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# AUTOMATIC CLOTHING TOOL USING RAIN SENSOR AND INTERNET OF THINGS (IoT)

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## ABSTRACT

In the increasingly developing modern era, the need for devices that can facilitate daily activities is increasing, including washing and drying clothes. Traditional drying of clothes is often disrupted by unpredictable weather, especially when it rains suddenly, which forces people to lift the clothesline and cause the clothes to get wet again. To overcome this problem, an automatic clothesline was developed that uses a rain sensor and Internet of Things (IoT) technology. This tool is designed to detect rain in real time and automatically move the clothesline to a safe place. In addition, users can monitor and control this tool remotely via an application on a smartphone. The application of IoT technology to this tool not only increases the efficiency and convenience of drying clothes, but also supports the smart home trend. This tool offers a practical and innovative solution to keep clothes dry without worrying about sudden changes in the weather.

## INTRODUCTION

The modern lifestyle increasingly demands convenience and efficiency in various aspects, including washing and drying clothes. Hanging laundry outside to take advantage of sunlight is often disrupted by unpredictable weather, such as sudden rain. This requires many people to quickly bring in their laundry, which not only interrupts other activities but also causes clothes to become wet again. In facing these challenges, technologies like sensors and the Internet of Things (IoT) offer innovative solutions.

Rain sensors can accurately and quickly detect the presence of rain, while remote control of devices has become possible through IoT technology. The need for devices that can simplify daily activities is becoming more urgent, given the frequent uncertainty of weather conditions. Therefore, an automated drying monitoring system based on IoT has been developed to address this issue, allowing for real-time monitoring and control of the laundry without needing to be on-site.

The automated drying system that utilizes rain sensors and IoT technology presents a relevant solution, as it can detect rain in real-time and automatically move the laundry to a safe location. Notifications to users can also be sent through smart devices, providing convenience in keeping clothes dry. With the rise of smart home trends, monitoring the drying system via smartphone applications further supports the integration of technology into daily life.

Based on this context, the author has titled the project “Automated Drying System Using Rain Sensors and Internet of Things (IoT).” Focusing on the design and implementation of this device, this research aims to reduce manual labor in drying clothes, leverage technology for remote control, and enhance user comfort in dealing with changing weather conditions.

## LITERATURE REVIEW

Internet of Things (IoT) refers to the concept where every physical object can communicate with one another as part of an integrated system using the internet as the connecting medium. The way IoT works is by utilizing programming arguments that allow each command to produce interactions between connected machines automatically, without human intervention, regardless of distance. As a result, IoT can collect data in real-time and provide valuable information to support decision-making and improve efficiency in various fields. In the development of this tool, IoT serves to enhance the efficiency and accuracy of sensor data measurement for users who monitor the data. It enables devices to connect to each other via the internet and exchange information to perform actions automatically.

Communication Models in IoT consist of several types, including Device-to-Device, Device-to-Cloud, and Device-to-Gateway. The Device-to-Device model connects two or more devices directly without needing a server or intermediary device. This model allows direct control between devices through transmission media like WiFi or Bluetooth. In contrast, the Device-to-Cloud model requires each device to connect to a cloud-based application to send and receive data. Here, IoT devices collect data and transmit it to the cloud server via the internet. Technologies like

MQTT, HTTP/HTTPS, and CoAP are commonly used for communication in this model. Another communication model is Device-to-Gateway, where devices connect through a gateway before reaching the cloud server. The gateway acts as a bridge between IoT devices and the central server or cloud, often utilizing technologies like Wi-Fi, cellular networks, or Bluetooth.

