

Design and Implementation of Rain Responsive Window System with Integrated Cloth Drying Unit

Parimala Gandhi¹, Rajesh BB^{2*}, Vikas K N³, Rakshitha R⁴

¹Department of Electronics and Communication Engineering, R. R. Institute of Technology, Karnataka, India

²Department of Electronics and Communication Engineering, R. R. Institute of Technology, Karnataka, India

³Department of Electronics and Communication Engineering, R. R. Institute of Technology, Karnataka, India

⁴Department of Electronics and Communication Engineering, R. R. Institute of Technology, Karnataka, India

*Corresponding Author Email: rajeshbbrajesh8889@gmail.com

Abstract

The Smart Rain Avoidance for Clothes project is an innovative home automation system designed to protect clothes and interiors from unexpected rainfall. In many households, clothes are dried outside in open spaces, which often creates inconvenience when sudden rain occurs, causing clothes to get wet again and delaying the drying process. Similarly, open windows during rain can allow water to enter, damaging furniture and creating discomfort. This project provides an automated solution using an Arduino Nano microcontroller, a rain sensor, and servo motors. The rain sensor continuously monitors weather conditions and sends a signal to the Arduino when rain is detected. In response, the Arduino activates Servo Motor 1 to retract the clothesline under a protective shelter and Servo Motor 2 to close the window, thus preventing water entry. When no rain is detected, the system restores the clothesline to the outdoor position and reopens the window for natural ventilation. The system has been tested successfully and demonstrates reliable operation with quick response time. It is low-cost, energy-efficient, and easy to implement, making it suitable for households, hostels, and apartments. Beyond convenience, the project contributes to the development of smart home automation technologies, with potential for future enhancements such as IoT integration, mobile notifications, and predictive weather-based operation.

Index Terms—Microcontroller Unit, Sensor Subsystem, Actuator System, Power Supply, Real-time Rain Detection

1. Introduction

Drying clothes under natural sunlight is one of the most convenient methods used in households. However, during monsoon or unpredictable weather conditions, clothes hung outdoors often get wet again due to sudden rainfall. This leads to inconvenience, extra workload, and increased drying time. Similarly, leaving windows open during rainfall can cause water to enter the house, damaging furniture, electrical appliances, and interior spaces. These situations create a need for an automated system that can react quickly to changing weather conditions without depending on human intervention. Advancements in microcontrollers, sensors, and low-cost automation technologies have enabled the development of smart home systems that enhance everyday living. The Rain

Responsive Window System with Integrated Cloth Drying Unit is a smart automation solution designed to protect clothes and prevent indoor water entry during unexpected rainfall. The project uses an Arduino Nano, rain sensor, and two servo motors to automatically move the clothesline from an outdoor position to a sheltered area when rain is detected. Simultaneously, another servo closes the window to prevent rainwater from entering inside. Once the rainfall stops, the system automatically restores the clothesline and window to their original positions, ensuring continued airflow and effective drying. This system is energy-efficient, cost effective, and user-friendly, making it suitable for households, hostels, and apartments. It minimizes manual monitoring, enhances convenience for users who may not be home during rainfall, and contributes to the growing field of smart home automation. With increasing urbanization and changing lifestyle patterns, the need for smart home automation systems has become more important than ever. One common

household problem is the unexpected rainfall that can damage indoor items and disrupt outdoor cloth drying. To address this issue, the Rain Responsive Window System with Integrated Cloth Drying Unit is designed as an automated solution that enhances convenience, safety, and energy efficiency. This system automatically detects rainfall using a rain sensor and responds by closing windows and retracting or protecting the cloth drying unit without human intervention. The integration of a microcontroller-based control unit enables real-time monitoring and precise control of window movement and drying mechanisms. By automating these processes, the system minimizes water ingress, prevents damage to furniture and electrical appliances, and ensures that clothes remain dry even during sudden weather changes. The proposed design is especially useful in residential buildings, hostels, apartments, and commercial laundry areas where continuous manual monitoring is not feasible. Additionally, the system supports sustainable living by reducing dependency on electrical dryers and optimizing the use of natural air

