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CONSTRUCTION OF AN AUTOMATIC CLOTHESLINE SYSTEM BASED ON AN ARDUINO UNO MICROCONTROLLER USING A RAIN SENSOR AND LDR

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Abstract: An Arduino Uno-based automatic clothesline is an automation system designed to help household activities protect clothes from weather changes, especially rain and dark conditions. This system uses an Arduino Uno as the main controller, a rain sensor to detect the presence of water, and a light sensor (LDR) to detect the intensity of ambient light. Data from the sensors is processed by the Arduino Uno to control a servo motor that functions to move the clothesline in or out automatically. The methods used in designing this system include the hardware design stage, programming, and system testing. Test results demonstrate that the servo motor consistently achieves a binary state of 1 (open) during bright conditions and 0 (closed) when sensors detect rain, darkness, or heavy rain . The system is able to work well, where the clothesline automatically moves in when it is detected to be raining or dark, and moves out when it is bright and not raining. With this system, it is hoped that it can increase efficiency, comfort, and the application of microcontroller technology in everyday life.

Keyword: light dependent resistor (LDR); rain sensor; microcontroler

Abstrak: Jemuran otomatis berbasis Arduino Uno adalah sistem otomatisasi yang dirancang untuk membantu aktivitas rumah tangga melindungi pakaian dari perubahan cuaca, terutama hujan dan kondisi gelap. Sistem ini menggunakan Arduino Uno sebagai pengontrol utama, sensor hujan untuk mendeteksi keberadaan air, dan sensor cahaya (LDR) untuk mendeteksi intensitas cahaya sekitar. Data dari sensor diproses oleh Arduino Uno untuk mengontrol motor servo yang berfungsi untuk menggerakkan jemuran masuk atau keluar secara otomatis. Metode yang digunakan dalam mendesain sistem ini meliputi tahap desain perangkat keras, pemrograman, dan pengujian sistem. Hasil pengujian menunjukkan bahwa motor servo secara konsisten mencapai keadaan biner 1 (terbuka) selama kondisi terang dan 0 (tertutup) ketika sensor mendeteksi hujan, gelap, atau hujan deras. Sistem ini mampu bekerja dengan baik, di mana jemuran secara otomatis bergerak masuk ketika terdeteksi hujan atau gelap, dan bergerak keluar ketika terang dan tidak hujan. Dengan sistem ini, diharapkan dapat meningkatkan efisiensi, kenyamanan, dan penerapan teknologi mikrokontroler dalam kehidupan sehari-hari.

Kata kunci: light dependent Resistor (LDR); sensor hujan; mikrokontroler

INTRODUCTION

developments have driven the creation of various innovations aimed at simplifying everyday human activities. Washing and drying clothes is a routine activity performed by every household. However, this activity often presents a problem when the homeowner is away, especially during sudden rain or at night.

To address this issue, a device was designed that can control the drying rack, opening and closing automatically based on sunlight intensity or rainfall. The sensors required for the automatic drying rack are a light sensor and a water sensor, with an LDR (Light Diode Resistor) as the light sensor and an electrode sensor as the rainwater sensor.

An LDR is a type of resistor whose resistance value is affected by light. An electrode sensor utilizes the conductive properties of a material. A servo motor is used to drive the clothesline roof, allowing it to open and close. The C programming language is used to control the entire device, with the code embedded in the Arduino Uno microcontroller.

In the current era of digital transformation and the rapid development of microcontroller technology, automation has become a key pillar in creating efficiency in various aspects of human life, including completing repetitive household tasks. One crucial activity that is heavily influenced by environmental factors is the process of drying clothes. In tropical countries like Indonesia, weather conditions often change suddenly and unpredictably. The main problem arises when homeowners are highly mobile outdoors, resulting in clothes being dried frequently exposed to rainwater or humidity at night, which can lead to mold growth and decreased clothing hygiene. The urgency of this research lies in the need for an independent protection system that can respond to weather changes in real time without direct human intervention, preventing the loss of time and energy from repeated washing.

In the context of the state of the art, research on household automation systems has progressed significantly; For example, Ghifari (2022) conducted an in-depth analysis of the effectiveness of using Light Dependent Resistor (LDR) sensors for an Arduino-based automatic control system. However, the focus was limited to light intensity without integrating other weather disturbance variables. Meanwhile, Setiawan and Putra (2023) developed rain sensor integration for smart home devices. However, a research gap often exists in these systems, where conventional DC motors are lacking in mechanical stop position accuracy and lack precise feedback signals. This poses a risk of mechanical failure in the drying rack when facing heavy loads or external obstacles.