The TCP/IP Network Layers form the foundation of IoT communication, consisting of five layers: Physical, Network Access, Internet, Transport, and Application Layers. The Physical Layer defines physical characteristics such as communication media, voltage, and current. The Network Access Layer, similar to the Data Link Layer in the OSI model, manages the reliable transmission of data frames over physical media. The Internet Layer ensures connectivity between different networks, using IP addresses to find destinations on the internet. In the IoT system discussed here, IPv4 is used for addressing. The Transport Layer defines methods for reliable end-to-end data transfer, utilizing protocols like TCP and UDP depending on the need for reliability or packet length. Finally, the Application Layer defines the applications running on the network, such as HTTP, FTP, and SMTP. In this system, HTTP is used to send data to the IoT web platform.

IoT Platforms are crucial for managing and controlling IoT devices centrally via the internet. These platforms allow users to monitor device status, control devices, and configure settings. One commonly used platform is Blynk, which is an IoT platform for iOS and Android designed to control modules like Arduino, Raspberry Pi, ESP8266, and others via the internet. It is user-friendly, enabling users to create projects using drag-and-drop widgets easily. Blynk is not tied to any specific module, allowing users to complete their projects in just a few minutes. The platform is known for its fast response times and efficient data transfer, making remote control of devices easy and reliable as long as there is an internet connection.

In summary, the Internet of Things connects real-world objects into a unified system that communicates through the internet. Different communication models like Device-to-Device, Device-to-Cloud, and Device-to-Gateway offer various methods for devices to interact. The TCP/IP network layers provide the structural foundation for IoT communication. IoT platforms, such as Blynk, enable centralized control and monitoring, making it easier for users to manage their IoT devices efficiently. Together, these components contribute to the growing ecosystem of IoT, enhancing data collection, decision-making, and overall operational efficiency across numerous industries.

**Table 1 Differences between ESP32 and Arduino Uno and ESP8266**

| Specification | Arduino Uno | NodeMCU ESP8266 | ESP32 |
|---|---|---|---|
| Voltage | 5V | 3.3V | 3.3V |
| CPU | Atmega3281MHz | Xtensa single core L106-60 MHz | Xtensa dual core X6-160 MHz |
| Architecture | 8 Bit | 32 Bit | 32 Bit |
| Flash Memory | 32kB | 16 MB | 16 MB |
| SRAM | 2kB | 160kB | 512kB |
| GPIO Pins (ADC/DAC) | 14 (6/-) | 17 (1/-) | 36 (18/2) |
| Bluetooth | No | No | Yes |
| Wi-Fi | No | Yes | Yes |
| SPI/I2C/UART | Yes | Yes | Yes |

ESP32 is a microcontroller module introduced by Espressif Systems, designed to control and accommodate all ports and ICs so that the devices or ports connected to the microcontroller can function properly. One of its key features is the built-in Wi-Fi module on the chip, which makes it ideal for developing web-based Internet of Things (IoT) applications that can connect to the internet wirelessly without requiring additional boards. The ESP32 also has input/output pins that can be used to connect sensors and read data. This versatility makes the ESP32 a popular choice for a wide range of IoT projects. Its specifications can be seen in Table 2.1, illustrating its capabilities in terms of processing power, connectivity, and interfacing options.

The Base Board ESP32 is a development board designed to simplify the use of the ESP32 module in electronic and IoT projects. This board features a powerful microcontroller with integrated Wi-Fi and Bluetooth connectivity, as well as interfaces such as GPIO, ADC, DAC, UART, SPI, and I2C. It typically includes a USB connector for easy programming and power supply. Moreover, pin headers provide access to all the pins of the ESP32 module, facilitating connections to external components such as sensors, actuators, and other modules. The board also features a reset button and flash mode button, which are useful for programming and debugging. With its compact design and comprehensive features, the ESP32 base board is highly popular among developers and hobbyists for creating advanced and efficient IoT prototypes and applications.

