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Prototype of Monitoring System and Automation Regulator Sound, Temperature, Humidity, Lighting, Window at the Swiftlet House (RBW Smart System) Based on Webserver

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Abstract:** Swiftlet nest is one of the export commodities with high economic value. The benefits of swiftlet nest are believed to be efficacious in curing several diseases. It makes the swiftlet nest in the market sold at a very high price. The potential of Indonesian swiftlet nests is quite significant, reaching 1.155 tons with a value of more than 28 trillion rupiahs per year in 2019 and increasing yearly. Swiftlets live in a calm atmosphere. If the place where they live is felt to be no longer safe and comfortable, then as a colony, the swallow will move to find another location that is felt calmer. The swiftlet house is attempted to be similarly possible to the condition of the cave in nature, so the swallow wants to live in it. Swiftlet farmers' efforts are made to make swiftlet feel at home and comfortable staying in their RBW (Rumah Burung Walet is a swiftle house in Indonesian) buildings. However, these efforts often experience problems because no integrated system regulates and monitors RBW buildings to match their natural habitat. The system currently in circulation is still partial, only dealing with specific problems. For example, only adjusting temperature and humidity, only adjusting automatic window opening and closing to prevent predators from entering and automation of expensive swallow call sounds, limited features and frequent errors, lighting, and monitoring of the swallow swiftlet house via video cam. Based on various problems in the swiftlet house, the researchers made an integrated technological engineering prototyping with its operation. So that swallow farmers can utilize in the hope of producing a more effective and efficient technology than partial tools that have not answered their needs. The prototyping system is named "RBW Smart System." It can be used to monitor and automatically regulate sound, temperature, humidity, and lighting, and open and close the windows in the swallow house so that it is expected to improve the quality and quantity of swiftlet nests for their owners.

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Keywords: Swiftlet Sound, Temperature, Humidity, Automatic Window, Automatic Light, Automatic Fog, Swiftlet House (RBW) Prototyping, Microcontroller

1. INTRODUCTION

1.1 Problem Background

The potential of Indonesian swiftlet nests is quite significant, reaching 1.155 tons with a value of more than 28 trillion rupiahs annually in 2019 and increasing yearly. As the world's largest swiftlet nests exporter, Indonesian business actors mainly target the Chinese market because the selling price is higher than other destination countries, which is between Rp. 25 million to Rp. 40 million per kilogram.

Swiftlets live in a calm atmosphere. If the place where they live is felt to be no longer safe and comfortable, then as a colony, the swallow will move to find another location that is felt calmer. The movement of this swallow generally occurs due to the disturbance of animals such as rats, snakes, geckos, and owls. The next problem that needs to be considered is maintaining the condition of the swallow house environment so that it has a temperature ranging from 26-30^{o}C and air humidity between 80-90%. It is done so that the swiftlet feels at home in its natural environment and breeds.[1]

It takes the sounds of the swiftlets to attract other swiftlets so they can nest in captivity. However, the problem arises because the calling device creates noise pollution, disturbing the comfort of people who live around the RBW. Although there are many swiftlet-calling devices on the market, the price is relatively high. Even those devices are challenging to operate and insufficient to meet the needs because the sound file that is played consists of only several types of sound, and the volume cannot be adjusted according to the desired time. According to users, errors often occur. You could say that the existing tools circulating in the market until now still do not meet the needs appropriately. Other problems are the need for automation to regulate temperature and humidity in the RBW and suitable lighting arrangements so that swallows are more comfortable according to their habitat. The disturbance of wild meat-eating animals, especially owls, which often enter through the bird's entrance and exit holes, is also a problem for swallow farmers.[2]

From the various problems that arise in the management of the RBW building, an integrated tool is needed to regulate the condition of the RBW building so that it is in its natural habitat and provides excellent comfort for the swiftlets and they are not disturbed. The tool can automatically adjust the humidity and temperature according to their natural habitat. The tool can also adjust the sound of the swallow caller, which can be easily operated but still uses more advanced technology than the swallow caller in general. In addition, the tool can also set automatic window opening and closing at specified hours, so predators cannot enter the RBW building. Prototyping of this system is integrated with its easy operation compared to partial tools that have not responded to market needs. The RBW Smart System's prototyping is expected to solve the problems of swiftlet farmers, not only domestic swallow farmers but targeted overseas. This system can monitor and automatically regulate sound, temperature, humidity, lighting, and open and close windows at the swallow's house.

