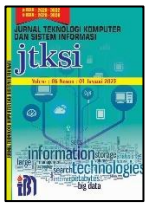

JTKSI (Jurnal Teknologi Komputer dan Sistem Informasi)

JTKSI, Volume 6, Nomor 01, Januari 2023
E ISSN: 2620-3030; P ISSN: 2620-3022, pp.72-79
Accredited SINTA 4 Nomor 200/M/KPT/2020
http://ojs.stmikpringsewu.ac.id/index.php/jtksi

Received: 26 Desember 2022; Revised: 13 Januari 2023; Accepted: 18 Januari 2023

Monitoring and Automation System of Swiftlet House Using Internet Of Things (IoT) Based

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Abstract

This research aims to make a tool in the form of a technological engineering system that is integrated with its operation so that swiftlet farmers can use it. This research is expected to produce a more effective and efficient technology than partial tools and has not yet answered the needs of swallow farmers. The stages in this study used flowcharts consisting of literature studies, program design, making system blocks, system integration, tool testing, and analysis of the results. The system design consists of determining tools and materials and making a block diagram of the work system of the tool with the ESP32 microcontroller. In system settings, it is divided into several system blocks: sound control system block, temperature and humidity control, window opening and closing control, lighting control and streaming video monitoring in swiftlet houses. Based on the results of the study, it was obtained that monitoring and automation system tools for swallow houses use IoT-based Esp32. This tool can automatically regulate and automate sound, temperature, humidity, lighting, and windows in swiftlet houses and can be monitored remotely.

Keywords: Monitoring, Automation, Swiftlet House, Esp32, Internet of Things

I. INTRODUCTION

The edible bird's or swiftlet nest is an excellent commodity because of its high economic value. It provides many benefits for consumption, so consumers demand them significantly. The high market demand and the limited number of goods make swiftlet nests very expensive because swallows are tropical birds in only a few regions of Asia. At the same time, their consumers come from all over the world.

In the Tionghoa ethnic community, apart from being used as a food ingredient, the edible bird's nest is also used as a medicinal ingredient which is believed to prolong life, increase the vitality of the body and even cure some severe illnesses [1]. The study's results also explained that using an edible bird's nest to prepare creams, gels, or ointments can accelerate wound healing. Itt contains glycosaminoglycans, N-acetylglucosamine, N-acetylglucosamine, N-acetylglucosamine, sialic acid, galactose, fucose, essential amino acids, nonessential amino acids, and 53-amino acid polypeptides [2].

One country in the Asian region that has the potential to produce swiftlet nests in Indonesia. Several areas in Indonesia are famous for producing swallow nests, one of which is Lampung. Since 2015, swiftlet nest has become an export commodity in Lampung. Based on data obtained from BPS in 2020, Lampung can supply around 5% of the total 1300 tons of national swallow nest exports, meaning that Lampung can supply as much as 62 tons of swallow nests for export [3].

Swiftlet farmers have made various efforts to increase the production of swiftlet nests. Swiftlet breeders try to make swallows feel comfortable and comfortable living in the swiftlet houses that have been provided. Because basically, swallows like to inhabit places with a calm atmosphere. So if the place where they lived felt unsafe and uncomfortable, the swiftlet colony would leave the place to move to a safer and more comfortable location. Therefore, swiftlet breeders must provide a swiftlet house that is as similar as possible to the conditions of a natural cave so that swallow colonies want to live and make nests in it. However, in reality, these efforts often experience problems due to the unavailability of an integrated system to regulate and monitor swiftlet house buildings to suit their natural habitat. Until now, the systems circulating in the market are still partial. It only handles specific problems, such as only controlling temperature and humidity, adjusting automatic window opening and closing to prevent predators from entering and automating voice calls, high prices, limited features and frequent errors, and setting the lighting and monitoring the swallow building via video cam.

Based on the problem description above, the researcher created a monitoring and automation tool that integrated with its operation so that swiftlet

farmers. They can use it in the hope that a more effective and efficient technology will be produced compared to partial tools that do not yet answer needs. It can automatically monitor and regulate sound, temperature, humidity, lighting, and open and close windows in swiftlet houses. It connects by the internet, which is expected to increase the quality and quantity of swiftlet nests for swiftlet house owners and facilitate the work of swiftlet farmers.

