# ANALYTICS OF ESPCAM ON ARDUINO-BASED AUTOMATIC CLOTHESLINE PROTECTORS

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**Abstract**

The ability to recognize weather conditions, such as rain or heat, is a main feature of the automatic clothesline. In previous research we developed an automatic clothesline that can recognize weather conditions using rain sensors and LDR with a success rate of 80% (Dicky et al. 2022). To be more convincing, we added ESPCam to be able to see clothes and the weather visually, so that users can ascertain the weather conditions. This research focuses on implement ESPCam to the automatic clothesline system that already build before and testing its reliability. The ESPCam is placed at the base of clothesline cover, so the ESPCam position will change according to clothesline cover. If the cover is closed, then the ESPCam can display a visual of the clothes. If the cover is open, then the ESPCam can visually display the weather conditions. The ESPCam is controlled by an ESP32 microcontroller which is connected wirelessly with user's mobile phone. Users can send command to ESPCam through the application interface on the mobile phone, the application also acts as a monitor to display realtime images captured by ESPCam, it can also store the data. With ESPCam, users can view streaming, store visual image data, and turn on or off the flash LED. System testing is done by sending a command to turn on streaming, followed by a command to turn on or turn off the flash LED. Based on the test data, the success rate of ESPCam used in the system reached 96.665%.

**Keywords** : ESPCam, Rain Detection, Clothesline Protector

## 1. Introduction

The ability to recognize weather conditions, such as rain or hot is very important for automatic clothesline. In previous research, we develop a clothesline that can recognize conditions based on rain sensors and LDR sensors with a success rate up to 80% (Dicky et al. 2022). To be more convincing, in this research we added ESPCam to be able to see clothes and the weather visually, so that users can ascertain the weather conditions. This research focuses on implement ESPCam to the automatic clothesline system and testing its reliability.

There are two main controllers in this system, Arduino Uno and ESP32. Arduino Uno controls the weather detection sensor which consists of three rain sensors and three LDR (light dependent resistors) and controls the motor to open or close the roof of the clothesline. The ESP32 controls the ESPCam camera and communicates with the android device on the user's side. The ESPCam module has a built-in LED (light emitting diode) which can be used as lighting when the camera is in use. There is an android application on the user side to display images captured by the ESPCam, also turn on or off the LED.

To measure the reliability of the ESPCam installed on automatic clotheslines, we test it with a black box testing method. The black box testing method was chosen because in previous research it has been proven that it can be used to measure system reliability, including for hardware (Fatih and Sudaryanto 2021) (Haris, Sudaryanto, and Sulistyawati 2021) (Dicky et al. 2022). The test is carried out by sending commands to ESPCam via an android device on the user's side, then observing that ESPCam responds correctly or incorrectly.

## 2. Literature Review

The use of image processing techniques, or those related has been widely carried out in previous research, some of them are pattern recognition techniques to interpret an image (Ronando and Sudaryanto 2018), deep learning to recognize certain images (Rahmadi and Sudaryanto 2020), use of hole filling technique to improve 3D image (Sudaryanto, Purnama, and Yuniarno 2019), or inpainting techniques to improve 2D image (Sudaryanto 2018), car tire damage detection using gray level cooccurrence matrix with neural network method (Febriyanto, Rahmad, and Bella Vista 2021), automatic cancer detection for USG image using active-contour Chan-Vese (CV) simplification model (Nugroho et al. 2022), selective encryption of medical images with using linear congruential generator (Nanda and Gelar 2022). In this research we do a simple image processing by implement ESPcam into automatic clothesline. In previous research, ESPCam has been proven to be effective in hardware systems and has succeeded in capturing and processing images (Sanjoto 2019), but in this research ESPCam is used to capture image only.

Many previous research are using image processing tehcniques to analize the wheater, some of them is doing cloud condition prediction using the result of satellite image processed with High-resolution Cloud Analysis Information (HCAI), and periodicly infrared enhanced image analysis to measure the cloud growth (Asmita and Widayana 2021). Result of that research, various parameters such as satellite imagery and wind movement were successfully processed to indicate the potential for extreme rain.