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1.2 Research Objectives and Benefits

Based on the problems that have been identified, we intend to solve these problems by creating an integrated tool to automatically monitor and regulate sound, temperature, humidity, and lighting, and open and close the windows in the swiftlet building, which we named the "RBW Smart System."

The purpose of this research is to create a tool that can:

1. Regulate the temperature and humidity with a misting system so that the temperature and humidity can be controlled automatically.
2. The system in misting can be set for how long it is ON and how long it is OFF at the desired time/timer interval so that the tool is more durable and can avoid other problems as tools are sold in the market.
3. Make sound players attract swiftlets to call swiftlets with distinctive sounds of swallows according to their natural habitat, consisting of Calling Sounds, Pull Sounds, Stay Sounds and Combination Sounds.
4. Sound player equipped with the ON-OFF feature, volume can be adjusted simultaneously, independent and automatic, so that it does not disturb the environment, but is interesting to come and colonize.
5. The sound amplifier on the sound player is made using TDA7866 IC (suitable for RBW with a solar panel system). It is low energy, high quality and inexpensive, resulting in clear sound and low energy use can be installed twitter which is quite a lot, around 3200 tweets, but at an affordable price.
6. The opening and closing of the window can be adjusted automatically; this is important so that predators cannot enter the RBW so that the swallows feel comfortable/and do not become prey which results in the swallow population/colonies decreasing.
7. Lighting can be adjusted automatically in such a way, making it easier for swiftlet chicks to enter and access the spaces in the RBW, thereby adding a new swallow colony to stay.
8. In the RBW building, the temperature, humidity, and swallow population can also be monitored so that swallow farmers do not need to enter the building, which can disturb swallows and leave the building.
9. Integrate the system to answer the problems of swiftlet farmers in general. Making a multifunctional tool that adapts the original swallow's habitat at a low price and can be reached by beginner and middle-class swallow cultivators is expected to increase the swallow population in Indonesia. RBW and also improve the quality of swallow nests
10. Easy tool operation using Android can be monitored directly via the LCD on the tool product made.

Literature Review

A. Swiftlet

Swiftlet comes from the family Apodidae; its distribution is almost all over the world except for Antarctica and Australia. Birds of the Apopidae family are often called Micropopidae, derived from the Latin word meaning "little feet." It is by the shape of its small and weak legs, so it cannot be used for perching. Swiftlet is a bird that can fly at speeds up to 100 km/hour3. Swiftlet nest is a commodity that has high economic value. However, breeding is

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problematic because it requires unique strategies and handling. One crucial component must be considered, the ideal condition of the swallow house, which must resemble its natural[4].

B. RBW Requirements

Swiftlet nest production is influenced by various factors, one of which is environmental conditions. Swiftlet's environment consists of microhabitats and microhabitats. The condition of the RBW is made possible to natural conditions habitat so that the swiftlets want to live in it. The following are some of the important elements that support the creation of microhabitats in swiftlet cultivation[3].

1) Temperature

According to swiftlet consultants, the ideal temperature inside the building is between 26^{o}C – 29^{o}C. This temperature can be created if the wall thickness, roof thickness, room width and the amount of ventilation in the swiftlet building are well organized.

2) Fumidity

The ideal humidity for the swiftlet building is 75-95%. Humidity that is too high usually causes the water content in the swallow's nest to increase and turn yellow. Conversely, if the humidity is too low (50-70%), it can cause the nest to crack and form imperfect and thin.

3) Lighting

Although sometimes swiftlets nest is found in a slightly lighted place, if observed, the quality of the nest is not as good as that produced in a slightly dark place. Nests that come from a relatively bright place are usually imperfect and thin.

