

Automatic Clothes Retriever (ACR)

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Abstract

As a tropical country, Indonesia is located below the equator and has sunshine all year round, the sun's rays have been used to dry wet clothes after people wash their clothes. However, with climate change happening, the current weather is difficult to predict. there are many chances of clothes getting wet due to unexpected rain. Especially now that people are busy at work and clothes are hung unattended. To solve this problem, many projects have been carried out, such as standalone clothes drying system, web-based drying clothes system, and the most advanced is clothes drying system that recycle AC heat waste as source of heat. In this paper, automatic clothes retriever (ACR) equipped with mobile apps-based monitoring system was made. Using the ESP32 as the main controller, LDR, rain sensor, limit switch, motor, fan and heating lamp, the ACR will automatically recognize the weather and retrieve-out or retrieve-in the hanger to protect clothes from unexpected rain. As a result, ACR managed to respond to weather change, by retrieve-inning the clothes hanger in 14.82 seconds with 10 Kg clothes on it. During the experiment, the maximum energy consumption of ACR was measured, which is 0.289KWh in one hour with full load in the system.

Keywords

Clothes drying system, clothes retriever, ESP32, automatic, IoT

1. Introduction

As a tropical country, Indonesia only has 2 seasons, namely the dry season and the wet season (Rahayu et al. 2018). Located below the equator, making Indonesia have sunshine all year round. But with climate change, Indonesia's wet and dry seasons are becoming less predictable (Moediarta R and Stalker 2007).

One of the ways for humans to protect their bodies from the weather is by wearing clothes and clothing become basic needs in human civilization. Clothes is used to protect the human body from the cold, heat and for health purposes. Every time clothes are used; they must be cleaned before they can be reused. This is to ensure that clothes are sterile and free from risky microscopic organisms (Sundi 2019).

Indonesian people usually wash clothes and dry clothes consistently. In Indonesia, solar energy is used as an important source for drying clothes. But in the rainy season, in certain areas there may be no sun rays for 1 to 2 days. In addition, the busyness of the community to work to support their daily needs forces people to leave their clothes to dry without being observed.

1.1 Objectives

The purpose of this research is to make a tool (clothing dryer system) to dry clothes automatically using a microcontroller and connected to the internet through a mobile application. Users can monitor the condition of the drying system remotely. This tool can also solve problems that often occur and are often experienced by people who live in busy areas.

The expected benefit of this tool is that it provides solutions to the community, especially among busy people in urban areas, such as Jakarta, who have little time to take care of their household needs. Users can also set the tool mode and

monitor clothes condition through the mobile application, thereby realizing the application of the Internet of Things (IoT) concept.

2. Literature Review

Several projects have been done, such as Smart Clothes Drying System (sCDs) is smart clothes drying system to utilize the warm air dissipated by residential air conditioner whilst being used in the nighttime. sCDs use Arduino UNO R3 board, motor driver circuit and water sensor devices as main component in the system. From the result obtained, using the warm air dissipated by residential air conditioner improves duration whilst using the prototype in the nighttime (Moediarta and Stalker 2007). But in sCDs, users can not observe or control the drying system by Internet. Similar to sCDs, a project conducted by Mahlia et al. (2010) and Widodo et al. (2021), they created the drying system using AC waste heat to dry the clothes. In other projects, web-based drying clothes system was made, the system can be controlled through the Internet by using GSM network and the system can withstand about 5 kg load (Cutinha et al. 2016). In Hegade (2016) the drying system protects the clothes using the cabinet and uses industrial blower to provide a large flow of air to dry the clothes in the cabinet. Electromechanical clothes drying system is introduced in (Sachin et al. 2019). The system continuously monitors the sun rays and rainy season and automatically take back the clothes from sun rays to protect from wet. The system uses tray that installed on roof and controlled through 8-bit microcontroller which recognizes this status of weather.