Another research are using NOAA satellite image with 137,9 MHz frequency and Erison Morphology to detect the rain (Permata, Munarto, and Firmansyah 2017). Result of that research is an automatic weather prediction system with a high degree of precision based on the brightness of cloud colors. Also research on HCL histogram analysis on cloud images using the K-Nearest Neighbor (KNN) algorithm to detect weather conditions (Hariani 2020). Based on the tests that have been carried out, the system is able to detect sunny cloudy, cloudy, rainy, clear nights, and rainy nights with 84.21% of accuracy.

Another research not use images to detect the weather, but using sensors like a water level sensor to detect flooding (Sudaryanto and Ariansyah 2020), or using rain sensor which combine with LDR (light dependent resistor) sensor to detect the rainy or sunny (Dicky et al. 2022).

The addition of ESPCam and the system requirement to connect with android devices on the user side, inevitably must be implemented using the IoT (Internet of Things) concept. IoT here means communication between hardware systems and other systems such as website servers, or android applications on the user's side which has been widely studied. For example, IoT for automatic tomato watering system based on temperature and humidity with fuzzy method which its data then sent to website server and android application for user (Rhamadhan 2019) (Irsansyah and Dwi 2020). IoT for communication between android application and fish feeding ship in the fishpond (Maulana 2019). IoT for communication between fish feeder machine and android application in user's side (Sudaryanto et al. 2022). Covid19 monitoring system based on IoT technology that uses several sensors to record conditions around the monitoring location and provide recommendations to users based on data taken around the monitoring area (Enda, Subandri, and Supria 2019). Utilization of NodeMCU ESP8266 and RFID Technology as Recognition of Teacher Honors (Wiranto, Solehudin, and Irawan 2020). Design of distance lamp control using thingsboard based on IoT (Yuswandari and Yuana 2020).

Another research is use the IoT concept to handle the communication between smart electric socket and website server which controlled by user (Sudaryanto, Wahyudianto, and Rizaldi 2020). Research about electrical monitoring system based on NodeMCU also using IoT so user can receive a good user interface and information, aslo can control it by website (Fatih and Sudaryanto 2021). Another research is not communicate the data to website server but only store it in a offline database automatically (Haris, Sudaryanto, and Sulistyawati 2021).

All of previous research that has been done become our trust that adding ESPCam then show it data to android application in the user's side for automatic clothesline is possible to do.

## 3. Method

The automatic clothesline used in this study consisted of a place to hang clothes, covers, sensors and microcontrollers, also an interface application on the user side.

The cover serves as a clothesline protector. When the weather condition is considered rainy based on sensor data, the protective cover will automatically be closed so that the clothesline is protected from rain. On the other hand, if the weather is considered not to be raining, the protective cover will open, so the clothesline will get direct sunlight and dry faster.

Sensors and microcontrollers used in this automatic clothesline are LDR (light dependent resistor) sensors and rain sensors or electrode sensors. The data from these two sensors is processed by the ESP32 microcontroller, and it will be assessed whether the sensor data shows rainy conditions or not. Weather conditions will affect the microcontroller in giving orders to open or close the clothesline protector.

The ESPCam camera in this system is positioned at the end of the cover or clothesline. The position of the ESPCam at the end of the clothesline allows the ESPCam to capture two types of conditions, namely clothing conditions, and weather conditions visually. The condition of the clothes can be captured by the ESPCam when the automatic clothesline is closed, while the weather conditions can be visually captured by the ESPCam when the automatic clothesline is open. The whole design of the ESPCam position on the system is shown in Figure 1 and Figure 2.