4) Predator

Predators and pests in RBW can interfere with the survival and comfort of swiftlets. For example, predators such as rats and owls disturb swiftlets, decreasing their population because they are eaten. Owl predators are challenging to eradicate because owls will look for prey at night and usually perch and enter through the bird's entry hole. Usually, the swiftlet farmers make bird entry holes of small size, making it difficult for owls to enter. However, the impact is that the bird's entry hole will be difficult to enter, especially for the bird's entry hole looking for a new RBW building, so the bird's entry hole is reluctant to enter the building. Swiftlet farmers sometimes make owl traps by installing glass with a particular inclination angle on the hole, but the results are not optimal. The best solution is usually for farmers to make automatic or manual windows using ropes on the hole in the RBW building, namely by setting the RBW window schedule by setting the automatic opening and closing schedule on the bird's entry hole.

5) Sound

A sound is made from the swiftlets and is used to invite swiftlets to nest in captivity so that other swallows are attracted to come closer. Machines or tools to call swiftlets are relatively needed in RBW, which functioned as a medium for the cultivation of swiftlet nests because

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using this tool has proven to be effective in attracting swallows to inhabit houses that functioned as a medium for cultivation of swallow's nests

C. Microkontroller

1. NodeMCU ESP8266

NodeMCU ESP8266 is a microcontroller material that is designed with ESP8266 inside. ESP8266 is helpful as a wifi network connectivity between the microcontroller itself and the Wifi network. The NodeMCU programming language is Lua, but NodeMCU can also use the Arduino IDE for programming.

Figure 1. NodeMCU Esp8266

2. NodeMCU ESP32

The ESP32 architecture is almost similar to the ESP8266, namely the Xtensa LX6 with a 32-bit architecture, but the advantages are that ESP32 has a dual core and already includes BLE. Not only that, the ESP32 has 128KB of ROM and 416K SRAM, as well as 64MB of Flash Memory (to store programs and data). Below is a Figure which is a block diagram of the whole ESP32.[5]

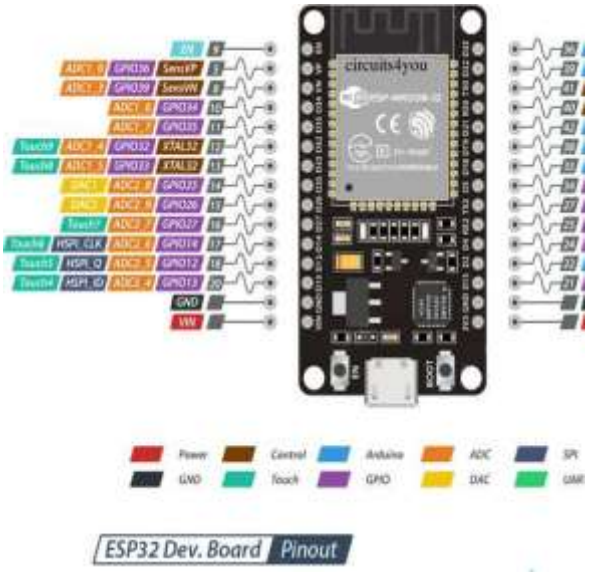

Figure 2. Pin ESP32

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D. Sensors

1. DFPlayer

DFPlayer is used to play MP3 files and controlled via Arduino/ESP32. This mini DFPlayer has a 16-pin interface, standard DIP pins, and header pins on both sides. Here is a mini DFPlayer image in image 3.[6]

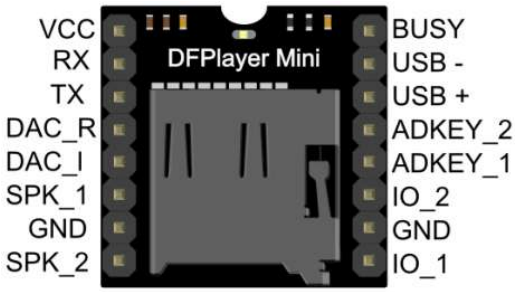

Figure 3. Pin DFPlayer

2. DHT22

The DHT-22 or AM2302 is a temperature and humidity sensor; this sensor has an output in the form of a digital signal with conversion and calculations carried out by the integrated 8-bit MCU. This sensor has accurate calibration with adjustment of room temperature compensation with coefficient values stored in the integrated OTP memory. The DHT22 sensor has a wide temperature and humidity measurement range. The DHT22 can transmit an output signal through the cable up to 20 meters, so it is suitable to be placed anywhere, but if the cable is longer than 2 meters, a buffer capacitor of 0.33µF must be added between pin # 1 (VCC) with pin#4 (GND).