Various sensors are utilized in this project, including a rain sensor and an LDR sensor. The rain sensor is designed to detect the presence or moisture of water in the surrounding environment. In an automatic laundry drying application, this sensor identifies when it is raining, providing signals to retract or lift the laundry to protect it from getting wet. It can also measure humidity levels in the air, helping to determine if the conditions are suitable for drying. Thus, the rain sensor plays a crucial role in maintaining the quality and cleanliness of the laundry while improving the drying process's efficiency. On the other hand, the Light Dependent Resistor (LDR) sensor changes its resistance based on the light intensity it receives. Made from semiconductor materials, its resistance is high in darkness and decreases significantly in the presence of light, allowing more current to flow. LDRs are commonly used in applications requiring light intensity detection or measurement, such as automatic lighting systems and security devices. They are known for their simplicity and affordability, although they may not respond as quickly to changes in light as other light sensors like photodiodes or phototransistors.

Stepper motors are another key component in this project. A stepper motor is an electric motor that moves in discrete steps, allowing for precise position control. Unlike conventional electric motors that rotate continuously, stepper motors move in specific angles per step, dictated by their internal construction. They are commonly used in applications requiring precise position control, such as automatic laundry drying systems, printers, CNC machines, robotics, and various industrial automation devices. Stepper motors operate based on electromagnetic principles, where electromagnetic coils in the motor are sequentially energized to attract the rotor to the desired position. By providing the correct sequence of electrical pulses, the rotor can be rotated in small, regular steps. The main advantage of stepper motors is their ability to maintain position without requiring feedback sensors, as each step can be accurately predicted from the given input signals. However, they may be less efficient than other motor types for applications requiring high speed or torque.

Other essential components include the motor driver, power adapter, and jumper cables. The stepper motor driver is an electronic device that controls the stepper motor by receiving signals from the control system (such as a microcontroller or computer) and translating these signals into the appropriate current and voltage to drive the motor. Its primary function is to control the excitation sequence of the motor coils, which determines the motor's direction, speed, and position. The driver often features settings for step modes (e.g., full step, half step, microstep), enabling smoother and more accurate control. The power adapter is used to convert AC voltage to DC voltage, supplying power to the electronic components in the system. It functions as a power supply unit, ensuring that all electronic devices that require power can operate efficiently. Jumper cables are used to connect different points on circuit boards like breadboards or PCBs without soldering. These cables come in various colors to facilitate easy identification during circuit assembly, allowing developers and hobbyists to quickly and easily create and modify circuits for various electronic projects. They are widely used in educational settings to teach the basics of electronics and programming.

## METHOD

Block diagrams have an important function in designing, planning, and describing how the components in this tool system are interconnected and interact. The form of this tool block diagram is as follows:

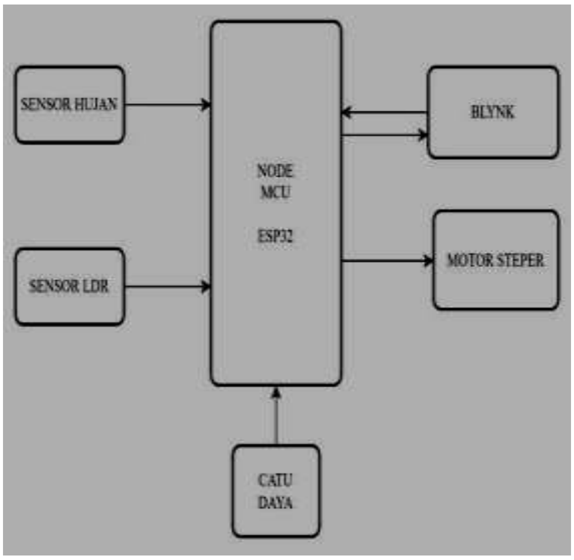


**Fig. 1 Block Diagram**

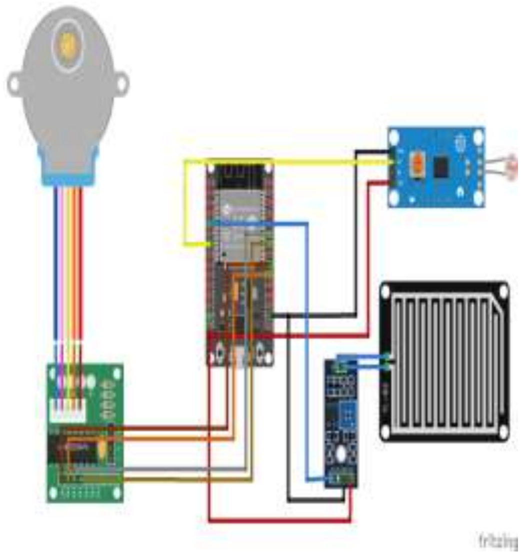


**Fig. 2 Whole Series**

JIETA
Journal on Internet Engineering Technologies and Applications
**Volume** 1, **Number** 1, July 2024, pp. 13-20

The block diagram is a system where the ESP32 acts as the main microcontroller. A rain sensor and an LDR are connected to the ESP32 to detect weather conditions. The sensor data is sent to Blynk, allowing remote monitoring and control via a smartphone. A stepper motor, controlled by the ESP32, automatically moves the clothesline based on sensor input. A power supply provides energy to the ESP32 and other components.

