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Automatic Clothesline Retrieval Prototype with Humidity Alert System to Aid Clothesline Drawbacks for Reducing Laundry Worries

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Abstract: The Automatic Clothesline Retrieval System with Humidity Sensor is an innovation whereby the user's clothesline will be retrieved and be pulled out when the system detects the change in surrounding weather. This Internet of Things (IoT) project was developed to resolve the problems of people too busy to retrieve their clothesline. The main objective of this project is to enhance and develop a prototype ACR system with Humidity sensor and application. The methodology used is the prototype model. Some of the hardware used are DHT22 Humidity Sensor and Micro Servo with connection to a laptop as its power source. The results from this project showed that the prototype acted accordingly with its respective surrounding's humidity and light reading. After implementation, the ACR prototype system returned results of 100% success in achieving its objectives with minimal room for error. As for commercial value, this project has been successfully tested and can be commercialized to potential users, which are students. From the survey, 100% of the respondents are interested in the ACR prototype system. The contribution of this project is impactful to students or people who are busy by relieving their worries about their clothes outside, allowing them to focus on other important business.

Keywords: System, Alert, Application, Servo, Humidity

1. Introduction

Nowadays, as students and as adults, people have a lot of work to do at one time. One of the most troubling things faced in household chores is the laundry drying on the clothesline. The packed schedule from classes and piling work makes the user unavailable to attend to their clothes on the clothesline when rain suddenly hits, leading to damp clothes. Besides, the unpredictable weather make it difficult for people to keep their clothes dry and cannot lift their clothes when it rains.

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The objectives of Automatic Clothesline Retrieval with Humidity Alert System are to enhance and develop a prototype of automated clothesline retrieval by using the humidity sensor and will have a desktop application that can connect with the system and receive a notification. This project divides the scope into two categories; user scope which focuses potential users, who are students and workers who have packed schedule and project scope which focus on using the Arduino with humidity sensor and servo motor and Visual Studio for the application.

2. Literature Review

2.1 Similar Project

Table 1 shows the comparison between the previous projects stated above in terms of its features, advantages and disadvantages of each project.

Table 1: Comparison table between previous projects

Project	Features	Advantages	Disadvantages
Automatic Clothesline [8]	Uses rain sensor	Detects the exact time when it is raining	Clothes will still get wet because it will be exposed to the rain first
	Uses DC motor	Able to pull the whole clothesline easily	Expensive
Automatic Laundry Cover [9]	Uses rain sensor	Detects the exact time when it is raining	Clothes will still get wet because it will be exposed to the rain first
	Uses servo	Affordable and easy to handle	Unable to pull a lot of clothes and is a bit weak
Automatic Clothes Line Retrieval System [5]	Uses rain sensor	Detects the exact time when it is raining	Clothes will still get wet because it will be exposed to the rain first
	Uses servo	Affordable and easy to handle	Unable to pull a lot of clothes and is a bit weak
Rain Detector [7]	Uses rain sensor	Detects the exact time when it is raining	Clothes will still get wet because it will be exposed to the rain first
	Uses servo	Affordable and easy to handle	Unable to pull a lot of clothes and is a bit weak
Prototype Smart Clothesline With Arduino [4]	Uses rain sensor	Detects the exact time when it is raining	Clothes will still get wet because it will be exposed to the rain first
	Uses DC motor	Able to pull the whole clothesline easily	Expensive

From the table above, all of the previous projects used the rain sensor to detect the rain. The advantage of using the rain sensor is it can detect the exact time when it is raining but, the clothes will still get wet because it will be exposed to the rain first before it is retrieved. The type of motor used by two of the projects is DC motor, which is more reliable than using the servo motor but by using DC motor, it consumes more money than the servo motor. By using servo motor, it is more convenience for students and workers who want to save money but at the same time want a system that can enhance their life.

2.2 Arduino UNO R3

The Arduino Uno is one of a microcontroller board and it was supported by the ATmega328. It has twenty digital input or output pins and six from it are used as Pulse Width Modulation (PWM) outputs and six of it are used as analogue inputs, as sixteen MHz resonator, as Universal Serial Bus (USB) association, as an influence jack, as Associate in Nursing in-circuit system programming ICSP header, and as a button. It contains everything required to support the microcontroller, simply connects it to a PC with a Universal Serial Bus (USB) cable or power it with an Alternating Current (AC) to Direct Current (DC) adapter or battery to power up the Arduino [3]. This project used Arduino Uno R3 as the microcontroller because of its in-depth support community that makes it straightforward to start operating with embedded physical electronics and have the programs load on by using the easy Arduino computer program.