Figure 4. DHT22[7]

3. Cooling and Humidity System

The mist cooling system is one of the evaporative cooling systems, the same as the principle of the mist cooling system. This system uses a nozzle diameter smaller than or equal to 0.1 mm so that the droplets that come out of the nozzle are in the form of mist, which functions to lower the temperature and increase the humidity.

E. Interface Program

In the system that will be made, a program interface using a web browser can be connected via the internet. It is to facilitate terms of setting settings and monitoring the system.

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F. Previous Research

1. Research on RBW has been conducted by Ikhsan (2017)[9]. The result: the system can play the swallow's sound, which is stored in a sound IC based on a pre-set time so that it can streamline the time to turn on and turn off the swallow's sound; in addition, this automation system can also be cost efficient when compared to buying an automatic twitter. The weaknesses of this system include 1. it is only partial to adjusting the sound in the RBW; 2. It can only play internal sound so that swallow farmers cannot choose the character of the swiftlet sound of their choice; 3. The sound produced only consists of one type of voice, while the need for RBW is usually a minimum of three types of voice characters; 4. It can not be remote controlled because it is not connected to the internet.
2. RBW research has also been conducted by Isma Ariyani (2018)[4]. The result: a system that can control temperature, humidity, and light conditions in the wallet housing. Weaknesses of this system include 1. still partial to control temperature, humidity, and light; 2. the system is still in the form of a prototype, so it is not yet feasible to use on an actual environmental scale; 3. It can not be remote controlled because it is not connected to the internet.

H. Research Contribution

The prototype is expected to be developed into a product that can later provide convenience/efficiency for RBW farmers to regulate and monitor RBW and increase swallow nest production. So, it can fulfill and increase the export value of Indonesian swiftlets nests to importing countries of swallow nests.

2. METHOD

A. Location

The research was conducted at the STMIK Pringsewu Campus and field trials on a limited scale in the RBW building in the nearest neighborhood.

B. System Planning

This design includes determining tools and materials and making a block diagram of the tool's work system, where this tool uses an ESP32 microcontroller. The system settings are divided into several system blocks. Namely: sound control system block, temperature and humidity controller, window opening and closing regulator, and lighting controller.

1. Sound Control System Interface

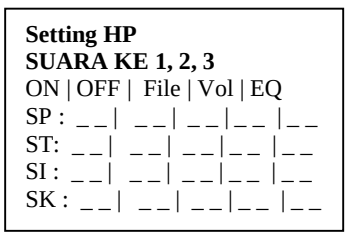

Figure 5. Blok Sistem Pengatur Suara

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Information:
SP: Call Sound
ST: Pull Sound
SI: Sound of the House
SK: Combination Sound