Kumar et al. (2016) developed an automated system is constructed using smart sensors for monitoring humidity in the environment, a set of photo voltaic sensors and a drive system. Based on the output from the sensor a microcontroller instructs the drive system to move the cloth towards the optimal section. The system uses rope, pulley and motors as the mechanic to move the clothes to the specific section. Different with Kumar et al. (2016), Nugraha (2020) developed a drying system uses fan and heater to control air temperature in the cabinet. The system also uses wifi to send data from the system to the application on smartphone through the Internet. Kumas et al. (2017) used pulley and reel as a mechanism to retrieve-in or retrieve-out the clothes. Kalyankar et al. (2018) developed cloth dryer and dehydrator as a single unit, the idea is good for energy efficiency but how to guarantee the detergent residu in clothes do not affect the food quality is not mentioned on the paper. Yunus and Sulistiyowati (2021) developed roof control system in IoT-based clothes drying room. This system can open and close the roof of the drying room automatically or manually relying on IoT. Chaihang and Puengsungwan (2021) developed system of the spiral moving type clothes drying rack, the system can support the drying weight of 2.5 kg per one drying time, which can save 68.2% of the space compared to fix type clothes drying rack. Ishak et al. (2020) developed automatic retractable cloth drying system, which is using a power window motor to retract the clothelines and withstand 5 kg of wet clothes.

Based on several projects mentioned above, we proposed drying clothes system which is called as Automatic Clothes Retriever (ACR). The system is a clothes retriever system that uses sunrays and electronics component to dry the clothes. Our proposed system is combining two methods which is the sunrays-based clothes drying system by Cutinha et al. (2016) and the temperatur control system by Hegade et al. (2016) and Romero et al. (2021). The system will retrieve-out the hanger to dry the clothes using sun rays in sunny day. But in rainy day, the system will retrieve-in the hanger to the cabinet and control the air temperature to dry the clothes. The system will decide to retrieve-in or retrieve-out the hanger based on LDR and rain sensor detection. With this feature the system react to the unpredictable weather changes. Instead of using industrial blower or electric fan and electric flat iron, ACR uses heating lamp and fan to control the air temperature in cabinet in order to dry the clothes. ACR has a monitoring feature, by using an application on an Android smartphone, users can monitor air temperature, humidity and ACR activity via the internet.

3. Methods

3.1 Hardware Design

Figure 1 is the block diagram of the proposed system called Automatic Clothes Retriever (ACR), ACR will retrieve-in or retrieve-out the hanger to dry the clothes using sun rays or using heating lamp and fan in rainy day or nighttime. In this project, ACR uses an ESP32 microcontroller as main controller to send/receive and process all data from the sensors. In this system, the ESP32 receives data from the rain sensor MD0127, Light Dependent Resistor (LDR), temperature sensor DHT22, and normally closed limit switches. Data from the rain sensor and LDR is used by the ESP32 to decide on the action to retrieve-out or retrieve-in the hanger. For example, if the weather is sunny (which is indicate by no water detected in rain sensor and low resistance in LDR), the ESP32 will retrieve-out the hanger, so that the clothes will be dried by the sun rays/dry air. But if it rains (which is indicate by water detected in rain sensor

and high resistance in LDR), the ESP32 will retrieve-in the hanger, so the clothes will be dried by the lamp and fan those are controlled and installed inside the ACR. Meanwhile, data from the temperature sensor is used to monitor inside ACR cabinet temperature and to decide whether to turn on or off the fan and lamp. To retrieve-out or retrieve-in the hanger, the ESP32 will send data to the BTS7960 motor driver until the hanger hits the limit switches. If the hanger hits the inner limit switch (limit switch 1) it means the hanger has been fully retrieve-ined, whereas if the hanger hits the outer limit switch (limit switch 2) means the hanger has been fully retrieve-outed. The ESP32 also connects and communicates system readings to the Blynk application using the built-in Wi-Fi module. By connecting the ACR to the Blynk Application, users can control and monitor ACR via smartphone and Internet.