2.3 Temperature and Humidity Sensor (DHT22)

This project will be using the latest version of the temperature and humidity sensor which is DHT22. The DHT22 is a basic, low-cost digital temperature and humidity sensor [2]. It uses a humidity sensor to measure the humidity around the air and a thermistor or an NTC temperature sensor to measure the temperature of surrounding air. It is also a sensor that is simple to handle but its reading of sampling rate is a bit low than the DHT11 which is 0.5Hz and this makes the sensor's data reading can be captured only once every two seconds instead of once every one second. This project intends to use this sensor because it has a better humidity and temperature data reading range which is 0 - 100% humidity readings with 2-5% accuracy rate and for temperature, it got -40 – 125 °C temperature readings with the range of 0.5°C accuracy rate [1].

2.4 Micro Servo SG 90

Micro Servo SG 90 is one of Servo motors that can help the project to make something move. The using of micro servo are popular because of its small size and the rotation ability to rotate and maintain the position or angle according to the control pulses [11].0° to 180° rotation can be done by almost all servos according to the gear arrangement, but it can also have a 360° rotation to make a full circle. [11]. The ability of a servo motor that can control its rotation angle is one of the main points on why this project chose servo motor instead of DC motor other than its low price compared to DC motor. It also has a simple way to operate and program.

2.5 Light Detection Resistor (LDR)

A light-dependent resistor or LDR is one of the resistor types that changes its resistance depending on the measure of light falling on its surface. When the light falls on the surface of the resistor, its resistance will react and send data. These resistors are mostly utilized in different circuits where it is needed to detect the distance or even the presence of light as they have an assortment of capacities and resistance. It will detect the presence of the light by its resistance and will determine if its surroundings have a light or not. Its resistance will be decreased if it is exposed to light and will be increased if in the dark [10]. This project decided to use LDR to make the system more convenient and efficient to the user by knowing the day and night of its surroundings. It will automatically stop when the nightfall.

3. Methodology

A methodology using a prototype model can be defined as a Software Development model in which a prototype will be built, tested, and reworked when needed until an acceptable prototype is achieved. Figure 1 shows that this prototype model has six-phase.

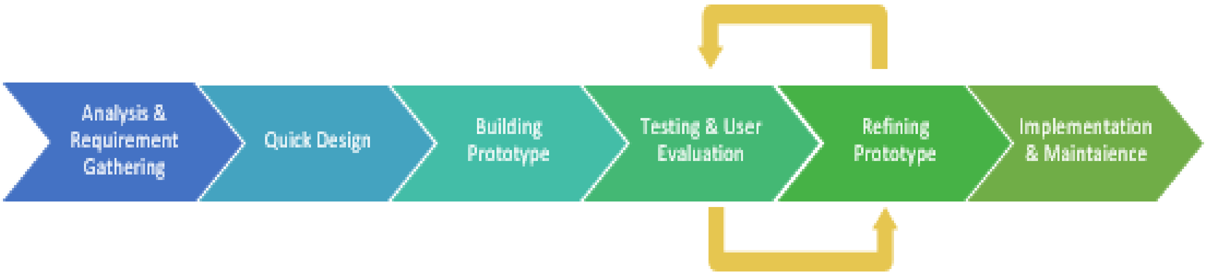

Analysis & Requirement Gathering
Quick Design
Building Prototype
Testing & User Evaluation
Refining Prototype
Implementation & Maintaience

Figure 1: Prototype Model Phase

From the model, the first phase is the requirements gathering and analysis. In this phase, A time planner is made for this project by using a Gantt Chart in Microsoft from the prototype model that is used as a guideline and a survey and the analysis of relative humidity for weather is done. The second phase is the quick design and will be about the prototype sketches. A physical sketch shows the overall image of the prototype, while a technical sketch shows the flow of the interaction between each component of the prototype. The third phase will be the prototype building process phase, which is about the step by step on how the prototype and the system will be built. The system components and application will be coded on Arduino IDE and Visual Studio. Next is the fourth phase, which is the initial user evaluation. The completed prototype model will have a test to see how well the prototype and the application work. The second last phase is the prototype refine phase where the problems that were found from the previous phase will be eliminated. Once all the problems have been solved, the previous phase will be repeated to see any problems arise. The last phase is the system implementation and maintenance product. This phase will have an observation on the system effectiveness and all issues identified will be fixed.