II. THEORETICAL BASIS

A. Swiftlet

The swiftlet widely cultivated in Indonesia is a white-nest swallow with the Latin *Collocalia fuciphaga*. This swiftlet is a species of the Apodidae family. This swallow bird species has characteristics ranging from 12 cm in length, with a weight of 8.7 – 14.8 grams, wings measuring 11.0 – 11.8 cm with elongated pointed shapes to form a crescent moon, and upper body colour blackish brown. In contrast, the underside of the body is brown. Swallows are monogamous. The female parent produces two eggs incubated by a pair of female and male birds for approximately 23 days [4]. In addition to these characteristics, swiftlets have short legs, so they cannot perch or rarely stand on the ground but can stick to walls. Swallows can also fly in dark places with the help of echolocation [5].

Swiftlets are birds that are sensitive to sounds. In adults, swallows make nests with raw materials derived from their saliva [6]. Furthermore, this saliva nest can be used as food or medicine because it has many benefits. Therefore, the swiftlet nest has high economic value.

B. Swiftlet House Requirements

The location for the construction of a swallow house must pay attention to environmental conditions consisting of micro and macro habitats. A microhabitat is where swallows make nests, rest, and breed. Furthermore, the macro habitat is where the swiftlet looks for food in the form of insects [7]

There are several criteria in the construction of swiftlet houses. They are location height, distance from industrial or city centers, air temperature, distance from rice fields or plantations, distance from waters, and distance from other buildings [8]. Furthermore, Hermawan & Seabtian (2014) states that the conditions for the establishment of swiftlet houses include being located in the lowlands with a maximum altitude of 1000 m above sea level, away from the crowds of influences from technological advances and community development as well as from disturbances by birds of prey. The most right is the rice fields, meadows, open forests, beaches, lakes, rivers, and swamps located in the swiftlet center area and the swiftlet trajectory [9].

The environmental conditions of the swiftlet house must be considered because they will influence the production of swiftlet nests. Therefore, swiftlet breeders try to condition the RBW as closely as possible to the conditions of their natural habitat so that swallows want to live in it. Several essential elements that support the creation of microhabitats in swallow cultivation include:

1) *Temperature*

The ideal temperature inside the swallow building is around 26ºC–29ºC. This ideal temperature can be created if the roof thickness, wall thickness, room width, and ventilation number in the swiftlet house are properly arranged [10].

2) *Humidity*

The ideal humidity inside the swiftlet building is 75-95%. Humidity that is too high will cause the water content in the swiftlet nest to increase and cause the nest to have a yellowish colour. Conversely, if the humidity in the Swallow Building is too low (50-70%), it can cause thin and imperfectly shaped nests that the nests are easily cracked [11].

3) *Lighting*

The quality of the swiftlet nest produced in a relatively sunny location is not as good as that produced from a rather dark place because the resulting nest is relatively thin and has a poor shape. Swiftlets prefer locations to make nests in places with lighting close to 0 lux or completely dark because swallows want comfortable conditions when resting [12]. During the day, the lighting inside the swiftlet house is no more than 10 lux [13].

4) *Predators*

Apart from humidity, temperature, and lighting, swiftlet predators or hams also need attention. Because the presence of predators can interfere with the comfort and continuity of swallows in the swiftlet house. If the swallow colony is threatened, it will seek a new place to nest [14]. The existence of predators such as rats and owls can make swallows disturbed, and even their population decreases because they are eaten.

Owls at night usually enter through the bird's entry hole to prey on the swiftlets. Therefore, swiftlet breeders or farmers will make small entry holes so that the owls cannot enter, but the impact is that it is difficult for swifts to enter the building, especially for swallows who are looking for new swiftlet houses. So that swallows are reluctant to enter the building. To deal with this problem, farmers or swiftlet breeders usually make owl traps by installing glass that forms a certain angle at the inlet, but the results are less than optimal. The best solution is to make windows or doors for swiftlets automatically. The results of the research by Widiasari, Pratama, & Styorini (2021) show that automatic doors can be made using sensors based on light intensity so that the doors can be opened in the morning and closed at night [15]. Furthermore, research by Kartika, Misriana, & Julsam (2021) automated doors to prevent pests and predators for swallows using a timer sensor so they can be scheduled [16].