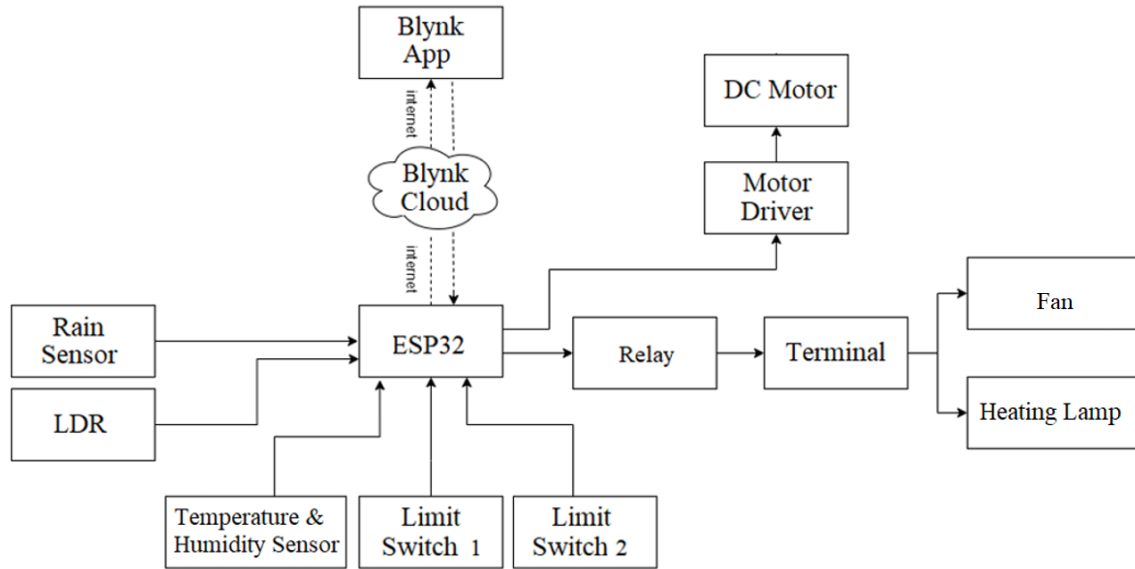


Figure 1. Block Diagram System

In ACR there are 3 actuators used, namely 200 W fan, infrared bulb 50 W as heating lamp and brushed DC motor with 150kgcm torque. The DC motor is connected to a special mechanic mounted on the hanger, with this setup the hanger can be retrieve-ined or retrieve-outed. To control the angular speed of the DC motor, the ESP32 sends Pulse Width Modulation (PWM) signals to the BTS7960 motor driver. Fans and heating lamp are used to dry clothes while the hangers are inside the ACR cabinet. If the temperature inside the ACR cabinet exceeds 55°C, the ESP32 will turn off the fan and lamp. However, if the temperature is below 53°C, the ESP32 will turn on the fan and heating lamp to continue the drying process.