4. Analysis Requirement and Design Phase

The problem requirements obtained by using a survey, titled “Student Laundry Survey” to gather the students’ view regarding the laundry problem. The designing phase is the phase in which every detail of the project, from the model of the prototype down to the user interface of the application is specified meticulously.

4.1 Analysis Requirements based on Survey

In the survey, the questions asked are simple and straight to the point. There was a total of seven questions, most of them on the students' background and how they handle their laundry. From the 50 respondents recorded, 76% of them preferred to hang their clothes outside on a clothesline, and 89.6% of them found that moving their clothesline when rain falls a hassle. When asked if they would be interested if there was an automatic system that would help retrieve their clothesline before it rains, 100% of the respondents agreed.

4.2 Physical and Technical Prototype Sketches

The physical sketch illustrates the overall image of the prototype, including the components used and its location on the prototype. Figure 2 is the physical prototype sketch on paper.

The technical sketch contains the flow of interaction between each component of the prototype. This sketch was made using Microsoft PowerPoint. Figure 3 is a technical sketch

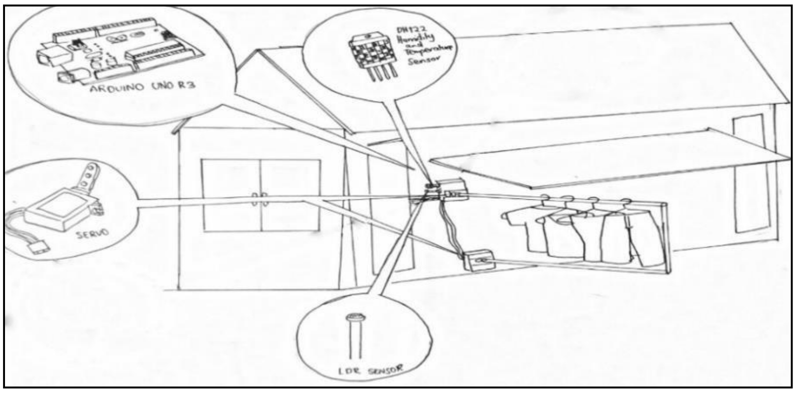


Figure 2: The physical prototype sketch.