5) *Voice*

Swiftlet is a type of bird that is sensitive to sound. Therefore, for this reason, swiftlet farmers can play recordings of the swiftlet sound to call upon the swallows to nest in the prepared captivity [17].

Machines or tools for calling swallows are relatively needed in swiftlet houses, which function as a medium for cultivating swiftlet nests. This tool has proven effective in luring swallows to inhabit houses that function as a medium for cultivating swiftlet nests. The sound of calls is usually dominated by the sound of the swallow [18]. In addition to the calling sound, there is a pulling sound and a staying sound. The pulling sound is the sound of an adult swiftlet, and it is played at the inlet. The sound that stays in is a sound that resembles the sound of a young swiftlet and is played in the room [19].

C. Internet of Things (IoT)

The Internet of Things is a concept that aims to expand internet connectivity's benefits continuously. IoT capabilities include data sharing and remote control so that a real object can transfer data without human-to-human interaction or from human to computer [20]. By utilizing IoT, the temperature and humidity conditions inside the swiftlet house can be monitored remotely at any time [21].

D. Microcontroller

The microcontroller is an I.C. chip with a microprocessor and memory, namely ROM (Read Only Memory) program memory and RAM (Random Access Memory) multipurpose memory [22].

1) *NodeMCU ESP8266*

NodeMCU ESP8266 is a microcontroller material designed to use ESP8266 to connect to a wifi network. The programming language used is NodeMCU Lua, but it can also use the Arduino IDE.

Figure 1. NodeMCU Esp8266

2) *NodeMCU ESP32*

The ESP32 architecture is almost similar to the ESP8266, namely Xtensa LX6, with a 32-bit architecture. However, the advantages of ESP32 are that it has a dual-core and includes BLE, has 128KB ROM and 416K SRAM, and 64 M.B. of Flash Memory.

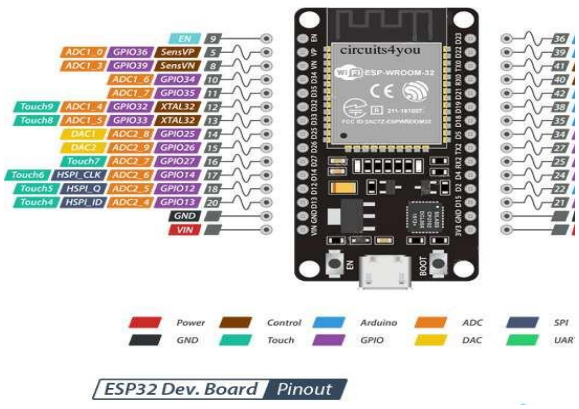

Figure 2. Pin ESP32

E. Sensors

1) *DFPlayer*

DFPlayer is used to play MP3 files controlled via Arduino/ESP32. DFPlayer mini has 16 interface pins, standard DIP pins, and header pins on both sides.

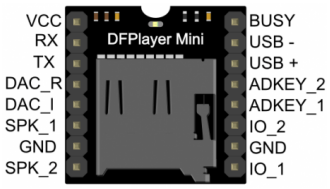

Figure 3. Pin DFPlayer

2) *DHT22*

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

Figure 4. DHT227

3) *Cooling and Humidity System*

The mist cooling system is an evaporative cooling system that is the same as the mist cooling system. This system uses a nozzle diameter that is smaller or equal to 0.1 mm so that the droplets that come out of the nozzle are mist which functions to reduce temperature and increase humidity.

F. Previous Research

According to Ikhsan (2017), his research results show that the recorded sound of swallows stored in the I.C. can be appropriately played based on a predetermined time, but the sound produced only consists of one type of sound. Even though farmers or swiftlet breeders need three sound characters in the swiftlet house: calling sound, pulling sound, and staying sound, the automation system cannot be remotely controlled because it is not connected to the internet [23]. Furthermore, in research, Ariyani (2018) found that using a microcontroller in a swiftlet house can control temperature and humidity. However, the results of this study have drawbacks because the control is still partial and cannot be controlled remotely because it is not connected to the internet [24].