drying. Overall, this project demonstrates the practical application of embedded systems and sensors in smart home technology, offering an efficient, reliable, and user-friendly solution to everyday problems. This system is designed to automatically sense rainfall and respond instantly by closing windows and activating a protective or retractable cloth drying mechanism. A rain sensor plays a crucial role by continuously monitoring environmental conditions and sending signals to a microcontroller-based control unit. Upon detecting rain, the controller processes the input and drives actuators such as servo or DC motors to close the window and safeguard the drying clothes. When the rain stops, the system can reopen the window or extend the drying unit, ensuring uninterrupted ventilation and efficient cloth drying. The integration of the cloth drying unit with the rain-responsive window system makes the design more practical and user-centric. It reduces the dependency on electric dryers, thereby saving energy and promoting eco-friendly practices. The system also minimizes the risk of damage to household items such as curtains, furniture, electronic devices, and laundry caused by unexpected rainfall. Additionally, it enhances indoor comfort by maintaining proper airflow and hygiene.

Overall, this project not only solves a common household issue but also showcases how embedded systems and automation can be applied to improve comfort, convenience, and efficiency in daily life.

2. Related Work

[1].Syahirah, Ghina Aqli, et al. "Smart Clothesline: Sistem Jemuran Otomatis Berbasis IoT dengan Raindrops Sensor." *Jurnal Janitra Informatika dan Sistem Informasi* 5.2 (2025): 215-225. : The work by Syahirah et al. proposed an IoT-based smart clothesline system that uses a raindrop sensor to automatically retract clothes during rainfall. Their system integrates internet connectivity for monitoring and control, enabling remote operation and improving user convenience. The study highlights the effectiveness of combining rain sensors with IoT platforms to address real-time environmental changes.

[2].Daud, Syamim, and Hikma Shabani. "Rain Detector for Cloth Hanger." *Progress in Engineering Application and Technology* 3.1 (2022): 542-548 : Daud and Shabani proposed a rain detector system for a cloth hanger using a rain sensor, NodeMCU ESP8266, and a DC motor. Their system automatically retracts the clothesline when rain is detected and extends it again when the weather becomes clear. The integration of IoT through mobile connectivity enhances user convenience by enabling monitoring and control via smartphone applications.

[3].Jain, Akshat, S. Hemalatha, and G. Deepa. "Automatic Rain-Sensing Wiper." 2026 4th International Conference on Intelligent Data Communication Technologies and Internet of Things (IDCIoT). IEEE, 2026 : Early work by Terakura et al. (2001) introduced an optical rain sensor system based on light reflection principles. This system detects rainfall by measuring changes in reflected light intensity and adjusts the wiper speed accordingly. The study also proposed algorithms to match wiping speed with rainfall intensity, making it one of the earliest intelligent wiper control systems.

[4].Ariska, Nadia Fitri, et al. "Construction Of An Automatic Clothesline System Based On An Arduino Uno Microcontroller Using A Rain Sensor And LDR." *JURNAL TEKNI*

6.1 (2026): 45-50 : Ariska, Nadia Fitri, et al. (2026) developed an automatic clothesline system using an

Arduino Uno microcontroller integrated with a rain sensor and LDR (Light Dependent Resistor). Their system detects rainfall and ambient light intensity to automatically move the clothesline. When rain is detected or light intensity decreases (indicating cloudy or nighttime conditions), the system retracts the clothesline to a sheltered area. Conversely, during sunny conditions, it extends the clothesline for efficient drying. The design emphasizes low cost, simplicity, and ease of implementation for household applications.

[5].Atsiq, Athaya, Andryan Gunawan, and Amin Alqudri Dwi Nugraha. "Automatic Clothing Drying Using Rain Sensors and Ldr Sensors Based on Arduino UNO." *Spectrum* 1.02 (2022): 12-20 : Atsiq, Athaya, et al. (2022) proposed an automatic clothing drying system using an Arduino Uno microcontroller integrated with rain sensors and LDR sensors. Their system detects environmental conditions such as rainfall and light intensity to control the movement of the clothesline. When the LDR sensor detects low light intensity (indicating cloudy or rainy conditions), the system interprets this as a possibility of rain and retracts the clothesline to a protected area. Similarly, when sufficient sunlight is detected, the clothesline is extended to facilitate drying. The rain sensor further enhances accuracy by directly detecting raindrops, ensuring reliable system response.