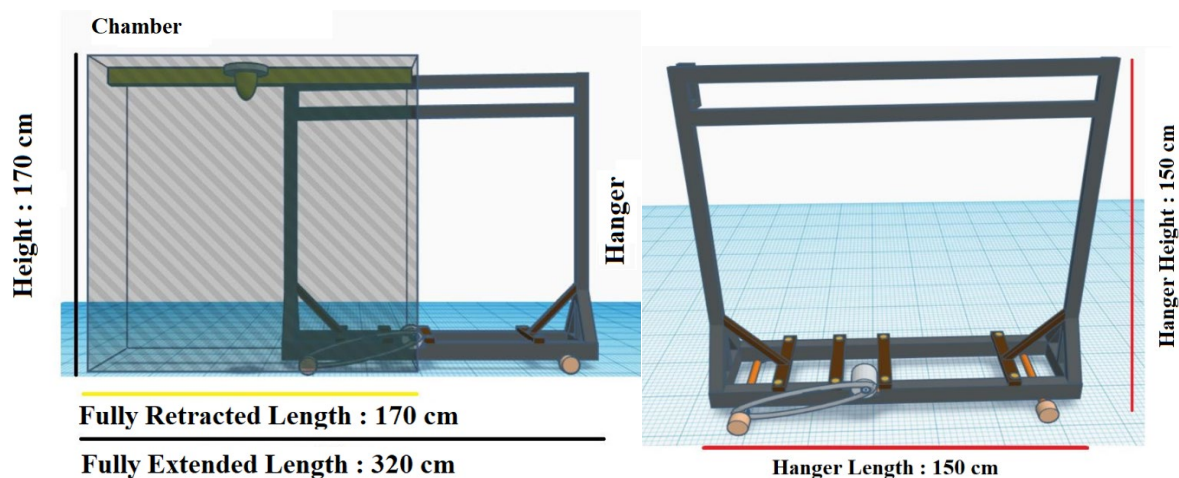


Figure 2. ACR side-view cabinet design (left); Hanger design (right)

Figure 2 is ACR's side-view cabinet design and hanger design that used in this project. The ACR height is 170 cm, and the length is between 170-320 cm depending on the position of the hanger. The length will be 170 cm, if the hanger was fully retrieve-in. And will be 320 cm, if the hanger was fully retrieve-out. Inside the ACR cabinet, there are sensors and actuators described in previous explanation. Obviously, the hanger size is smaller than the ACR cabinet, the goal is to protect the clothes from rain.



Figure 3. ACR with clothes and hanger fully retrieved-out (left); ACR with clothes and hanger fully retrieved-in (right)

Figure 3 is the entire ACR system during an experiment in this project, figure on the left is the ACR with the clothes and hanger fully retrieved-out due to sunny weather. Figure on the right is the ACR with clothes and hangers fully retrieved-in due to rainy weather.

3.2 ACR Mobile App layout

Figure 4 (a) is ACR mobile App view when hanger is about to be retrieved out. As explained before, ACR can be monitored by mobile app, and if the sunny day occurs the hanger will be retrieved out, so the hanger with clothes will be outside the cabinet. If the hanger is fully retrieved-out, pop-up window will give information about the hanger position (b). The temperature and humidity values will be visible when the hanger is inside the cabinet. Hanger will be retrieve-in if the rainy weather occurs, Figure 4 (c) is when the hanger is about to be retrieved-in. If the hanger is fully retrieved-in, pop-up window will give information about the hanger position (d). By using mobile app, ACR can be monitor everywhere as long as Internet is available.

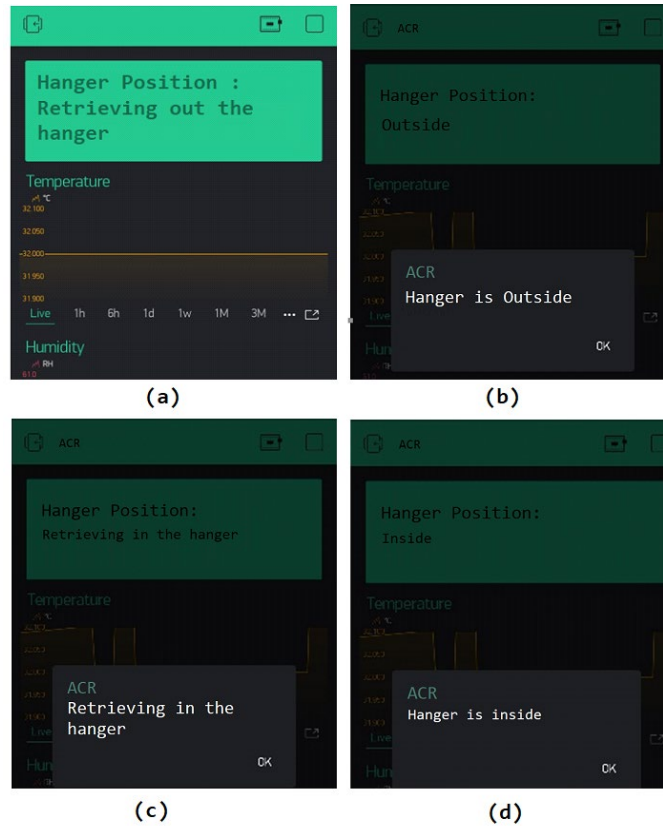


Figure 4. ACR Mobile App View when hanger is about to be retrieved-out (a); the hanger is fully retrieved-out (b); hanger is about to be retrieved-in (c); the hanger is fully retrieved-in (d)