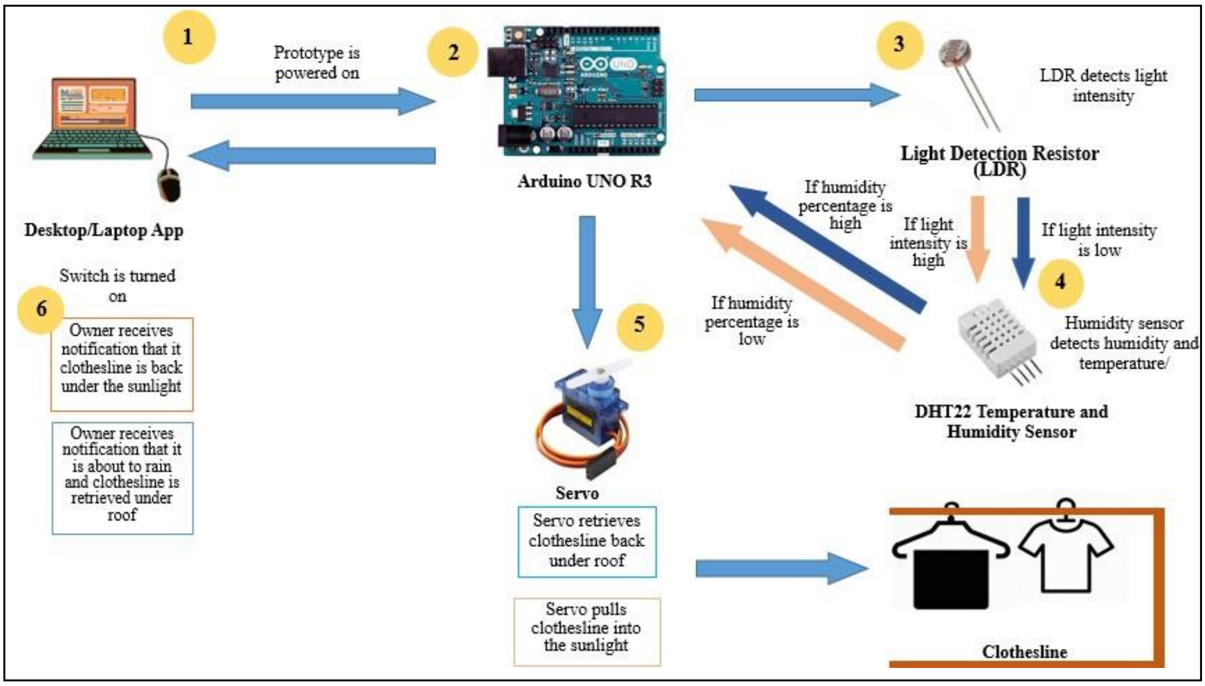

1
Prototype is powered on
2
Arduino UNO R3
3
LDR detects light intensity
Light Detection Resistor (LDR)
Desktop/Laptop App
If humidity percentage is high
If light intensity is high
If light intensity is low
4
Switch is turned on
6
Owner receives notification that it clothesline is back under the sunlight
Owner receives notification that it is about to rain and clothesline is retrieved under roof
5
If humidity percentage is low
Humidity sensor detects humidity and temperature/
DHT22 Temperature and Humidity Sensor
Servo
Servo retrieves clothesline back under roof
Servo pulls clothesline into the sunlight
Clothesline

Figure 3: The physical prototype sketch.

4.3 Creating the Visual for User Interface of Desktop Application

The user interface for the desktop application was designed using Visual Studio 2019. A simple interface was designed for the application and will have a pop-up notification. Figure 4(a) and 4(b) shows the initial design for the application interface.

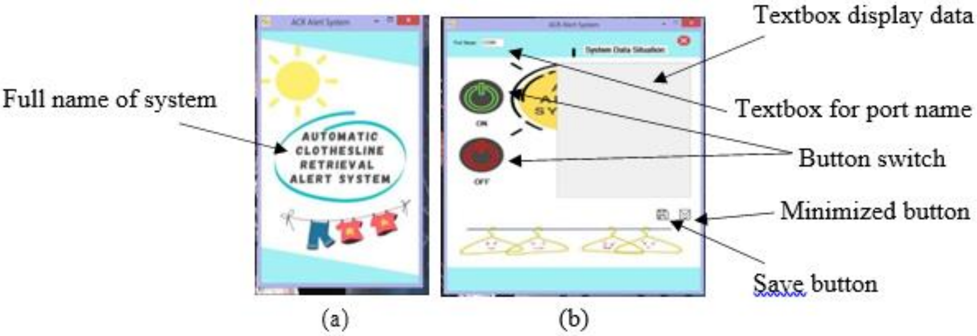


Figure 4: (a)The design of the first page and (b)the main page of the application interface.

5. Build Prototype and Implementation Phase

This phase will include the details on how the process of the ACR System was built from the building process of the prototype until the process to generate the codes for the ACR System to move successfully.

5.1 Building the prototype

To build the physical prototype, there are a few materials needed such as boxes, glue, blade, scissor, wooden sticks, and threads. After all the measurement processes are done, the real prototype will be built based on the size that has been decided. A 3D prototype form will be drawn by using Tinkercad. Figure 5 below is the finished prototype.

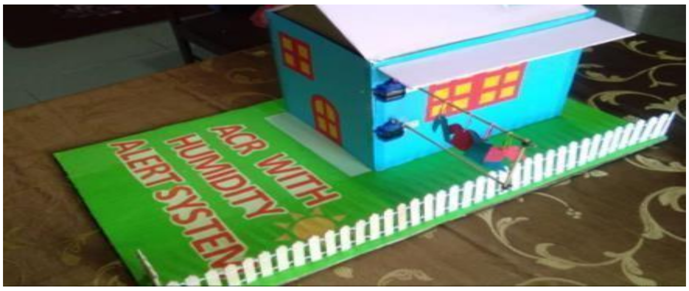
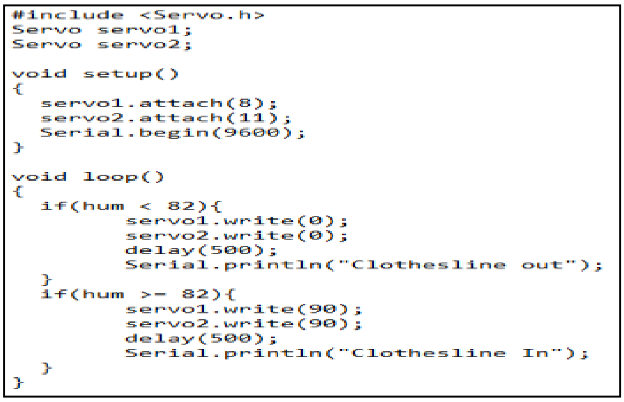


