

Automated battery-powered water detection system (Cloduino) in clothesline using Arduino-Uno R3

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Abstract

This study was carried out to utilize the battery-powered Arduino Uno R3 and a water detection system to add features to a traditional method of drying clothes and the traditional clothesline. The Cloduino aimed to automatically detect rain and prevent clothes from getting wet with a motorized rotating clothesline attached to an Arduino Uno R3 rain-detecting sensor, which would rotate and move the clothesline to a shaded or covered area for protection when it rained, ensuring clothes remained dry and protected. The researchers aimed to develop the Automated Battery-Powered Water Detection System (Cloduino) in a clothesline using Arduino UNO R3 to help individuals who leave their clotheslines unattended, enhancing convenience, reliability, and sustainability during sudden rainfall. This study addressed four main research questions: the amount of rainfall (water droplets) and duration. maximum weight and 12V battery efficiency. The findings revealed that the Automated Water Detection System in Clothesline 100% accurately detects rainfall (water droplets). In terms of duration, the system performs quickly when fewer clothes are hung, which results in a lesser weight of clothes. Lastly, the study found that the 12V battery is efficient when powering the system, especially the DC motor. However, a converted battery is recommended. The study concluded that the system is a valuable and effective solution for the convenience of drying clothes. The study recommends further improvements, such as using a battery converter, a lighter pulley in weight, and a higher voltage DC motor. Future researchers may add more materials to improve the system's features for more than 10 clothing items.

Keywords: Arduino Uno R3, Cloduino, clothesline, dc motor; rain sensor; water detection system

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1. Introduction

In many developing regions, drying clothes outdoors remains the most common and economical method of laundry care. However, unpredictable weather conditions often disrupt this traditional practice, especially during the rainy season. Sudden rainfall can soak freshly laundered clothes, leading to unpleasant odors, the need for re-washing, and increased water and electricity consumption. The hassle of checking the weather every moment compounds the stress, especially for those away from home because of work, school, or other commitments. David et al. (2015) highlight that innovative systems contribute significantly to a better quality of life by streamlining tedious household chores and minimizing stress in this era. In response to these mundane issues, other individuals dry their clothes on porches or in garages. Still, the clothes remain wet and prone to mold or mildew without adequate ventilation and sunlight.

Even with progress in home automation, there is a lack of cost-effective, accessible, and environmentally friendly solutions aimed explicitly at helping with outdoor clothes drying. Unlike weather-adaptive laundry solutions, most commercially sold smart home products are biased toward security systems, lighting, or indoor climate control (Mohd et al. 2021). Also, electric clothes dryers are costly, consume a significant amount of energy, and are unsuitable for low-income families. Further, currently available innovative drying systems are mostly complex to install and maintain, which makes them unfit for ordinary users. As much as IoT-based home systems are gaining research, the area of study that addresses the convergence of sustainable living, convenience, and local weather responsiveness in outdoor drying practices is still lacking, as Kundu et al. (2020) mentioned. The researchers named the product Cloduino, a device built using Arduino technology that connects easily to a clothesline and pole. Cloduino allows clothes to dry using the traditional outdoor method, and with an added feature: it detects rainfall. When it senses rain, Cloduino automatically draws garments undercover. This is convenient on drizzly days or when no one is around to track the weather.

This study focused on developing a rain-detection system to keep garments from getting wet, using an environmentally responsible battery-powered, automated setup. A sensor authorizes the system to extend or retract the clothesline, ensuring the clothes stay dry and secured from rain. The researchers came up with the Cloduino after they observed that clothes outside in the rainy season are prone to getting damp from the rain. The researchers proposed the product because it can benefit many individuals who frequently leave their houses and protect their clothes from getting wet.

Statement of the Problem - This study aimed to develop an automated battery-powered water detection system (Cloduino) using Arduino UNO R3 for drying clothes. Specifically, this study sought to answer the following: (1) How many droplets of water are needed for the functionality of the automated battery-powered detection system (Cloduino) using a rain sensor module, single droplets, light showers, and heavy droplets? (2) How long is required to fully activate the automated battery-powered detection system (Cloduino): less than 10 seconds, 10 to 20 seconds, or more than 20 seconds? (3) What is the maximum weight of clothes the automated battery-powered detection system (Cloduino) can effectively support: less than five damp clothes, 5 to 10 damp clothes, and more than 10 damp clothes? (4) Is the Arduino Uno R3, a 12V battery, a DC motor, and a rain sensor effective in performing the function and developing the automated water detection system in the clothesline?