2. Temperature and Humidity Control System Interface

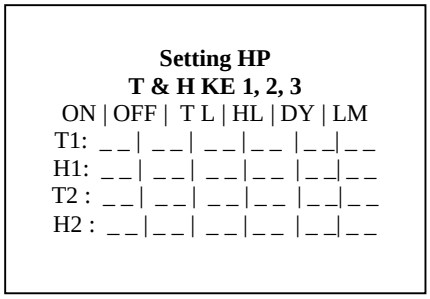

Figure 6. Block Temperature and Humidity Control System

Information:
T1: Temperature 1
H1: Humidity 1
T2: Temperature 2
H2: Humidity 2

3. Control System Interface Open Close Window

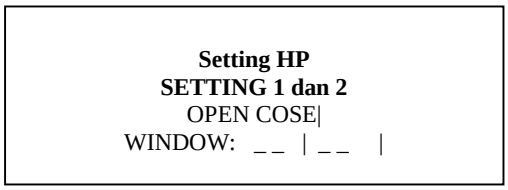

Figure 7. Block System Manager Open Close Window

4. Lighting Control System interface

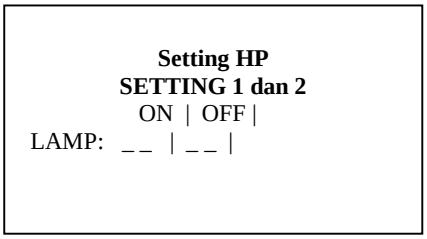

Figure 8. Lighting Control System Block

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5. Inovasi Mechanisms/ Innovation Products

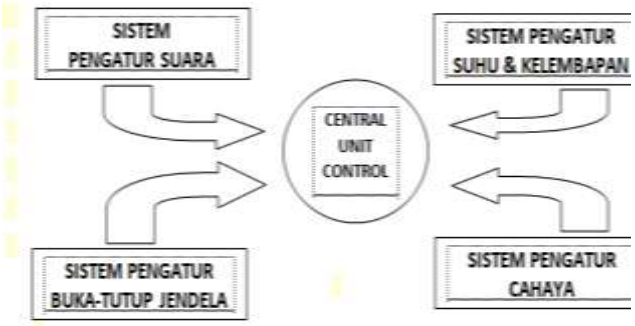

Figure 9. System Overview Block

B. Research stage

The stages in this research to achieve the targeted output can be briefly described in the flow chart as follows:

The diagram of the tool design work steps in Figure 11 can be explained as follows:

1. Literature Reviews
   The Literature Reviews were conducted to study various reference sources or theories related to the research title, namely "Monitoring and Automation System for Controlling Sound, Temperature, Humidity, Lighting, Windows in RBW Smart System
2. Program Design
   Perform data analysis as needed, create system interfaces, algorithms, and program coding according to the conditions required for each part/block of the system.
3. Creating System Sub/Blocks
   Create and test each part of the system blocks.
4. System Integration
   We are merging each system block into a single unit.
5. Tool Design
   We are creating system paths on the Arduino microcontroller with the ESP32/ESP8266 wifi module, sensors, and other supporting components.
6. Testing Tool
   This test is carried out to ensure that the tools used and assembled meet the desired criteria.
7. Analysis
   The final stage of the research work step is to analyze the tools that have been made and whether the results can be as expected.

3. RESULT

Based on the results of the study, a prototype monitoring and automation system for controlling sound, temperature, humidity, lighting, and windows in the RBW Smart System was obtained, as shown in Figure 10 as follows:

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Figure 10. Prototype RBW Smart System

Figure 11. LCD Prototype RBW Smart System

1.3 Controller

Figure 12. Controller

Researchers use ESP32 as a control because it is considered quite reliable and affordable prices. The controller functions to regulate the system, receive input, and provide output in the form of electrical signals to be converted into information or other actions. On this machine controller, there is an RTC to retrieve clock data, so the machine will run according to the predetermined settings, even though the electricity is cut off because there is a battery.

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1.4 Sound Control System Block