[6].Ishak, Nurul Najwa, et al. "Automatic retractable cloth drying system." *Progress in Engineering Application and Technology* 1.1 (2020): 198-205 : Ishak, Nurul Najwa, et al. (2020) proposed an automatic retractable cloth drying system based on an Arduino Uno microcontroller to address challenges caused by unpredictable weather conditions. The system integrates rain sensors and light sensors (LDR) to monitor environmental changes and automatically control the movement of the clothesline. When rain is detected or light intensity decreases, the system retracts the clothesline to protect clothes from getting wet. Conversely, under sufficient sunlight, the clothesline is extended to enhance drying efficiency. The design incorporates a motorized mechanism (power window motor) to ensure smooth and reliable operation, and it is capable of handling a moderate load suitable for household use. This work demonstrates a practical, low-cost, and automated solution, improving convenience compared to

manual drying methods while maintaining simplicity in design and implementation.

[7].Abidin, Rama Kurniawan, Imam Hizbullah, and Hafid Saifudin. "Prototype design of automatic clothesline using raindrop sensor and light dependent resistor (ldr) based on arduino." *IOP Conference Series: Earth and Environmental Science*. Vol. 1454. No. 1. IOP Publishing, 2025 : Abidin, Rama Kurniawan, et al. (2025) presented a prototype design of an automatic clothesline system using a raindrop sensor and Light Dependent Resistor (LDR) based on Arduino. The system is designed to automatically respond to environmental conditions by detecting rainfall and ambient light intensity. When the raindrop sensor detects rain, the clothesline is retracted to prevent clothes from getting wet. Similarly, when the LDR senses low light intensity, indicating cloudy or unfavorable drying conditions, the system ensures the clothesline remains in a protected position. During sunny conditions, the clothesline is extended to maximize drying efficiency.

[8].Habibulloh, Ibrahim Sulton, et al. "Design And Build Smart Clotheslines Using Android Applications Based On The Inter-net of Things (IoT)." *2025 11th International Conference on Wireless and Telematics (ICWT)*. IEEE, 2025; Habibulloh, Ibrahim Sulton, et al. (2025) proposed a smart clothesline system based on the Internet of Things (IoT) integrated with an Android application to enhance user convenience and remote accessibility. The system uses environmental sensors such as rain sensors and light sensors to detect weather conditions and automatically control the movement of the clothesline. In addition to automation, the system enables users to monitor and control the clothesline remotely through a smartphone application, providing real-time updates on weather conditions and system status.

[9].MR, AMIT M. JANRAO, et al. "Rain Detection and Clothes Protection Using Arduino." *INTERNATIONAL JOURNAL* (2025): 686-689 : Janrao, Amit M., et al. (2025) proposed a rain detection and clothes protection system using Arduino, aimed at preventing clothes from getting wet during unexpected rainfall. The system primarily uses a rain sensor to detect water droplets and automatically triggers a mechanism to protect or retract the clothesline. The Arduino microcontroller acts as the

central control unit, processing sensor inputs and controlling the motor or actuator accordingly. The design focuses on simplicity, low cost, and practical implementation, making it suitable for household applications.

[10].Jayakrista, Suriandi, and Roly Glendy Wowiling. "Proto-type of IoT-based Clothes Drying Control System." *Journal of Computer Engineering, Electronics and Information Technol-ogy* 3.1 (2024): 27-34 : Jayakrista, Suriandi, and Roly Glendy Wowiling (2024) developed a prototype of an IoT-based clothes drying control system aimed at improving automation and user convenience in household drying processes. The system integrates environmental sensors such as rain sensors and light sensors with a microcontroller and IoT module to monitor weather conditions in real time. Based on sensor inputs, the system automatically controls the movement of the clothesline—retracting it during rainfall and extending it under favorable drying conditions.