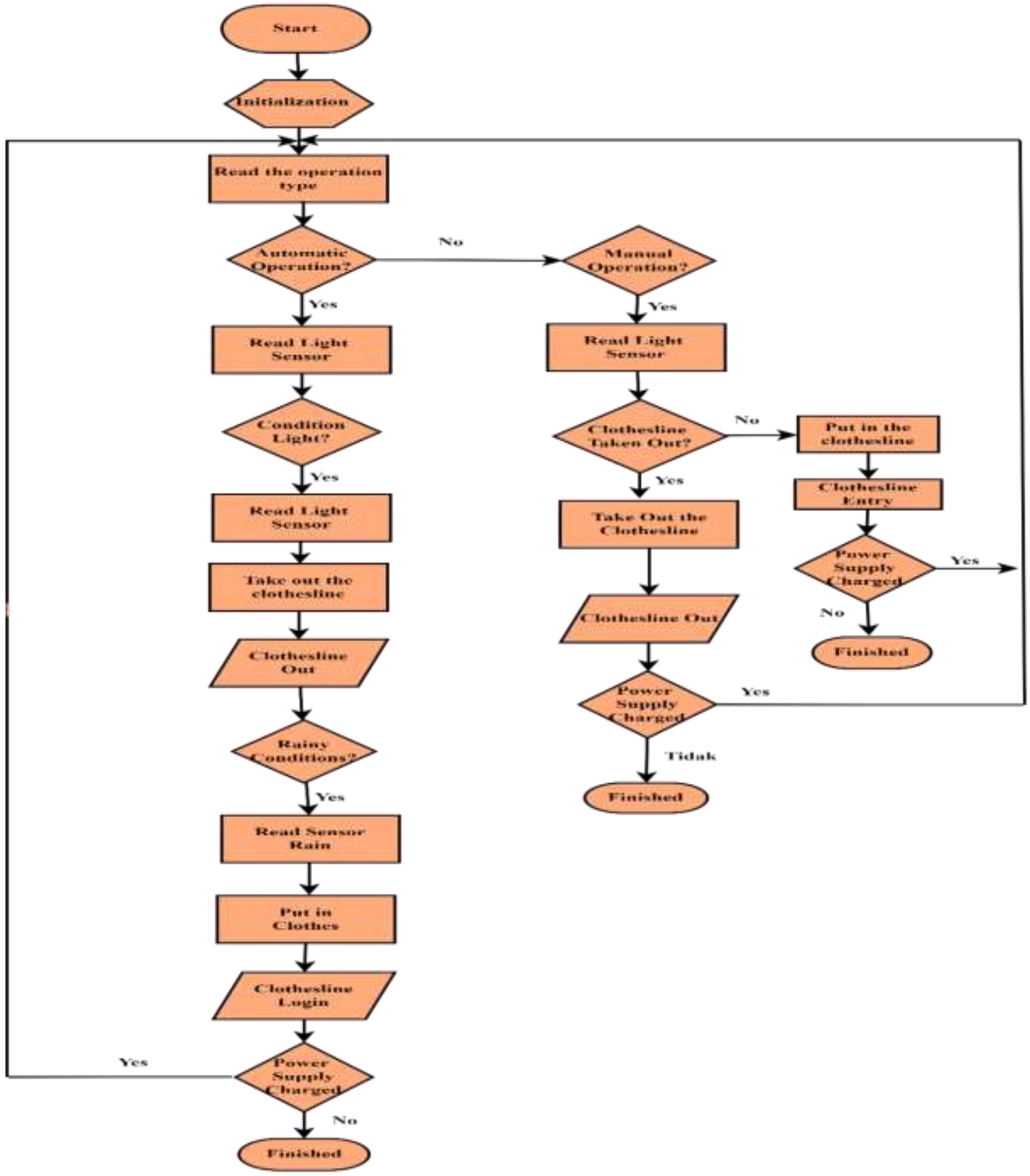


**Fig. 2 Flowchart**

The flowchart shows the automation of the clothesline system. The process begins by activating the rain sensor and LDR to monitor weather conditions. The system then checks the operating mode: manual or automatic. In manual mode, the user controls the clothesline directly. In automatic mode, the system takes out the clothesline if the weather is good or pulls it in when rain is detected. Condition data and decisions are sent to the Blynk platform for remote monitoring and control.

**Tabel 2 Connecting Each Device to the ESP32**

| Sensor Pin | ESP32 Pin | Description |
|---|---|---|
| **Rain Sensor** | | |
| VCC | 5V | Power Supply |
| GND | GND | Ground |
| Signal Output | GPIO 35 | Data Signal |
| **LDR Sensor** | | |
| VCC | 3V3 | Power Supply |
| GND | GND | Ground |
| Signal Output | GPIO 33 | Data Signal (Analog) |
| **Base Board** | | |
| VCC | 3V3 | Power Supply |
| GND | GND | Ground |
| GPIO (varies) | GPIO X | Data Signal |
| **Motor Driver** | | |
| VCC | 5V | Power Supply |
| GND | GND | Ground |
| STEP | GPIO X | Motor Step |
| **Power Adapter** | | |
| VCC | 5V / 3V3 | Power Supply |
| GND | GND | Ground |
| **Jumper Wires** | | |
| Pin 1 | GPIO X | Data Signal |
| Pin 2 | GPIO Y | Data Signal |

## RESULT

After the design and construction of the device are completed, the focus shifts to testing and analysis of the automatic clothesline system. The purpose of the testing is to ensure that the device functions according to its design and intended use. The testing involves assessing the system's performance, including whether the sensors can accurately detect rain and light, and whether the device operates properly.

**Fig. 3 Testing of Automatic Clothesline**

The testing process includes verifying whether the automatic clothesline device works correctly, whether the sensors can send information to the Internet of Things (IoT) platform, and whether the data can be monitored through an Android application. The results from testing and measurement will be used for analysis and evaluation, aiming for

JIETA
Journal on Internet Engineering Technologies and Applications **Volume** 1, **Number** 1, July 2024, pp. 13-20

optimal performance. The testing process involves verifying data from the LDR and rain sensors and ensuring that the information is accurately displayed on the Blynk application.

This test is carried out to find out whether the ESP32 used is connected to the internet network, by checking using the AT command in the serial monitor as in Figure 4 below.