Significance of the Study - This study aimed to develop an automated system that utilizes rainwater detectors, with the researchers testing its accuracy and assessing its potential benefits to humanity. Additionally, this study is significant in the following ways: This study would benefit adults since it makes doing laundry easier, which is usually done by most adults. The system lessens labor-intensive physical labor and weariness, enabling more

pleasant external drying. Students: This study would benefit the students since they are the individuals who frequently go out, leaving their clothes unattended. Students would have less hassle and be unable to think about their clothes. Community: This study would benefit the community, wherein people prefer this project over utilizing advanced appliances, which require more electricity and money. The Cloduino system is battery-powered and does not contribute to the rise in electricity prices, which can be convenient for society. Future researchers can also derive significance and benefits from this study. It may be a valuable reference for those planning to conduct analyses related to this topic.

Scope and Delimitation of the Study - This study focused on developing and testing the Cloduino automated clothesline drying system utilizing Arduino technology. The study observed the system's ability to automatically move the clothesline when it rained in a shelter and return it to sunlight for drying. Cloduino could not withstand heavy garments such as bed sheets and duvets. Therefore, Cloduino could only handle a limited number of clothes. Clothes must be put on a hanger before using the product to maintain distance between clothes while drying. Data collection focused on the system's accuracy, performance, and the extent to which it could support typical household clothes-drying needs. This study was conducted over the 2024-2025 school year, encompassing the design, development, testing, and improvement stages. This study was limited to developing Cloduino for a standard clothesline with a fixed length. The research tested the system under typical weather conditions (i.e., moderate rain and light showers). Extreme weather conditions like heavy storms or intense sunlight are beyond the Cloduino system's capabilities. The scope did not include full-scale commercial production but focused on the prototype and its proof of concept. The study did not assess long-term durability beyond the project's duration or potential use for large-scale applications.

2. Methodology

Research Design - This study used an experimental research design to develop an effective device to help people automatically secure their clothes. An experimental research design was employed in this study, wherein the droplets of water were tested. This design was used to accumulate data from various observations and experiments to measure the effectiveness of Cloduino in regulating the amount that Cloduino can hold. It was also used to assess the rain manually when detecting it. The researchers used experimental research to design a water detection system that uses a rain sensor to detect rain. The rain sensor detects droplets of water, then senses and performs the required actions. This system is controlled through Arduino. The Arduino UNO R3 board is sufficient to prevent rain sensors and interface with the sensor. Meanwhile, the movement of the sensor is controlled by a droplet of water control module. This module is controlled using the Arduino UNO R3 board as a microcontroller.

Data Gathering Procedure - The researchers created an assessment checklist to test the functionality of the product. The checklist outlines the efficiency of the automated battery-powered water and detection system for clotheslines using Arduino UNO R3. With this, the researchers can effectively test the product according to its characteristics and their knowledge. The rationale is that the researchers themselves have automated clotheslines. The weather can influence product testing (an independent variable that can be controlled), and the researchers noted that Cloduino could be advantageous for them before conducting the test and survey. Testers need to test the product to establish if Cloduino is valuable and helpful to them. The experiment was carried out under rain (water droplets) and sunshine to obtain significant data and findings from the researchers, enabling a better understanding of the device's advantages, disadvantages, and shortcomings. The researchers applied the product in their area and, upon testing the product, responded to the survey questionnaire. This enabled the researchers to arrange and analyze the data collected from experience.

Research Process: Stage 1 Preparation and Gathering of Materials - The researchers bought some of the materials from online stores. The estimated cost is One Thousand Four Hundred Thirty pesos (₱1430). The following materials were used to create the product: A. For clothesline development: Chain-like plastic clothesline, Wooden pulley, and Wooden or steel poles; B. For automation: Arduino Uno R3, Breadboard, DC motor, L293D,

Rain sensor, Jumper wires, Battery 12V and Resistor.

Stage 2: Building and Development of the Project - The researchers developed an automated battery-powered water sensor system for clotheslines using Arduino Uno R3. Using recycled components and creating the Cloduino, the researchers sought to protect all students and homeowners from unexpected weather that might be experienced when drying clothes. To test if the product is functional, the researcher constructed the product, and for coding, the researcher employed the Arduino IDE application for the product coding and testing. The remaining components were bought via an online shop. The materials are finalized to complete the product. The researchers completed the sensor monitoring via codes and programming. The researchers used jumper wires to link all the components. The researchers used the automated clothesline with Arduino UNO R3, which alerts the sensor to shift the clothesline to a safer location. The development of Cloduino started on January 8, 2025, and finished on March 6, 2025.