3. Methodology

The methodology describes the systematic approach used to design, develop, and implement the Rain Responsive Window System with Integrated Cloth Drying Unit. This chapter covers the problem analysis, system design, working principle, block diagram, applications, advantages, and limitations. Problem Identification Drying clothes outdoors is a common household practice, but sudden rainfall can soak clothes again, causing inconvenience and additional drying time. Open windows during rain also allow water to enter homes, damaging interiors and creating discomfort. These problems highlight the need for: Real-time rain detection Automatic movement of clothes to shelter. Automatic closing of windows. Reduction of human effort The goal is to create an automated, efficient, and reliable system using affordable electronic components. System Design The system integrates both hardware and software components for automated operation. The block diagram consists of the following interconnected units: Power Supply Rain Sensor Arduino Nano Servo Motor.

1 (Clothesline control) Servo Motor 2 (Window control) Hardware Components Arduino Nano – Central controller for decision-making Rain Sensor Module – Detects raindrops Servo Motor 1 – Moves

the clothesline to a sheltered position Servo Motor 2 – Opens and closes the window Power Supply Provides regulated 5V to all components Software Components Arduino IDE Embedded C programming .Servo library for angle control Continuous monitoring loop for real-time response Working Principle The rain sensor continuously monitors for raindrops. When no rain is detected: Clothes remain outside (Servo 1 → 0°) Window stays open (Servo 2 → 0°) When rain is detected: Servo 1 moves clothes to the shelter (60°) Servo 2 closes the window (90°) When the rain stops, the system returns to its default position. These operations run continuously in a loop through the Arduino. Applications Smart Home Automation – Helps in automatic window control and clothes protection. Hostels and Apartments Protects clothes when occupants are away. Laundry Services Ensures fabric safety during unpredictable rains. IoT Integration Can be upgraded to send alerts to smartphones. Weather-responsive homes Supports humidity and moisture monitoring systems. Advantages Fully automatic operation Saves time and reduces manual work .Protects clothes and indoor areas .Energy efficient system. Quick. real-time rain response .Easy to install and maintain Can be extended with IoT features Disadvantages Requires proper installation and mechanical setup Sensor may give false triggers due to dew or moisture Servos may need maintenance over time Higher cost than manual systems Limited torque for very large windows/clothes loads Power dependency for continuous operation

A. BLOCK DIAGRAM

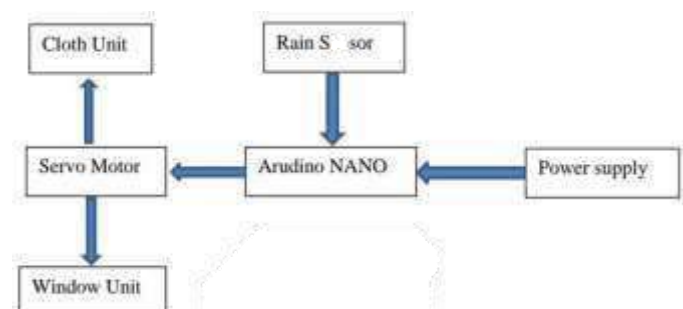


Fig. 1. BLOCK DIAGRAM

Automated Rain-Protection System designed to manage household fixtures based on weather conditions. At its core is the Arduino NANO, a compact microcontroller that serves as the central processing unit, receiving electrical signals from the Rain Sensor. This sensor acts as the primary

input device, detecting moisture levels and relaying that data to the Arduino. The entire system is energized by a dedicated Power Supply, ensuring stable voltage for both logic processing and mechanical movement. Once the Arduino processes the sensor data and identifies precipitation, it triggers the Servo Motor, which serves as the system's actuator. Unlike standard motors, a servo allows for precise angular control, which is necessary to manipulate the physical units attached to it. The motor is mechanically linked to two outputs: the Cloth Unit and the Window Unit. In a practical scenario, this suggests a retractable laundry line and an automated window closer. The bidirectional arrows indicate a reversible logic flow; when the sensor dries, the Arduino instructs the motor to return to its original position, reopening the window or redeploying the clothes. This closed-loop interaction creates an efficient, hands-free solution for protecting property from sudden environmental changes.

