculty of the Mechanical Department. Their support was indispensable. Finally, to everyone who directly or indirectly, thank you for your involvement.

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