The system will be made using a web browser and can be connected via the internet, and this is to make it easier in terms of system settings and monitoring

III. RESEARCH METHODS

A. Research Stages

The stages in this study are briefly described in the flowchart below:

1) Literature Study

The literature study was 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 Swiftlet House."

2) Program Design

At this stage, data analysis is carried out as needed, creating system interfaces, algorithms, and program coding according to the conditions required for each part/block of the system.

3) Create System Sub/Block

Create and test each part of the system blocks

4) System Integration

This stage combines each system block into a single unit.

5) Tool Design

Create system paths on the Arduino microcontroller with the ESP32/ESP8266 wifi module, sensors and other supporting components.

6) Tool Testing

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 whether the results are as expected.

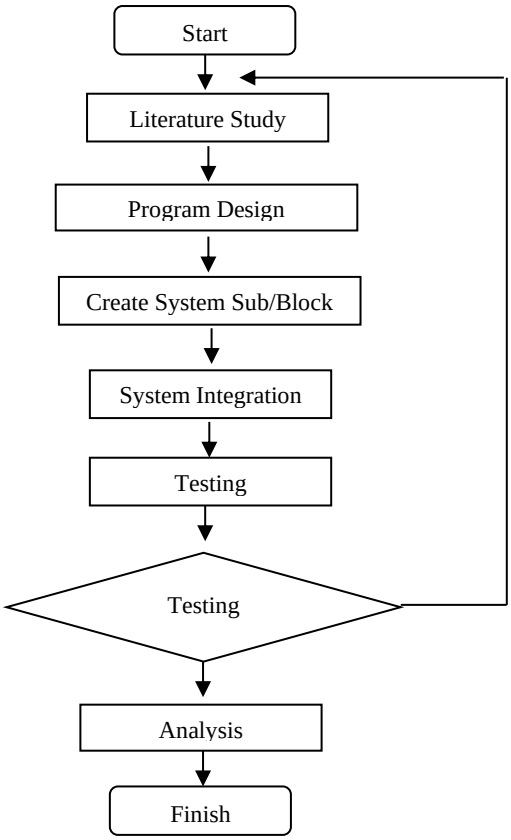

Figure 5. Research Flowchart

B. System Design

This design includes determining the tools and materials and making a block diagram of the tool's work system, where this tool uses an ESP32 microcontroller. In system settings, it is divided into several system blocks: sound control system block, temperature and humidity control, window opening and closing control, lighting control and streaming video monitoring in swiftlet house

C. Tools and Materials

In carrying out this research, starting from the observation stage to the tool design and simulation stages, the authors used computer equipment and smartphones as media to run the program. Tools and materials to make this system include:

- PSU 5V 3A and 12V 20A
- ESP32
- LCD Shield 4x20
- ESP32CAM Module
- Parabolic Actuator
- DFPlayer
- Amplifiers (TDA7386)
- SD Card
- DHT21 Temperature and Humidity Sensor
- Pump 115 PSI
- 3x4 cm fan
- Misting nozzle
- Hose
- LEDs
- Relays