B. FLOW CHART

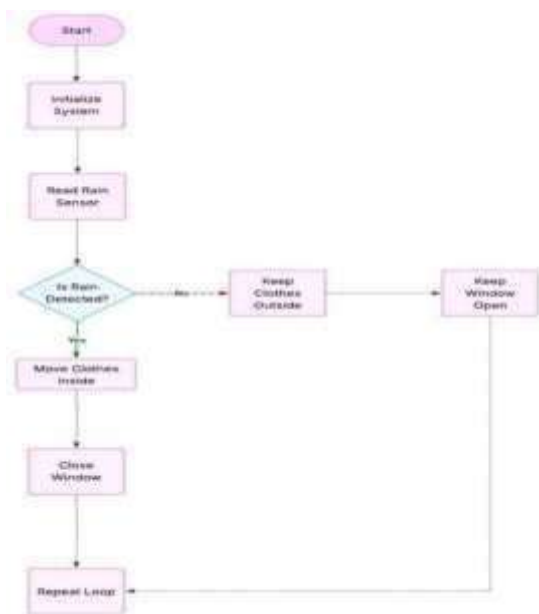


Fig. 2. FLOW CHART

The flow chart simplifies the process into decision-making steps and shows how the system continuously loops to ensure real-time monitoring.

Step-by-Step Flow Chart

1.Start: The system is powered on, and the Arduino Nano initializes the input/output pins. Both servo motors are set to their default positions (clothes outside, window open).

2.Initialize Components: Rain sensor pin configured as input. Servo 1 (clothes) and Servo 2 (window) attached to Arduino. Serial communication starts for monitoring.

3.Read Rain Sensor: The Arduino continuously checks the rain sensor to detect whether raindrops are present.

4.Decision: Rain Detected. If the rain sensor gives a HIGH signal, it indicates rainfall; if the rain sensor gives a LOW signal, it indicates no rain.

5.If Rain Detected (YES branch): Servo 1 rotates to 60° \rightarrow moves clothes into the sheltered area. Servo 2 rotates to 90° \rightarrow closes the window. Display message on Serial Monitor: "Rain detected! Moving clothes and closing window."

6. If No Rain (NO branch): Servo 1 remains at 0° \rightarrow keeps clothes outside. Servo 2 remains at 0° \rightarrow keeps window open. Display message on Serial Monitor: "No rain. Keeping clothes outside and window open."

7. Delay for Stability: The system waits for a short delay (1000 ms) before repeating to prevent fluctuations.

8. Repeat Loop: The process repeats continuously, ensuring real-time detection .

4. Results and Discussion

The software implementation defines how the system reads sensor inputs and controls the servo motors to perform automatic actions during rainfall. The program is developed using the Arduino IDE and written in Embedded C / Arduino Programming Environment Platform: Language: Arduino IDE Language: Embedded C / Arduino Programming Language Microcontroller: ATmega328P (Arduino Nano) Libraries Used: Development Environment Platform: Arduino IDE Programming Language: Embedded C . Microcontroller: ATmega328P (Arduino Nano) Libraries Used: Servo.h \rightarrow To control both servo motors using PWM signals Software Workflow The software is designed to perform real-time monitoring of weather conditions and control

the mechanical actions accordingly. Step 1: Initialization Define rain sensor pin as input .Attach Servo 1 (Clothes movement) to digital pin D9 .Attach Servo 2 (Window control) to digital pin D10 .Set default servo positions Clothes outside .Window open Step 2: Continuous Sensor Reading The microcontroller continuously