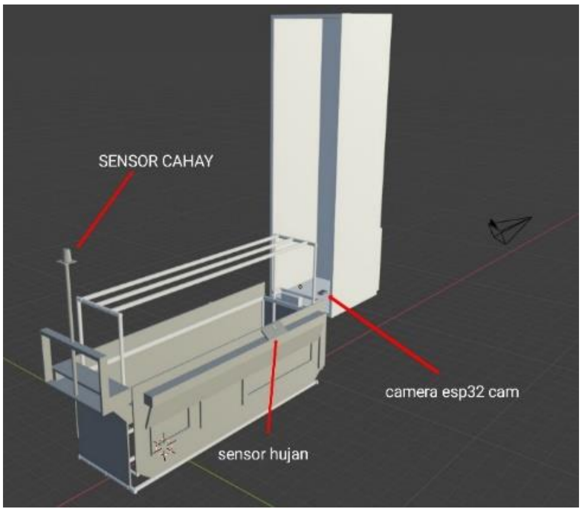


Fig. 1. ESPCam position in system

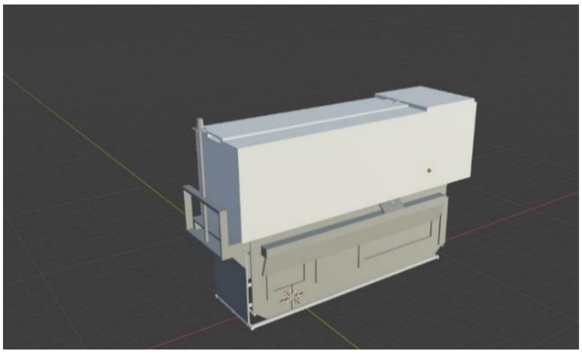

Fig. 2. Overall design

Another part of this automatic clothesline system is the monitoring application on the user's mobile phone. The application consists of a streaming panel, an LED on button and an LED off button. The streaming display will turn on automatically when the system is activated. The LED on button functions to turn on the LED flash while the LED off button functions to turn off the LED flash.

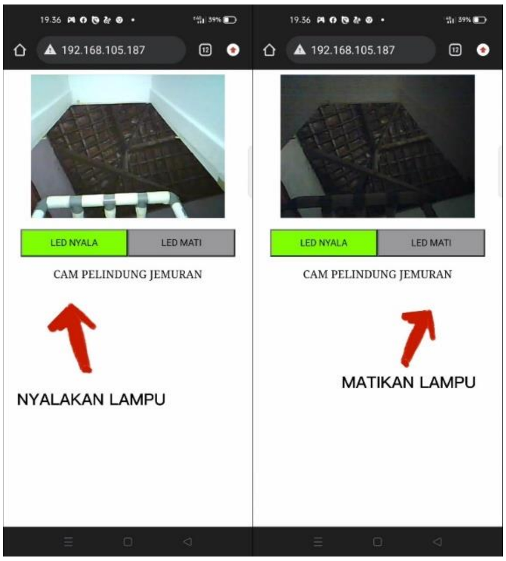


Fig. 3. Website interface in the user's side

The ESP32 microcontroller is devoted to controlling the ESPCam and to communicating wirelessly with the user-side website server. By accessing the website server, user be able to monitor the clothesline and the weather visually, also able to send command to capture the image of clothes or the sky, also command to turn on or off the LED. If not want to capture image, user also able to just show the streaming of ESPCam into website. The interface of user side website showed in the figure 3.

## 4. Results And Analysis

The ESPCam test in this study was carried out by sending a command to display streaming on the ESPCam module, followed by command to turn the LED on or off. The response of ESPCam module for the command given then observed, is it true or false. The testing are repeated 15 times for every combination of command (show streaming with LED and show streaming without LED). The result of testing for command to show streaming with LED showed in table 1 and the result of testing for command to show streaming without LED showed in table 2.

Table 1. Testing of Turning on LED and Streaming Command

| No. | Command | | Expected result | Obtained result | Status |
|---|---|---|---|---|---|
| | **ESPCam** | **LED** | | | |
| 1 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 2 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 3 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 4 | Active | ON | Streaming ON, LED | Streaming ON, LED | Success |

| No. | Command | | Expected result | Obtained result | Status |
|---|---|---|---|---|---|
| | **ESPCam** | **LED** | | | |
| | | | ON | ON | |
| 5 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 6 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 7 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 8 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 9 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 10 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 11 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 12 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 13 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 14 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| 15 | Active | ON | Streaming ON, LED ON | Streaming ON, LED ON | Success |
| Success rate | | | | | 100% |

Table 1 show the result of testing for command to show streaming with LED. Testing done when the LED is off, then sent command to show streaming and turn on the LED. If ESPCam response is true, the streaming will appear in website and the LED will turning on. But if ESPCam response is false, the streaming will not appear in website or the LED will not turning on. The testing is repeated 15 times.