Figure 5: Finished physical prototype

5.2 ACR System Coding Process

For the ACR System to work well, the components have to be coded well so that all of them can communicate and work fine together. Each of the components has its code to run and its position on the board. The position of the wire should also be considered as the main aspect to a lookout to make sure it works. There are a few components that need to code, which are the light-dependent resistor(LDR), Humidity Sensor (DHT22) and Micro Servo. The Light Detection Resistor will detect the surrounding light to determine if the current time is day or night. This will determine if the system should be started or not because the system will be shut off during the night. The code for LDR is focusing on the connection between the LED and the LDR which will tell the user if the current time is day or night.

The Humidity sensor will be the component that will determine whether the weather will be raining or still be sunny. The code at this section needs to focus on reading the humidity percentage and the temperature in Celsius. The data reading will be displayed to the user. Without the Micro Servo, the clothesline cannot be taken in and out of the covered area. At this project, two Micro Servo are needed to make a stable clothesline. The code for Micro Servo is to make sure that the Micro Servo will be moving at the same time when the humidity and LDR value reaches a predetermined value to make the servo move. Figure 6 is the coding used for the Micro Servo.



```
#include <Servo.h>
Servo servo1;
Servo servo2;

void setup()
{
   servo1.attach(8);
   servo2.attach(11);
   Serial.begin(9600);
}

void loop()
{
   if(hum < 82){
            servo1.write(0);
            servo2.write(0);
            delay(500);
            Serial.println("Clothesline out");
   }
   if(hum >= 82){
            servo1.write(90);
            servo2.write(90);
            delay(500);
            Serial.println("Clothesline In");
   }
}
```

Figure 6: Coding of Micro Servo

5.3 ACR System Desktop Application Coding Process.

There are two pages for ACR System Desktop Application which are the front page that shows the system's full name and the main page that have a few functions to control the system such as the switch button and textbox that displays the serial monitor output from the Arduino IDE. User can also minimize and exit the system desktop app.

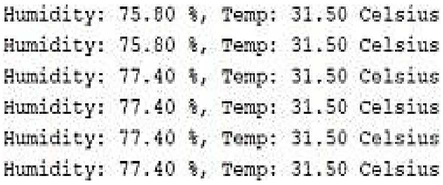
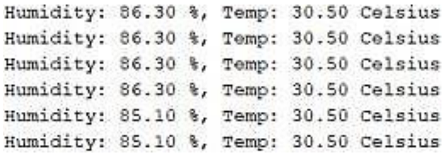
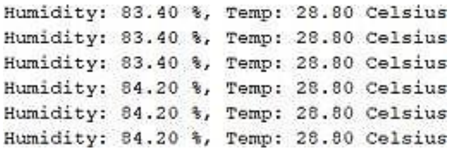
6. Prototype Testing

There are several components that were tested which are the DHT22, LDR and Micro Servo Motor.

6.1 DHT22

For the Humidity sensor, Table 2 shows the results of when the atmosphere is dry, cloudy and rainy are tested with cotton facial pads tissue to mimic such situations.

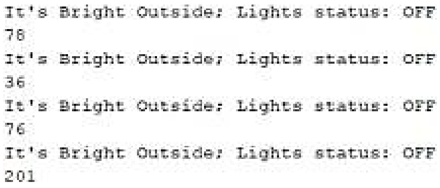
Table 2: Tests to get the humidity value