checks the rain sensor's digital output: LOW → No rain HIGH → Rain detected Step 3: Decision-Making Logic If no rain, the system ensures: Clothes stay outside (Servo 1) Window remains open (Servo 2) .If rain detected, the system automatically: Moves clothes into shelter (Servo 1) Closes the window (Servo 2) Step 4: Servo Actuation The Servo.h library generates precise PWM signals to rotate the motors to the required angles. Servo 1 → Controls position of clothesline Servo 2 → Controls window mechanism Step 5: Loop Execution The logic runs inside the loop() function, ensuring that the system: rain sensor Responds immediately to rainfall Returns to default state once rainfall stops Maintains continuous monitoring Working principle Development The Rain Responsive Window System with Integrated Cloth Drying Unit works on the principle of automatic rain detection and controlled mechanical movement using an embedded system. The main control unit of the system is the Arduino Nano, which continuously monitors the output of the rain sensor and controls the servo motors accordingly. The system is powered by a 9V battery. Since electronic components require a stable voltage, the battery output is passed through a 7805 voltage regulator to obtain a regulated 5V DC supply. This regulated power is used to operate the Arduino Nano, rain sensor module, and servo motors. A switch is included to turn the system ON or OFF. The rain sensor is placed in an exposed area where it can directly sense rainfall. Under dry conditions, the sensor output remains low. When rain droplets fall on the sensor surface, the conductivity increases, and the sensor generates a digital signal. This signal is fed to the Arduino Nano through a digital input pin. Once rain is detected, the Arduino processes the signal and sends control commands to the servo motors. One servo motor closes the window to prevent rainwater from entering indoors, while the second servo motor retracts or protects the cloth drying unit. When the rain stops, the sensor signal returns to normal, and the Arduino commands the servo motors to reopen the window and extend the drying unit. The flow chart represents the sequence of operations carried out by the system to detect rain and actuate the servo

motors for clothes movement and window control. It simplifies the process into decision-making steps and shows how the system continuously loops to ensure real-time monitoring. Step by Steps of Flow Chart 1.Start The system is powered on, and the Arduino Nano initializes the input/output pins. Both servo motors are set to their default positions (clothes outside, window open). System with Integrated Cloth Drying Unit was evaluated through a series of tests conducted under different environmental conditions. The tests focused on the system's response time, accuracy of rain detection, servo motor functioning, and overall reliability. Testing Environ- ment Hardware Used Arduino Nano 1.Rain Sensor Module Outcome: This project Successfully Tested and validated and the response is recorded. 3. No Rain Test There are no alert messages the controller receives when the weather condition is dry or no rain and the System Response is recorded as follows : 1.Sensor output remained LOW .Clothes stayed outside 2.Servo Motor 1 (Clothes movement) Testing Conditions 1.No rain (Dry conditions) 2.Rain detected (Simulated using water droplets on sensor) 3.Intermittent rain (Wet-Dry alternating) Observation Tools 1.Serial Monitor (Arduino IDE) 2.Visual observation of servo movement Testing Procedure Initatie the system The system was powered ON. Both servo motors moved to default positions: Check the weather condition Keep the Clothes outside and Windows open Check the weather condition and check Water droplets by rain sensor. On rain detection the Rain sensor sets the output HIGH .Rain sensor sends the conditions to Controller unit On detection of control signal the Arduino activates the motor unit Servo motor on receive the command signal from controller does the following actions: Trigger the cloth drying unit and moves the unit under shelter to protect the cloth from rain To avoid rain drops entering into to the house the motor unit activates the windows and closes the window .The control action is communicated and the output is displayed on the display unit with the message "Rain detected! Moving clothes and closing window." .Window remained open .Serial output displayed: "No rain. Clothes outside, window open." Outcome: Correct system behavior 4. Intermittent Rain Test The sensor was alternated between wet and dry conditions. System Response: 1.Servo motors adjusted positions quickly based on real-time sensor readings.2.No delay or malfunction observed 3.System proved stable even

during repeated switching of rain states Outcome: High reliability during fluctuating conditions Model Observation Initial State 1.Clothesline positioned out- doors Window open 3.No rain detected Final State 1.Clothes- line moved to sheltered area 2.Window closed 3.Rain detected Overall Result The prototype worked successfully in all test scenarios. The automated mechanism accurately detected rain and responded by adjusting both servo-controlled units. The system demonstrated: Fast reaction time .Reliable per-formance .Efficient protection of clothes and windows .Stable functioning under fluctuating weather conditions The project achieved its objective of developing a smart, cost-effective, and user friendly rain-responsive system.