4. Data Collection

To prove the concept of how the ARC works, measurements and experiments were carried out. ACR tested in real weather conditions, tested in rainy and sunny weather. ACR energy consumption is also measured, to find out how much energy is used when the maximum load occurs. With all the data captured, the maximum weight of clothes that the ACR can handle is estimated.

5. Results and Discussion

5.1 Sensors Experiments

Table 1. show about digital values from LDR dan Rain Sensor during sunny day. ACR was tested in real condition in Banten, Tangerang Selatan when the sun is in sky dan enough sun rays to dry the clothes. Based on the experiments in the table, digital value below 1000 in LDR is used to determine if there are enough sun rays to dry the clothes. And digital value above 3000 in rain sensor is used to determine if it is not raining that day.

Table 1. Sensor experiment in sunny day

#Experiments	Digital LDR Value	Digital Rain Sensor Value	Time
1	921	4095	06:11
2	843	4095	06:16
3	711	4095	06:21
4	624	4095	11:05
5	509	4095	11:10

#Experiments	Digital LDR Value	Digital Rain Sensor Value	Time
6	403	4095	11:15
7	383	4095	13:25
8	368	4095	13:30
9	355	4095	13:35
10	336	4095	13:40

Table 2. show about digital values from LDR dan Rain Sensor during no sun rays and rainy day. Same as experiment before, ACR was tested in real condition in Banten, Tangerang Selatan when the sun is blocked by the cloud dan raining. Based on the experiments in the table, digital value above 1000 in LDR is used to determine if there are not enough sun rays to dry the clothes. And digital value below 3000 in rain sensor is used to determine if it is raining that day.

Table 2. Sensor experiment in no sun rays and rainy day

#Experiments	Digital LDR Value	Digital Rain Sensor Value	Time
1	2363	1920	12:32
2	2357	1996	12:37
3	2143	2650	12:42
4	2139	2649	18:09
5	2159	2582	18:14
6	2136	2602	18:19
7	2463	2956	17:08
8	2429	2937	17:13
9	2179	1031	17:18
10	2213	1035	17:23

5.2 Graphical Results

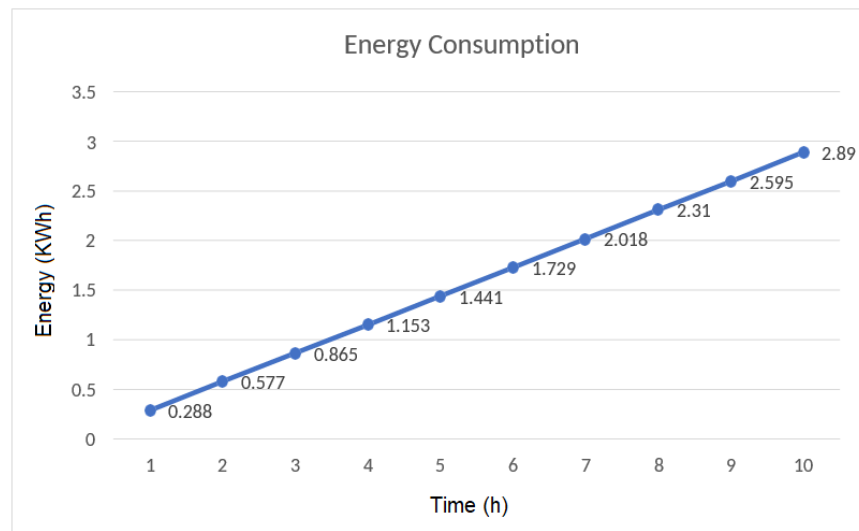


Figure 5. ACR Energy Consumption in KWh

To measure the maximum energy used by ACR, ACR is conditioned when the weather is raining or dark. With this condition the hanger will be fully retrieve-ined, the fan and the heating lamp will be on, so the maximum energy load will be occurring. For 10 hours the ACR is fully powered on and energy consumption is measured hourly using a

wattmeter. Figure 5 is the graph of energy consumption conducted by full load ACR. With full load, ACR will consumed 0.289KWh in an hour or 2.89 KWh in 10 hours.