Based on table 1 which is the result of testing for command to show streaming with LED, we can see that all testing result is success. In other word we can say that the system is 100% success to show the streaming and turn on the LED.

Tabel 2. Testing of Turning Off LED and Streaming Command

| No. | Command | | Expected result | Obtained result | Status |
|---|---|---|---|---|---|
| | **ESPCam** | **LED** | | | |
| 1 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 2 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 3 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 4 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 5 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 6 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 7 | Active | OFF | Streaming ON, LED OFF | Streaming OFF, LED OFF | Failed |
| 8 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 9 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 10 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 11 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 12 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 13 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 14 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| 15 | Active | OFF | Streaming ON, LED OFF | Streaming ON, LED OFF | Success |
| Success rate | | | | | 93,33% |

Table 2 show the result of testing for command to show streaming without LED. Testing done when the LED is on, then sent command to show streaming and turn off the LED. If ESPCam response is true, the streaming will appear in website and the LED will turning off. But if ESPCam response is false, the streaming will not appear in website, or the LED will not be turning off. The testing is repeated 15 times.

Based on table 2 which is the result of testing for command to show streaming without LED, we can see that all testing result is success except the

7th testing. The 7th testing result is failed, because it can turn off the LED like the command but cannot show the streaming. In other word we can say that the success rate of the system to show the streaming and turn off the LED is 93,33%.

For all of testing including test to show streaming with LED and test to show streaming without LED, the average success rate of the system is 96,665%.

## 5. Conclusions And Suggestions

Based on the testing that has been done, we can conclude that the ESPCam work well in this automatic clothesline system. The average success rate of the system is 96,665% for both command to show streaming with LED and command to show streaming without LED.

The main function of this automatic clothesline system, is run well (Dicky et al. 2022), and the adding of ESPCam is the next stage of development which also run well with 96,665% of success average rate. For another next development or research, can be done by develop the additional function that support the main function.

The main function of this automatic clothesline system is to protect the clothes from rain, so when the ESPCam is already added, it become possible to use ESPCam to detect weather visually. Some method that may can be used is HCL histogram analysis for cloud image using K-Nearest Neighbor (KNN) algorithm (Hariani 2020), or using pattern recognition method (Ronando and Sudaryanto 2018), color sorter method (Sanjoto 2019), or deep learning method (Rahmadi and Sudaryanto 2020) to detect the different between cloudy, sunny, or rainy sky image. If the ESPCam image is still not eligible to be processed with these method, we can do preprocessing to the images with inpainting method (Sudaryanto 2018), or other preprocessing method.

Another function that possible to develop is about communication between hardware and interface in the user's side. To make sure that communication between hardware and interface in the user's side is running well, we can use Blynk (Sudaryanto et al. 2022). The advantages of using Blynk is its has a pretty good interface, but the disadvantages is it is not free. The data of weather condition or parameter will be better if stored as a offline database (Haris, Sudaryanto, and Sulistyawati 2021), or store in a website server (Rhamadhan 2019) (Irsansyah 2020).

Last thing that possible to develop is about networking. We need to minimalize network problem that may happen to the system. Some of solution is by simplified network setting process using paramiko library (Dria Perkasa, Sudaryanto, and Dwi Hartono 2021), automated the network configuration backup periodicly, so if the network down, system can do resetting network with the last configuration (Afrianto, Agus, and Aris 2019). Or we can analyze the kind of network we used, for example, better use IPSec or OpenVPN based on data security and network speed (Ari and Sudaryanto 2021).

## Acknowledgment

Thank you to all leaders of Universitas 17 Agustus 1945 Surabaya (Untag Surabaya) and Politeknik Elektronika Negeri Surabaya. Thank you for Institute of Research and Community Service of Universitas 17 Agustus 1945 Surabaya (LPPM Untag Surabaya). Thank you to all of lecture on Informatic Engineering Department of Universitas 17 Agustus 1945 Surabaya, and all lecture of Teknologi Game Politeknik Elektronika Negeri Surabaya. Also thank you to all students who help this research. The last, thank you to all who help this research to be done, but cannot mention one by one.

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