**Fig. 4 Connection view in serial monitor**

**Table 3 Time Testing**

| **Time** | **Experiment** | **Weather Condition** | **Duration of Moving Clothesline (Seconds)** | **Blynk App Notification (Seconds)** | **Condition of the clothesline** |
|---|---|---|---|---|---|
| 22.06 | 1 | Rain | 450 | 45 | Enter |
| | | No Rain | 390 | 0 | Go out |
| 22.40 | 2 | Rain | 390 | 33 | Enter |
| | | No Rain | 354 | 0 | Go out |
| 23.50 | 3 | Rain | 390 | 41 | Enter |
| | | No Rain | 422 | 0 | Go out |
| 00.20 | 4 | Rain | 357 | 11 | Enter |
| | | No Rain | 411 | 0 | Go out |
| 00.50 | 5 | Rain | 387 | 41 | Enter |
| | | No Rain | 351 | 0 | Go out |

## DISCUSSION

Testing and analysis of the automatic clothesline system utilizing rain sensors and light sensors (LDR) showed several important findings regarding the performance of the device in real conditions. First, testing was carried out to ensure that the ESP32 as the main microcontroller could be connected to the internet network and the Blynk platform, which functions as a user interface for remote monitoring and control. The results of the connectivity test40 showed that the ESP32 was successfully connected to Blynk, allowing users to receive notifications and control the clothesline via a smartphone application. This proves that the integration between hardware and software has been successful, providing the desired monitoring and control capabilities.

Furthermore, testing the performance of the rain sensor and light sensor was carried out in two weather scenarios: sunny and rainy. The rain sensor is responsible for detecting rainfall and triggering the system to pull the clothesline inside, while the LDR sensor measures the intensity of sunlight to determine sunny or cloudy conditions. The test results show that both sensors work according to the predetermined threshold values, where the clothesline automatically moves inside when the rain intensity is high or sunlight decreases, and moves out when the weather conditions are sunny again. Furthermore, testing showed variations in the time it took for the clothesline to move in or out, ranging from 357 to 450 seconds in rainy conditions, and 351 to 422 seconds in sunny conditions. These differences can be caused by several factors, including rain intensity, wind speed, and the mechanical condition of the device itself. In addition, the notification time in the Blynk application also showed quite significant variations, ranging from 11 to 45 seconds. This delay indicates

 **Volume** 1, **Number** 1, July 2024, pp. 13-20

that there is latency in the communication between the sensor, microcontroller, and Blynk application, which may be caused by network or data processing factors. Although these variations do not hinder the main function of the device, improvements in system optimization to minimize delays can improve the overall responsiveness and performance of the device.

This analysis shows that this automatic clothesline system has successfully met its main objective of providing a practical solution for efficient and reliable clothes drying in the face of changing weather. However, to achieve optimal performance, improvements are needed such as further calibration of the sensors, improvement of the control algorithm for faster response, and development of a more efficient notification mechanism. By making these improvements, the automatic clothesline will not only provide convenience for users in their daily activities, but can also be an integral part of a more sophisticated and responsive smart home system to environmental conditions. Potential further developments include integration with online weather data for more accurate predictions and integration with other home automation systems to create a more comprehensive smart home ecosystem.

## CONCLUSION

The design and development of the automatic laundry drying system have successfully demonstrated its capability to detect and respond to changing weather conditions. Using a rain sensor and an LDR sensor, the system can accurately determine when to move the laundry rack indoors or outdoors. This ensures that clothes are protected during rain and maximizes drying efficiency during sunny conditions. Testing has shown that these sensors provide accurate data, which is then transmitted to the Internet of Things (IoT) platform for real-time monitoring via an Android application.

The integration of the ESP32 microcontroller with the internet and the Blynk application has proven to function effectively, despite some variations in response times and notification delivery. The system operates autonomously in automatic mode, ensuring the laundry is protected from rain or exposed to sunlight as needed. Additionally, a manual mode is available, allowing users to control the laundry rack according to their preferences, independent of weather conditions. This dual functionality adds flexibility and convenience, ensuring the system can adapt to various user needs.

Overall, the automatic laundry drying system performs well in achieving its primary goal of automating laundry drying while safeguarding against adverse weather. Although the system demonstrates robust performance, there is still room for further optimization, particularly in enhancing response speed and improving the reliability of communication between components. This optimization could lead to even more efficient and seamless operation, making the system an even more practical solution for everyday use.

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