The front view of the model represents a prototype of a smart house integrated with an automated clothes drying and rain responsive window control system. The model is designed to demonstrate the real-time operation of the system during normal and rainy conditions. In the front section, a clothesline arrangement is shown with clothes hung outside the house. This clothesline is mechanically connected to a servo motor mechanism, which enables automatic movement of clothes between the outdoor drying area and the sheltered indoor space. Under normal weather conditions, the clothes remain outside to allow effective drying using natural air and sunlight. A rain sensor module is mounted on the top roof area of the model. This placement allows the sensor to directly detect rainfall. When raindrops fall on the sensor surface, it generates a signal that is sent to the Arduino Nano controller. The Arduino Nano, placed on the side of the model along with the power supply unit, acts as the central control unit. It continuously monitors the rain sensor output and controls the servo motors accordingly. Upon detection of rain, the Arduino triggers the servo motor responsible for clothes movement, pulling the clothesline into the protected area. At the same time, another servo motor is activated to close the window automatically, preventing rainwater from entering the house. The power supply section, consisting of batteries and voltage regulation circuitry, provides a stable 5V supply to the Arduino, rain sensor, and servo motors. All electrical connections are arranged externally for easy observation and troubleshooting during demonstration. Overall, the front view clearly demonstrates the functional working of the rain responsive mechanism, highlighting how clothes protection and window automation are achieved

using embedded systems. This model effectively showcases the practical application of smart home automation concepts in daily household activities. Model Implementation The side view of the model illustrates the internal arrangement and mechanical movement of the Rain Responsive Window System with Integrated Cloth Drying Unit. This view mainly highlights the placement of electronic components, servo motor mechanisms, and power supply units used for system operation.



Fig 3 CLOTHS AND WINDOW ARE OPENED IF SENESOR DON'T DETECT RAIN



Fig 4 CLOTHS AND WINDOW ARE OPENED IF SENESOR DON'T DETECT RAIN

Cloth drying Control unit From the side view, the Arduino Nano controller board is clearly visible along with the battery pack and control circuitry. The Arduino Nano acts as the brain of the system, continuously receiving input signals from the rain sensor and generating control signals for the servo motors. The glowing LED indicates that the system is powered ON and actively functioning. The servo motor mounted on the side wall is responsible for controlling the movement of the clothesline mechanism. When rain is detected, the servo rotates to pull the clothes into the sheltered region. Another servo motor is connected to the window mechanism, enabling automatic opening and closing of the window depending on weather conditions. The rain sensor, placed on the roof, is

electrically connected to the controller through external wiring, which is clearly visible in the side view. This placement ensures accurate detection of rainfall and quick response by the system. The power supply unit, consisting of batteries and voltage regulation components, provides a stable 5V supply to the Arduino Nano, rain sensor, and servo motors. External placement of components allows easy observation, maintenance, and troubleshooting during demonstration. Overall, the side view of the model clearly demonstrates the hardware integration, actuator placement, and wiring structure of the system. It helps in understanding how the electronic and mechanical components work together to achieve automatic rainresponsive control, making the system suitable for smart home automation applications. The model side view indicates the power up unit for the overall control of the project. Also the model shows the rain sensor fitted on the roof top of the house to detect the water droplets and servo motor to control that connected to control the operation of the drying and window unit. The project uses 6.6V Lithium ion battery to control the overall operation of the project . Outcome of the Project: On Rain detection Window closed and drying unit kept indoor One of the key outcomes of this project is the automatic protection of indoor spaces. The system efficiently closes the window as soon as rainfall is detected, preventing rainwater from entering the room. This helps in avoiding water damage to household items, furniture, and electrical appliances. The automatic window control mechanism using a servo motor showed smooth and precise operation, validating the effectiveness of the control logic implemented in the software. Another important outcome is the continuous and efficient drying of clothes during rainy conditions. When rain is detected, the integrated cloth drying unit activates automatically, ensuring that clothes remain dry even during unfavorable weather. This reduces dependence on sunlight and manual drying methods, especially during monsoon seasons. The use of a controlled heating and air circulation mechanism improves drying efficiency while maintaining safety. The project also highlights the successful integration of hardware and software components. The Arduino Uno software effectively processes sensor data and controls actuators such as motors and relays. The power