6. Conclusion

Based on the experiments and measurements in this project, ACR can retrieve-in or retrieve-out the hanger automatically depends on the weather conditions. The LDR and the rain sensor need to be set correctly in order to response the weather changes. Based on the experiment, the LDR on the ACR needs to be set to a digital value below 1000 to indicate sunny conditions, and the rain sensor needs to be set to a digital value above 3000 to indicate whether it is a rainy day. While a digital value above 1000 on the LDR indicates dark conditions and a digital value below 3000 on the rain sensor indicates a rainy day. ACR consumes quite much energy in maximum load, it is 0.289KWh in one hour. Different load on the hanger affects the time for ACR to retrieve-in or retrieve-out the hanger completely. Heavier load will make ACR takes longer times to retrieve-in or retrieve-out hanger completely. ACR can withstand more than 5kg, based on the experiment it is recommended that user only put 10Kg load on hanger, so ACR can retrieve-in the hanger completely in 14.82 seconds if the rain occur. By using ACR, user can dry the clothes, control the hanger, monitor temperature, humidity and movement of the hanger from their smartphone.

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Biography

Rico Wijaya, S.Kom. MTI is a lecturer dan Deputy Head of Computer Engineering Study Program in Bina Nusantara University, Jakarta, Indonesia. He earned S.Kom. in Computer Engineering and MTI in Master of Information Technology from Bina Nusantara University, Jakarta, Indonesia. He has published journal and conference papers. His current research interests include technology for disability users, Internet of Things (IoT), wireless sensor network (WSN), and Mobile Ad Hoc Network (MANET).

Ivan Alexander, S.Kom., MTI works as Lecturer at Bina Nusantara University in Computer Engineering Department. Mr Alexander holds Bachelor of Engineering Degree from Bina Nusantara University and a Master of Information Technology in Bina Nusantara University. He received grant from Ministry of Research, Technology and Higher Education of the Republic of Indonesia in Calon Perusahaan Pemula Berbasis Teknologi (CPPBT) Program to create a Startup Company. His research interest include Indoor Positioning System, Computer Network, and IoT in Agriculture

Adira Dzaky, B. Eng. is a business operation at PT Bank Rakyat Indonesia. Prior to joining BRI, he worked as an intern at PT Sarana Advance Prosperity for six months. at the company, he worked as a service engineer who took notes to troubleshoot damaged equipment. Then he worked for an insurance company as a process advantage to test applications that had been made. His Bachelor's degree is majoring in Computer Engineering and concentrating in Embedded Intelligence System from Binus University in 2020.

At the time of college, Adira Dzaky participated in a student activity called HIMTEK which was used to apply the soft skills of each student, besides that he had been the chairman of an event that aimed to gather students. Adira Dzaky has also participated in the 2018 Asian Games volunteer event, he has served as a place and environment department to manage the entry flow.

Muhammad Faisal Fadhil, B. Eng. is a Network Engineer in PT. Lintasarta, an IT solution company serving thousands of clients for more than two decades. His Bachelor's degree is majoring in Computer Engineering and concentrating in Network and Communication System from Binus University in 2020. His research interest are involving in Microcontroller, Arduino, ESP32 and Programming Language C++.

During the bachelor's degree years, his work has focused upon developing cost-effective and efficient methods to face the next civilization, which is the automation era. His work is focused on households problems and mainly to alleviate the worriness of people towards clothing problems. This research work includes making simulation upon real cases of rain, optimization of the sensors, manufacturing the whole system sustaining all possible cases, and to be reliable to the society during all weathers.