Figure 1. Actual Product of Automated battery-powered water detection system (Cloduino) in clothesline using Arduino Uno R3

Stage 3: Experimental Stage, Observation, and Data Recording - To test the effectiveness and reliability of the product, the researchers would allow the participants to use the product with a conventional clothesline at home and observe which one is more reliable and whether the product is effective. The automated clothesline can be placed in a backyard, on a balcony, or wherever a conventional clothesline is. It would start to activate the sensor by sensing water within its location. When the detector senses raindrops, the clothesline shifts to the corresponding area. After the trial, the researcher prepared a checklist for their feedback on the product's effectiveness. After inspecting the device, the researchers activated the sensor and monitored the detector system. Each time the device was tested or used, the researchers tested the sensor's operation by water contact to determine whether the device would shift the clothesline. To improve the above device, the researchers also pointed out Cloduino's weaknesses that could affect its operation. The researchers decided to test and enhance the product's capabilities. The experimentation duration took the researchers almost 2 weeks to finalize the observation.

Statistical Treatment of the Data - The percentages and frequencies were computed to illustrate how well the automated battery-powered detection system performs and describe the accuracy, efficiency, and response rate in various environmental conditions. This study used weighted mean computation to determine whether the Cloduino system's performance is influenced by multiple factors, such as changes in moisture content and electrical usage, during the study period.

3. Results and Discussions

Table 1 shows that the Cloduino system works effectively in any case, no matter how much rain it detects. Whether it's just one droplet, a light shower, or heavy droplets, the system always responds immediately with 100% accuracy in each trial. This Cloduino means the system is well-founded and can detect any level of rainfall

without failing. The Cloduino system has been proven reliable when detecting rain, no matter how many falls. Since it gave 100% correct results in all tests, it is clear that the system is well-made and works well in any weather conditions. With this Cloduino system, people would lessen their worry about their clothes being damaged by rain. This ability to detect rain accurately is essential to improve comfort and protection, as it has proven to have a consistent and precise performance. According to the data obtained from Ardiansyah (2018), such sensors are transmitted to a fuzzy interface for processing. It can forecast weather conditions such as sunny, cloudy, drizzle, or heavy rain, which can help determine rainfall levels. The Cloduino system, when tested, proved to be highly dependable in sensing all rainfall intensities, ranging from showers to heavy rains. It executes with 100% accuracy and is reliable under real-world weather conditions, which may prove crucial in areas where rainfall must be constantly monitored.

Table 1

Test result data from the rain sensor

Number of trials	Testing of Rain Sensor			Results
	Single Droplets	Light shower	Heavy Droplets	
1 st trial	100%	100%	100%	100%
2 nd trial	100%	100%	100%	100%
3 rd trial	100%	100%	100%	100%
4 th trial	100%	100%	100%	100%
5 th trial	100%	100%	100%	100%

Legend: * Ideal amount of water to function effectively—single droplet. 100%: Accurate in sensing rainfall instantly

Table 2

Duration test results of the system to fully activate the Cloduino

Number of trials	Duration to fully activate the Cloduino		
	Less than 10 seconds	10 to 20 seconds	More than 20 seconds
1 st trial	100%	50%	10%
2 nd trial	100%	50%	10%
3 rd trial	100%	50%	10%
4 th trial	100%	50%	10%
5 th trial	100%	50%	10%

Legend: * Ideal amount of time to function effectively—less than 10 seconds. 10%-49% Extremely slow; 50%-99% Slower than ideal; 100% Ideal

Table 2 emphasizes that the task was consistently performed quickly across all trials without delay or variation. The results indicate that all five trials finished in under 10 seconds, each attaining a 100% success rate. It shows how carefully and effectively Cloduino would work. The average of 100% confirms that the activity was reliably finished in less than 10 seconds for each attempt. Generally, the task was carried out effectively, achieving an efficient success rate across the board. Meanwhile, the rate of attempts that exceeded the 10-second limit was 50%. Hence, the rotation speed is slower than the ideal duration; the same goes when the attempt exceeds the 20-second limit. The system's rotation would not be able to function as designed and possibly could not perform its primary purpose because of the low rate of speed. The research of Lin et al. (2018) discusses an intelligent means to regulate the speed of a DC motor to achieve the ideal duration with minimal limitations. This method adjusts the motor's speed efficiently by continuously improving its settings through coding and multiple

trials from various experiments to be faster and more efficient. Likewise, the results in the table show that the DC motor works consistently and fast, with all the trials finishing in less than 10 seconds. Like the BAS-PID controller, it optimizes motor speed through repeated adjustments. The Cloduino system demonstrates effectiveness and reliability in every test. Both studies identify how high-end control techniques improve and stabilize performance speed. Following Sudhakar et al. (2024), control the DC motor with a preferred speed manipulated by the researchers. The voltage source could be adjusted since the speed of the DC motor goes with the voltage input.