Figure 13. Sound Module

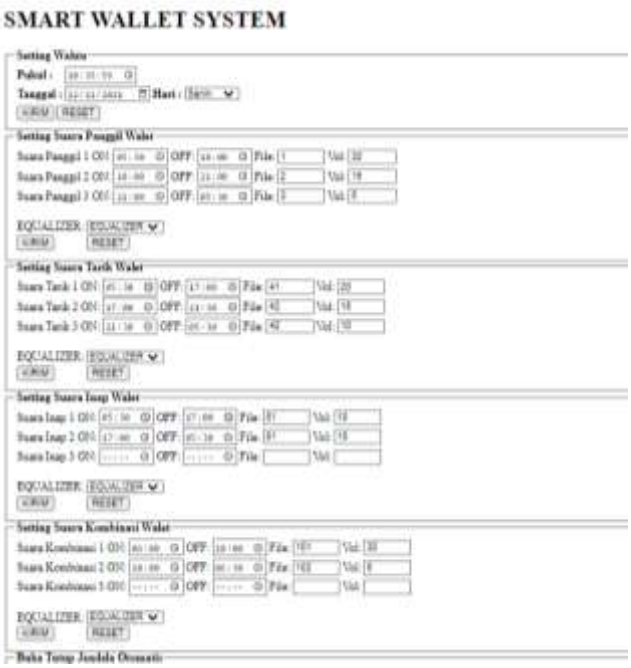

Figure 14. Sound Control Program Interface

On the sound control device, there is a player module. This player module plays sound on the SD card according to files. Files can be filled with up to 99 voices, making it easier for swallow farmers to choose the right voice at the appointed time. The advantage of this tool is that it rarely makes errors with a high level of accuracy compared to other MP3 modules that are widely installed in swallow timer amplifier systems. Because in this module, there are commands that can be ordered from the controller.

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1.5 Amplifier Module

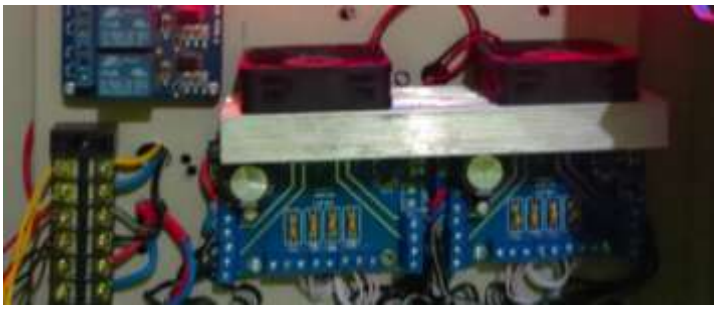

Figure 15. Sound Module

In the amplifier, the researchers used the TDA7386 IC. Because it is cheap and has four sound channels with 45 watts of power, it does not require many modules to improve energy efficiency and space further and reduce costs. In addition, this IC is also classified as Low Noise, although with a significant output power of about 45 watts per channel, so 800 twitters per channel can be installed. Because one IC consists of 4 channels, this IC can root 3200 twitter. It is very suitable for large RBW buildings. In this IC, a heatsink and fan are also installed to reduce heat, so it is not easily damaged, or there is a decrease in performance due to heat even though it is used continuously.

1.6 Window Manager Open Close Module

Figure 17. Open Close Window Module

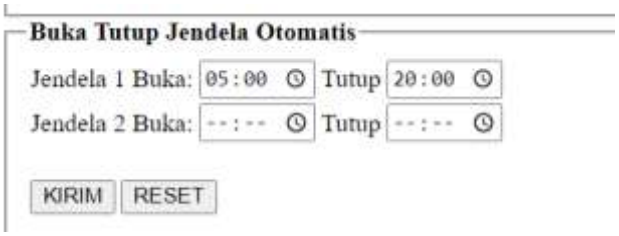

Figure 16. Interface Program Manager Open Close Window

The relay function is an automatic switch that is used to open and close the window automatically.

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1.7 Temperature and Humidity Sensor