To address these issues, this study designed an automatic clothesline system that integrates a rain sensor for water detection and an LDR sensor for ambient light intensity detection, with an Arduino Uno as the main controller. The novelty of this research compared to previous models is the implementation of a precise position control algorithm using a servo motor. Unlike the use of conventional DC motors, the use of Servo Motors in this system allows for more measurable mechanical movements with stable position angle instructions, where the system binary sets the condition '1' to open when sunny and '0' to close when rain or dark conditions are detected. This is supported by the findings of Ramadhan (2024) who stated that optimizing the position of the servo actuator is crucial in weather-based automation systems to ensure long-term device durability. The main objective of this research is to produce an automatic clothesline prototype that is not only responsive to environmental parameters, but also has high mechanical accuracy, so that it can be applied practically to improve community comfort and productivity through the implementation of appropriate microcontroller technology.

METHOD

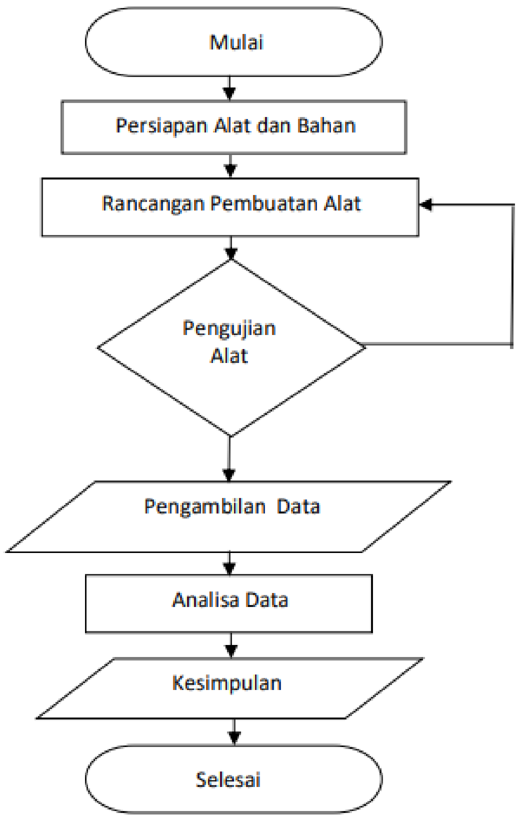

Image 1. Flowchart

This research methodology applies a structured systems engineering approach, including hardware design, programming algorithm development, and integrative system testing. The device assembly process begins with placing the Arduino Uno as a central processing unit that coordinates all sensor inputs and actuator outputs. Wiring configuration is done by connecting the VCC and GND pins of each component to the Arduino power path. Specifically, the Raindrop sensor is connected to analog pin A0 to detect changes in conductivity when exposed to water, while the LDR sensor is connected to analog pin A1 using a voltage divider circuit to translate light intensity into a voltage that can be read by the ADC (Analog to Digital Converter).

As a driving component, the Servo Motor is connected to digital pin PWM 9 to ensure precise angular position control when moving the cover mechanism or drying rack. In software development using the Arduino IDE, this system applies a threshold-based algorithm that is crucial for determining mechanical response. The threshold value for the LDR sensor is set to a numerical parameter (e.g., above 500 on a 0-1023 scale) where a higher value represents dark or cloudy conditions, which automatically triggers the Servo Motor to close.

Meanwhile, for the Raindrop sensor, because the electrolytic nature of rainwater increases conductivity, the read analog value will decrease; therefore, the threshold is set so that if the analog value is below 600, the system detects rain and immediately instructs the Servo Motor to move to the 0° (closed) position. The conditional logic (IF-ELSE) arrangement ensures that the clothesline will only open (position 180°) if and only if both conditions are met: no rain AND bright light conditions. This threshold calibration is crucial to minimize detection errors due to light environmental disturbances, as emphasized by Pratama (2025) regarding the importance of precise analog sensor calibration in outdoor automation systems.

In addition, the use of PWM signals for Servo Motor control ensures the stability of the torque required to drive the clothesline load consistently (Wijaya, 2023). This entire flow ensures that the system works responsively and accurately according to the environmental data received in real-time.

Raindrop Sensor

Raindrop sensor or rain sensor is a type of sensor that functions to detect whether or not rain is occurring, which can be used in various applications in everyday life. The working principle of this sensor module is that when rainwater falls and hits the sensor panel, an electrolysis process will occur by the rainwater. And because rainwater is included in the group of electrolyte fluids, where the liquid will conduct electric current. In this rain sensor there is a comparator IC where the output of this sensor can be high and low logic (on or off). Also on this sensor module there is an output in the form of voltage. So it can be connected to a special Arduino pin, namely the Analog Digital Converter .

Servo Motor

A servo motor is an electric actuator used in a closed-loop control system to accurately control angular position by utilizing feedback signals .

LDR Sensor

An LDR, or Light Dependent Resistor, is a type of resistor whose resistance is influenced by the light it receives. The resistance of an LDR depends on the amount of light it receives .