Table 3

Time test results of the system in correspondence to the weight

Number of trials	Time Test		
	Less than five damp clothes	5 to 10 damp cloths	More than 10 clothes
1 st trial	5.81 seconds	8.2 seconds	Not functioning
2 nd trial	6.17 seconds	8.03 seconds	Not functioning
3 rd trial	6.71 seconds	9.44 seconds	Not functioning
4 th trial	5.92 seconds	9.37 seconds	Not functioning
5 th trial	5.38 seconds	8.56 seconds	Not functioning
Average	5.998 seconds	8.72 seconds	Not functioning

Legend: * Ideal weight of clothes to function effectively—less than 5 damp clothes.

Table 3 shows how long Cloduino takes to work with different amounts of damp clothes. Researchers used an automated battery-powered water detection system (Cloduino) in a clothesline using Arduino UNO R3 to determine Cloduino's ability to hold different amounts of damp clothes. Five trials occurred in the experiment, measuring the processing times for less than five damp clothes, 5 to 10 damp garments, and more than 10 damp clothes. It works the fastest when there are under five clothes, finishing in about 5 to 7 seconds. For 5 to 10 damp clothes, it takes around 8 to 9 seconds to work.

Meanwhile, for loads exceeding 10 damp clothes, Cloduino could not handle the weight, making it hard to pull the clothes by the motor. The researchers compared the times to determine the number of clothes that the Cloduino can process well. Because the time continues to increase, it indicates that the higher the number of clothes added, the slower it processes. Based on this, the Cloduino cannot effectively support more than 10 clothes since it also takes longer. This pattern supports the idea that a powerful DC motor is necessary. Cloduino's result implies that it works well for small to moderate loads but may take longer to process or not function for larger loads of damp clothes. In the work of Hashim et al. (2022) mentioned previously, it was found that an automatic clothesline puller similar to the function of Cloduino was created to help consumers with their laundry issues. However, applying a heavy laundry workload will not perform the yeast function. The Cloduino system also has the same idea of retracting clothes automatically indoors when a raindrop is sensed. As shown in Table 3, the Cloduino cannot effectively support over 10 damp clothes, though it has a longer processing time depending on the number of items.

Table 4 shows the functionality test of the automated battery-powered water detection system (Cloduino) in a clothesline using Arduino Uno R3. All variables stated have been able to perform their functions throughout the experimentation; the 12V battery and the DC motor utilized can function in the automated water detection system in the clothesline. However, the experimentation proves that a higher voltage or a DC motor must be used to function the system more efficiently and smoothly. As indicated by Garche et al. (2015), it is demonstrated that the 12V battery effectively powered the automatic water detection system and the DC motor of the clothesline. Yet, a more powerful DC motor or higher voltage would be recommended for a successful outcome. It explains how batteries and motors work in moving systems like automatic sensors. The researchers prove through their study that a 12V battery is enough to drive simple systems like sensors and tiny motors (like the one used in the clothesline project). However, the researchers also discovered that while the system works, it

could work better if there were a stronger motor or more voltage. This would make the rotation smoother and faster, handy when clothes must be quickly drawn in once rain pours. This research is part of the theory that shows that although this setup can work, it can still be improved to be more efficient and reliable.

Table 4

Functionality test of the Automated battery-powered water detection system (Cloduino) in clothesline using Four main Materials

Components	Performance
Arduino Uno R3	1
Battery 12V	1
DC Motor	1
Rain Sensor	1

Legend: 1 Functional; 0 Not Functional

4. Conclusions

The following conclusions are presented based on the findings: The rain sensor module efficiently and accurately activates the clothesline's automated water detection system instantly (Cloduino). The Cloduino system acts quickly when fewer clothes or less weight are applied. It can effectively support fewer than five damp clothes. The system does not function properly when the maximum weight is exceeded. The DC motor utilized is ideal for the 12V battery. However, a battery converter must be applied to ensure efficiency.

Recommendations - The following recommendations are offered based on the findings: The researchers recommend that future developers consider the following: First, use a more substantial 12V battery or a higher power source as an alternative to improve the functionality of the Cloduino. Second, for a consistent power output, leading to the system's battery lasting longer without power drain, the researchers highly recommend replacing wooden pulleys with lightweight and smooth plastic pulleys to decrease friction and wear, improving the system's lifespan and performance. Third, using a more potent motor to increase workload management. The choice of materials, including the pulleys, would ensure durability for outdoor conditions; thus, they may improve the performance and interaction between the DC motor and the battery voltage with the Arduino code. Moreover, the researchers recommend a simple addition to the Cloduino: a rubber layer on the midsection of the pulley. A rubber material is flexible, low-cost, and provides a better grip for continuous rotation. This addition would minimize the slippage between the clothesline and the pulley, making the rotation smoother.

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