Figure 17. Temperature and Humidity Sensor

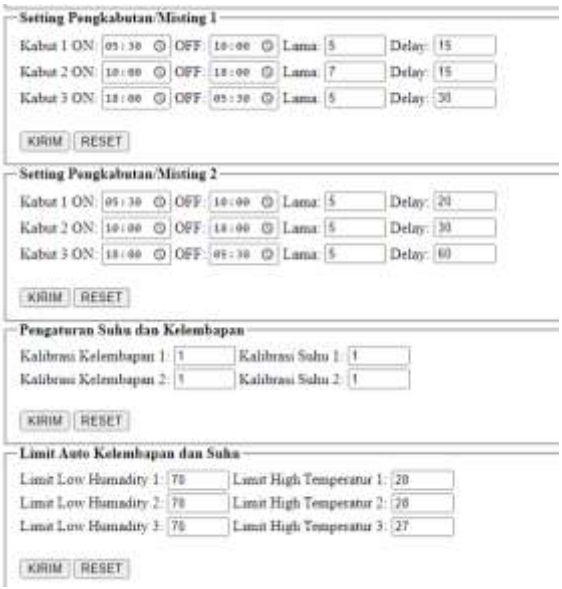

Figure 18. Temperature and Humidity Control Program Interface

This DHT 21 sensor is used to detect humidity and air temperature by collecting digital signal data. It produces an output in the form of a calibrated data signal so that the resulting data is reliable and stable. This sensor can be connected to a single chip 8-bit computer as a controller. This model sensor has temperature data that has been accurately calibrated in the calibration chamber, and the coefficient for calibration has been stored in the OTP memory on the sensor. When the sensor detects the state of temperature and humidity, the detected data will be matched according to the calibration coefficient value contained in the memory. This DHT21 sensor has advantages such as its small size of 22285mm, saving electricity, and a long transmission distance of 20 m, so that this sensor is suitable and easy to apply. This sensor is equipped with a 4-pin connector for easy operation.

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43 Features and Applications:
1) Full range temperature compensated
2) Measurement of air temperature and humidity
3) Calibrated digital signal
4) Stable for long-term use
5) No extra components needed
6) The transmission distance is quite far, 20 meters
7) Equipped with four pins for sensor connection to the microcontroller.

1.8 Misting/Fog Machine

Figure 19. Misting/Fog Machine

Misting mist is used to break down water molecules into smaller ones. It is commonly used to lower the temperature and increase the humidity of the air. So that the desired temperature and humidity are achieved the building is similar to its natural habitat.

1.9 Light Control Module

Figure 20. The light at the bird entry hole in the swiftlet building

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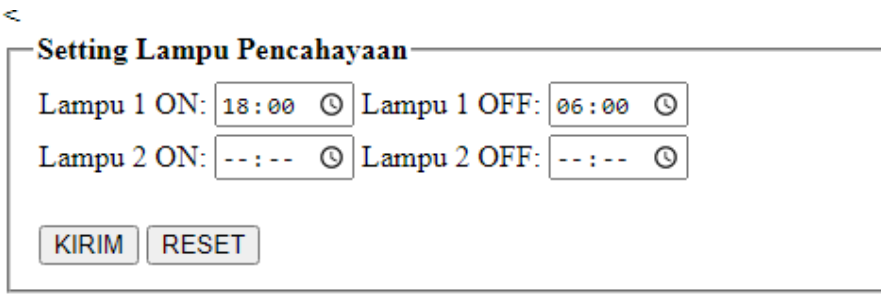

Figure 21. Interface Program Manager Open Close Window

In the RBW, it is necessary to put a light on the bird entry hole to make it easier for the swiftlets to recognize the RBW. Especially for swiftlet chicks, it is necessary to provide lights that are pretty dim so that new swiftlets can easily explore the RBW.

4. CONCLUSIONS

Based on the results of the implementation and product results of tools in the form of a monitoring system and automation of sound control, temperature, humidity, lighting, and windows in the swiftlet building (RBW smart system), it can be concluded that:

1. The product can adjust the type of call sound, pull sound, stay sound, and combination sound independently according to the RBW layout.
2. From twitter can be adjusted. According to the layout in the RBW, the schedule, volume, and type of voice character.
3. Sound settings can be done three times in operational.
4. Products made can turn on the misting/fog machine to lower the temperature and increase the humidity to the desired limit.
5. The misting/fog machine can be scheduled for long life and set on and off at a predetermined schedule.
6. The on and off misting/fog machine can be set with three operations.
7. The product that is made can set the window to open and close automatically.
8. Open and close the window can be set with two operations.
9. The manufactured product can set the lights on and off automatically.
10. Light on and off can be set with two times of operation.
11. Monitoring of temperature, humidity in 2 rooms, and the running system can be seen on the LCD Shield 4x20 screen installed on the system box.

Suggestion

1. Further development is needed for the prototype that is produced into a product that swallow farmers can use to increase the production of swiftlet nests.
2. Further analysis is needed on whether the resulting product can increase the production of wallet bird nests compared to the existing system.

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