supply system ensures stable operation of all components, demonstrating reliable energy management. The final stage of the model represents the condition when rain is detected by the rain sensor and the system performs its protective actions automatically. In this stage, the rain sensor mounted on the roof senses the presence of raindrops and sends a digital signal to the Arduino Nano controller. The successful implementation of the Rain-Responsive Window System with Integrated Cloth Drying Unit demonstrates the effectiveness of sensor-based automation in real-life domestic applications. The project outcome proves that environmental conditions such as rainfall can be detected accurately and responded to automatically without human intervention. The rain sensor reliably senses the presence of rain and sends real-time data to the microcontroller, enabling quick and appropriate system response.

5. Conclusion

The Design and Implementation of a Rain Responsive Window System with Integrated Cloth Drying Unit successfully demonstrates an innovative solution for improving household convenience and energy efficiency. The system is designed to automatically detect rainfall and close windows using rain sensors and motorized mechanisms, thereby protecting indoor spaces from water damage. Simultaneously, the integrated cloth drying unit provides a practical method for drying clothes efficiently during unexpected weather changes. The project combines embedded systems, sensors, automation, and mechanical design to create a smart and user-friendly solution. By reducing manual intervention, the system enhances comfort, saves time, and minimizes the risk of clothes getting wet during rainfall.

References

- [1]. Syahirah, Ghina Aqli, et al. "Smart Clothesline: Sistem Jemuran Otoma-tis Berbasis IoT dengan Raindrops Sensor." *Jurnal Janitra Informatika dan Sistem Informasi* 5.2 (2025): 215-225.
- [2]. Daud, Syamim, and Hikma Shabani. "Rain Detector for Cloth Hanger." *Progress in Engineering Application and Technology* 3.1 (2022): 542-548.
- [3]. Jain, Akshat, S. Hemalatha, and G. Deepa. "Automatic Rain-Sensing Wiper." 2026 4th

International Conference on Intelligent Data Communication Technologies and Internet of Things (IDCIoT). IEEE, 2026.

[4]. Ariska, Nadia Fitri, et al. "Construction Of An Automatic Clothesline System Based On An Arduino Uno Microcontroller Using A Rain Sensor And LDR." JURNAL TEKNI 6.1 (2026): 45-50.

[5]. Atsiq, Athaya, Andryan Gunawan, and Amin Alqudri Dwi Nugraha. "Automatic Clothing Drying Using Rain Sensors and Ldr Sensors Based on Arduino UNO." Spectrum 1.02 (2022): 12-20.

[6]. Ishak, Nurul Najwa, et al. "Automatic retractable cloth drying system." Progress in Engineering Application and Technology 1.1 (2020): 198-205.

[7]. Abidin, Rama Kurniawan, Imam Hizbullah, and Hafid Saifudin. "Pro-totype design of automatic clothesline using raindrop sensor and light dependent resistor (ldr) based on arduino." IOP Conference Series: Earth and Environmental Science. Vol. 1454. No. 1. IOP Publishing, 2025.

[8]. Habibulloh, Ibrahim Sulton, et al. "Design And Build Smart Clotheslines Using Android Applications Based On The Internet of Things (IoT)." 2025 11th International Conference on Wireless and Telematics (ICWT). IEEE, 2025.

[9]. MR, AMIT M. JANRAO, et al. "Rain Detection and Clothes Protection Using Arduino." INTERNATIONAL JOURNAL (2025): 686-689.

[10]. Jayakrista, Suriandi, and Rolty Glendy Wowiling. "Prototype of IoT-based Clothes Drying Control System." Journal of Computer Engineer-ing, Electronics and Information Technology 3.1 (2024): 27-34.