- Twitter
- Resistors, capacitors, etc

D. System Mechanism

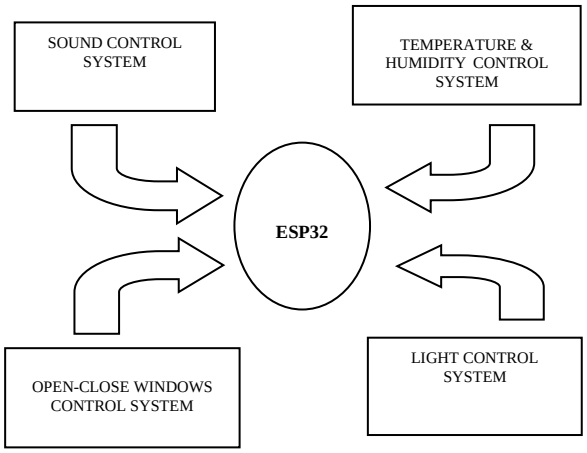

Figure 6. System Mechanism

1) In Figure 6 above, the system is divided into several system blocks, namely systems for adjusting sound, temperature and humidity, opening and closing windows and adjusting light. When the first time the installation process is complete and all devices are connected to the system, the user makes a Bluetooth connection to set the desired conditions.
2) The voice control system allows the user to schedule when the swiftlet sound is ON and OFF. The sound is divided into 4: namely, calling sound, pulling sound, inpatient sound, and combination sound (can be placed on the roof of the building for hexagonal sound filling). Each sound can be adjusted according to the desired character based on the schedule set.
3) In the temperature and humidity control system, the user lowers the temperature and raises the humidity by turning on the misting or fog machine. The working system is if the temperature rises and the humidity drops to the limit the user wants. Then the fog will turn on for a few minutes according to the inputted L.M. value. After that, the fog machine turns off according to the interval value the engine starts or the D.Y. value entered. After that, the machine revives the mist until the temperature and humidity conditions are as desired.
4) In the automatic window-closing system, the user can operate two times. For example, the user sets OPEN: 05.30 and CLOSE: 19.00, then the window will open at 05:30 and close automatically at 19:00. Editing can be done two times if the user wants it, for example, OPEN:02:00 and CLOSE:04.00 for the first set and the second setting OPEN:05:30 and CLOSE:19:00.
5) Like in the automatic window lighting system, if you can turn on and turn off the lights automatically.
6) In the monitoring system, swiftlet farmers can see humidity and temperature, and the system runs on the LCD Shield screen.
7) Swiftlet farmers can also see conditions in the swallow building through a web browser attached to the ESP32CAM controller without entering the house building so that the swiftlet is not disturbed.

IV. RESULTS AND DISCUSSION

The results that have been achieved are in the form of monitoring and automation system tools for controlling sound, temperature, humidity, lighting, and windows in Swiftlet Houses using IoT-based ESP32. The tool can be seen in Figure 7 below.

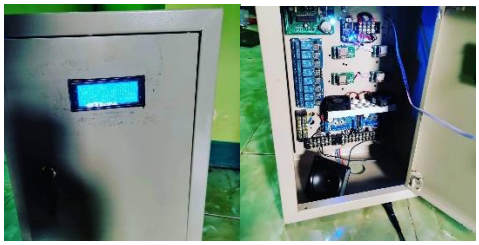

Figure 7. Tool Appearance

A. RBW Smart System Prototype

1) Controllers

Figure 8. Controllers

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. Researchers use ESP32 because it is considered reliable, affordable, and supports the Internet of Things. On this machine controller, there is an RTC DS3231SN to retrieve clock data so that the machine will run according to predetermined settings, even if the electricity is cut off because there is a battery in it

2) Sound Control System Block

In the sound control tool, there is a player module. This module plays sound on the S.D. card according to the files set. Files can be filled with up to 99 sounds, making it easier for swiftlet farmers to choose the right sound at a predetermined time. The advantage of this tool is that it rarely errors with a high degree of accuracy compared to other MP3 modules widely installed in swallow timer amplifier systems. Because in this module, there are commands that can be ordered from the controller.

Figure 9. Sound Module

3) Amplifier Module

Figure 10. Sound Module

In the amplifier, the researchers used the TDA7386 IC, because this I.C. is cheap and has four sound channels with a power of 45 watts, so it does not require many modules; it can further increase energy efficiency and space and reduce costs. In addition, this I.C. is also classified as Low Noise, although with a significant enough output power of aroun 45 watts per channel, so 800 tweeters per channel can be installed. Because one I.C. consists of 4 channels, this I.C. can root 3200 Twitter. It is especially suitable for large swiftlet house buildings. It also has a heatsink and fan installed to dissipate heat. So that even though the amplifier is used continuously not easily damaged or performance decreased due to heat effects.

4) Relay Module

Figure 11. Relays Module

The relay function is an automatic switch used to turn on the pump/misting in the misting technique to reduce temperature and humidity. The relay is also used to turn on and turn off the lights. It also functions to open and close windows automatically.