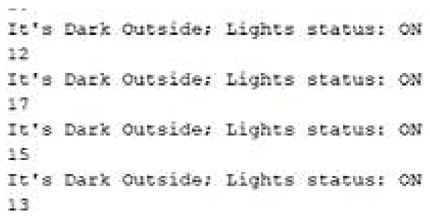
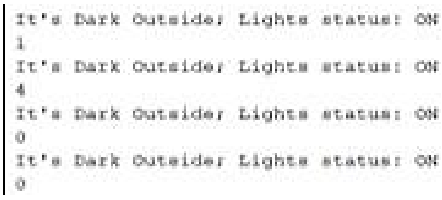
Situation	Cotton	Humidity Value
Dry situations using dry cotton.		 Humidity: 75.80 %, Temp: 31.50 Celsius Humidity: 75.80 %, Temp: 31.50 Celsius Humidity: 77.40 %, Temp: 31.50 Celsius Humidity: 77.40 %, Temp: 31.50 Celsius Humidity: 77.40 %, Temp: 31.50 Celsius Humidity: 77.40 %, Temp: 31.50 Celsius
Damp situations using wet cotton.		 Humidity: 86.30 %, Temp: 30.50 Celsius Humidity: 86.30 %, Temp: 30.50 Celsius Humidity: 86.30 %, Temp: 30.50 Celsius Humidity: 86.30 %, Temp: 30.50 Celsius Humidity: 85.10 %, Temp: 30.50 Celsius Humidity: 85.10 %, Temp: 30.50 Celsius
Rainy situation using damp cotton.		 Humidity: 83.40 %, Temp: 28.80 Celsius Humidity: 83.40 %, Temp: 28.80 Celsius Humidity: 83.40 %, Temp: 28.80 Celsius Humidity: 84.20 %, Temp: 28.80 Celsius Humidity: 84.20 %, Temp: 28.80 Celsius Humidity: 84.20 %, Temp: 28.80 Celsius

6.2 LDR

Table 3 shows the steps taken to test the appropriate LDR readings are to test the readings in three situations, which are bright, cloudy and dark situations.

Table 3: Tests to get the LDR value

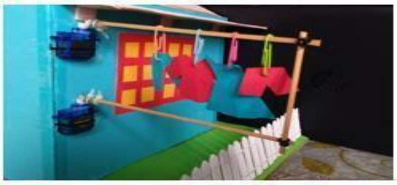
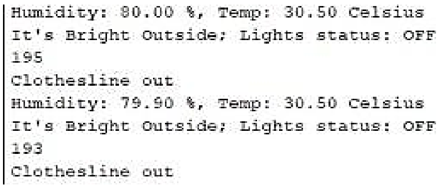
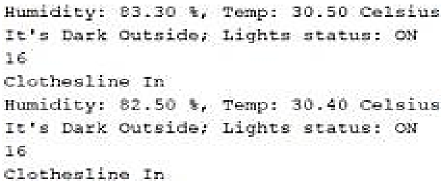
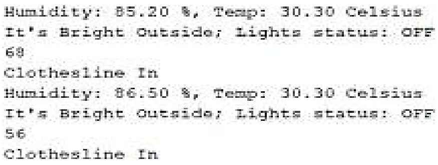
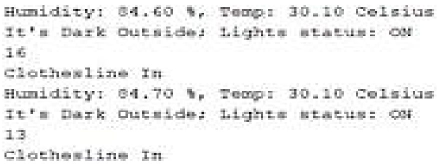
Situation	LDR	LDR Value
Bright.		 It's Bright Outside; Lights status: OFF 78 It's Bright Outside; Lights status: OFF 36 It's Bright Outside; Lights status: OFF 76 It's Bright Outside; Lights status: OFF 201

Cloudy		It's Dark Outside; Lights status: ON 12 It's Dark Outside; Lights status: ON 17 It's Dark Outside; Lights status: ON 15 It's Dark Outside; Lights status: ON 13
Dark		It's Dark Outside; Lights status: ON 1 It's Dark Outside; Lights status: ON 4 It's Dark Outside; Lights status: ON 0 It's Dark Outside; Lights status: ON 0

6.3 Micro Servo Motor

Table 4 shows four situations tested in this section, which is when it is bright and hot, cloudy, rainy and dark.

Table 4: Tests to get the clothesline position

Situation	Micro Servo Motor	Output in Serial Monitor
Bright and hot		Humidity: 80.00 %, Temp: 30.50 Celsius It's Bright Outside; Lights status: OFF 195 Clothesline out Humidity: 79.90 %, Temp: 30.50 Celsius It's Bright Outside; Lights status: OFF 193 Clothesline out
Cloudy		Humidity: 83.30 %, Temp: 30.50 Celsius It's Dark Outside; Lights status: ON 16 Clothesline In Humidity: 82.50 %, Temp: 30.40 Celsius It's Dark Outside; Lights status: ON 16 Clothesline In
Rainy		Humidity: 85.20 %, Temp: 30.30 Celsius It's Bright Outside; Lights status: OFF 68 Clothesline In Humidity: 86.50 %, Temp: 30.30 Celsius It's Bright Outside; Lights status: OFF 56 Clothesline In
Dark		Humidity: 84.60 %, Temp: 30.10 Celsius It's Dark Outside; Lights status: ON 16 Clothesline In Humidity: 84.70 %, Temp: 30.10 Celsius It's Dark Outside; Lights status: ON 13 Clothesline In

6.4 ACR System Desktop Application

For the ACR System desktop application, Figure 7 shows the interface and table 5 shows the tested by testing the functions of every button, data storage, application minimization and the alert messages.