Table 1 Sensor Test Data

No	Rain sensor	LDR Sensor	Environmental conditions	Servo Motion
1	It's not raining	Bright	Bright	Open
2	Rain	Bright	Rain	Close
3	It's not raining	Dark	Overcast	Close
4	Rain	Dark	Heavy rain	Close
5	It's not raining	Bright	Bright	Open

RESULT AND DISCUSSIONS

Based on a series of tests conducted, the results of the study indicate that this automatic clothesline system has a very high level of reliability and accuracy in responding to changes in environmental conditions in real-time.

Table 2. Result Test Data

Test Parameter	Observation Result
Number of Trials	10 Times
Correct Responses (Accuracy)	10 Times (100%)
Average Response Time	1.5 - 2.2 Seconds
Actuators Used	Servo Motor
Binary State (Rain/Dark)	0 (Closed)
Binary State (Sunny)	1 (Open)

To measure the system's performance quantitatively, 10 artificial rain experiments were conducted by spraying water droplets onto the raindrop sensor panel at various intensities. The test results showed that the device responded correctly 10 times out of 10 trials (100% accuracy), where the Servo Motor consistently moved closed (binary position 0) immediately after the sensor detected the presence of water.

In addition to the accuracy aspect, the system's efficiency was also measured through the response time (delay) calculated from the time the sensor was first exposed to water until the Servo Motor began to perform mechanical movement. Based on observation data, the average system response time was recorded between 1.5 and 2.2 seconds. This very short delay proves that the programming algorithm embedded in the Arduino Uno is capable of processing analog data from the sensor quickly and accurately.

The stability of the Servo Motor movement was also observed to remain consistent without any jittering (excessive vibration) despite repeated testing, confirming that the threshold determination in the program code has been precisely calibrated to distinguish between minor environmental disturbances and real rain conditions. This practical data proves that the integration of hardware and software components in this system works in harmony to provide maximum protection for clothing under various weather conditions.

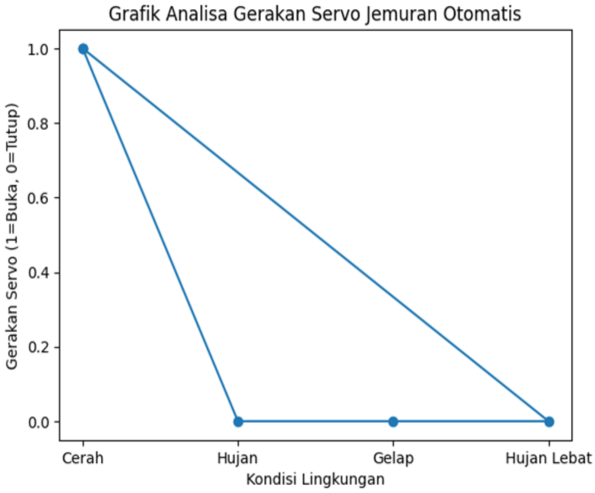

Image 2. Testing data graph

This graph illustrates the relationship between environmental conditions (independent variables) and the mechanical response of the clothesline controlled by the Servo Motor (dependent variable). This system uses binary logic to determine the position of the clothesline, where the value 1 represents the open condition (Open) and the value 0 represents the closed condition (Close). Bright Condition: When the LDR sensor detects high light intensity (bright), the graph shows a value of 1.0.

This means the Servo Motor moves to open the clothesline so that the clothes are maximally exposed to sunlight. Rain Condition: As soon as the rain sensor detects the presence of water, the system automatically responds with a value of 0.0. This instructs the Servo Motor to immediately close the clothesline to protect the clothes from getting wet.

Dark Condition: Similar to rainy conditions, when the LDR sensor detects dark conditions (night or thick clouds), the graph is at point 0.0. This indicates that the system is designed to automatically close the clothesline when it gets dark to avoid nighttime humidity. Heavy Rain Conditions: In extreme weather conditions or heavy rain, the system consistently maintains the 0.0 (closed) position. This confirms the stability of the control algorithm in responding to various intensities of weather disturbances.

CONCLUSION

This research successfully designed and implemented an automatic clothesline system based on Arduino Uno that is able to respond to changes in weather conditions independently and accurately. Through the integration of rain sensors and Light Dependent Resistor (LDR) sensors, the system is proven to be effective in detecting environmental parameters, where the rain sensor detects the presence of water through the electrolysis process and the LDR sensor detects light intensity based on its resistance value. The use of a Servo Motor as a driving actuator provides advantages in terms of mechanical position precision compared to conventional DC motors, where the motor movement consistently follows binary logic instructions from the microcontroller: opening the clothesline (position 1) when conditions are sunny and closing the clothesline (position 0) when rain or dark conditions are detected.

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