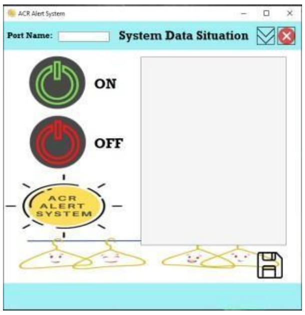
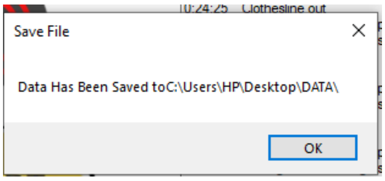
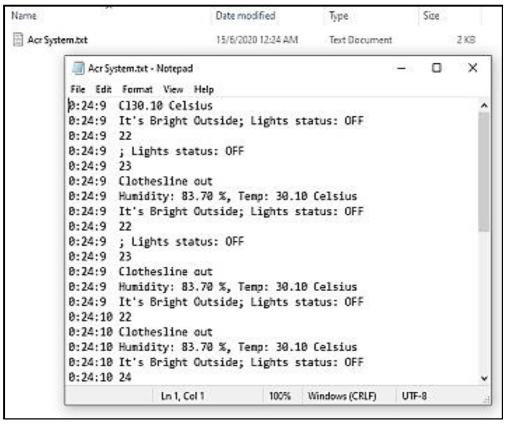
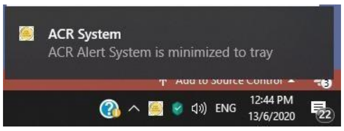
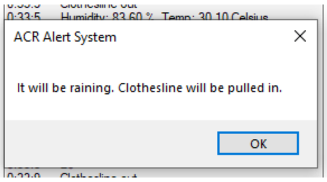


Figure 7: Interface of the application

Table 5: Function testing and interface.

Functions	Interface	Other Result
Message box when click the save button and data that stored at file.	 0:24:25 Clothesline out Save File Data Has Been Saved toC:\Users\HP\Desktop\DATA\ OK	 Name Date modified Type Size Acr System.txt 15/6/2020 12:24 AM Text Document 2 KB Acr System.txt - Notepad 0:24:9 C130.10 Celsius 0:24:9 It's Bright Outside; Lights status: OFF 0:24:9 22 0:24:9 ; Lights status: OFF 0:24:9 23 0:24:9 Clothesline out 0:24:9 Humidity: 83.70 %, Temp: 30.10 Celsius 0:24:9 It's Bright Outside; Lights status: OFF 0:24:9 22 0:24:9 ; Lights status: OFF 0:24:9 23 0:24:9 Clothesline out 0:24:9 Humidity: 83.70 %, Temp: 30.10 Celsius 0:24:9 It's Bright Outside; Lights status: OFF 0:24:10 22 0:24:10 Clothesline out 0:24:10 Humidity: 83.70 %, Temp: 30.10 Celsius 0:24:10 It's Bright Outside; Lights status: OFF 0:24:10 24 Ln 1, Col 1 100% Windows (CRLF) UTF-8
Minimizing the system	 ACR System ACR Alert System is minimized to tray ENG 12:44 PM 13/6/2020	
Notification message	 ACR Alert System It will be raining. Clothesline will be pulled in. OK	

7. Conclusion

Based on the project implementations, it is proven that Automated Clothesline Retrieval is useful to aid the laundry problems and give many advantages in this new lifestyle where everyone is busy with their work. In addition, this system will make the daily life of the user becomes more efficient and can live without worry about anything, especially about their laundry. Easy alert system that comes with this project can ease the user about the current state of their clothesline and laundry. This system can be enhanced by using a better motor to support the clothesline that can handle more load and if the user does not like a repeated alert about the situation, can be enhanced by reducing or limiting the numbers of alert that will be given out to the user.

Acknowledgement

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