5) Temperature and Humidity sensors

Figure 12. Temperature and Humidity Sensors

The DHT 21 sensor is used to detect humidity and air temperature by collecting digital signal data and producing 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 8-bit computer chip as the controller. This model sensor has temperature data that has been calibrated accurately in the calibration chamber, and the coefficients for calibration have been stored in the OTP memory on the sensor. When the sensor detects temperature and humidity conditions, the detected data will be matched according to the calibration coefficient value contained in the memory. The DHT21 sensor has advantages such as its size of 22285mm, small electricity consumption, and a long transmission distance of 20 m, making it suitable and easy to apply. This sensor is equipped with a 4-pin connector, making it easy to operate. It has 43 features and applications: full range temperature compensated; measurement of air temperature and humidity; calibrated digital signal, stable for long term use; does not require extra components; transmission distance is quite far 20 meters; equipped with four pins for connecting the sensor to the microcontroller.

6) Misting/Fog Machine

Figure 13. Misting

Misting is used to break down water molecules into smaller ones, commonly used to lower the temperature and increase the humidity in the air. Temperature and humidity are achieved in the building so that the building approaches its natural habitat.

G. Interface Program

An interface program is a web browser to connect the user with the device so that the device can be controlled and set via a cellphone or computer, both locally and using the internet:

1) *Sound Control Interface*

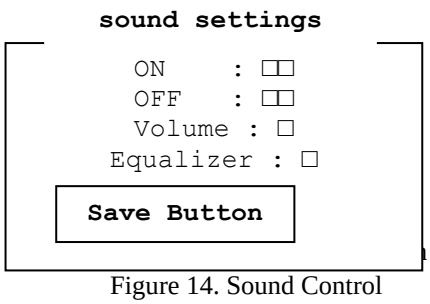

Figure 14. Sound Control

In figure 14, the user can make settings using a smartphone/computer to determine when the call sound, pull sound, stay sound, and combination sound are on/on and off/off, respectively, at the specified time in the first condition, the second condition and the third condition. ON is the timer for hours and minutes run, and OFF is the timer for hours and minutes stop. File to determine the type of sound being played, vol for the

volume, and E.Q. for the character tone of the voice. Each setting can be edited up to 3 times, so swallow farmers will be more able to adjust the type of sound and volume in the morning, afternoon, and evening.

2) *Temperature and Humidity Control Interface*

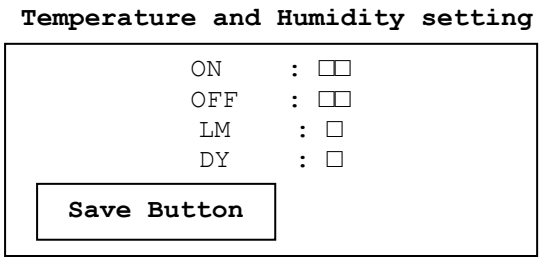

Figure 15. Temperature and humidity control

In figure 15, the user can make settings using a smartphone/computer to determine temperature and humidity limits adjusted to the RBW conditions of swallow farmers. LM is to set the time the mist is on, while DY is to set the time interval for the fog system to turn on/off again. It is for the effectiveness and durability of the fog machine and to reduce the impact of the excessive fog system, which can make the swiftlet fins moldy. The misting system for increasing humidity and decreasing temperature can be adjusted three times to be ON and OFF at the desired times.

3) *Open Close Window Control Interface*

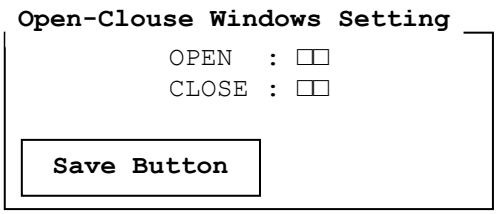

Figure 16. Open-Close Windows Control

In figure 16, the user can make settings using a smartphone/computer to determine when the window in the swiftlet house building closes and opens two times. For example, if the user in the first setting edits OPEN: 05.30 AM and CLOSE: 07.00 PM, then the window will open at 05:30 and close automatically at 07.00 PM. Editing can be done two times if the user wants it, for example, OPEN:02.00 PM and CLOSE:04.00 PM for the first set and the second setting OPEN:05.30 AM and CLOSE:07.00 PM.

4. Lighting Control Interface

In figure 17 below, the user makes settings using a smartphone/computer to determine when the lights in the RBW building turn on and off two times. For example, the user in the first setting edits LAMP OFF: 05.30 AM and ON: 06.00 PM, then the LED light will turn on at 06:00 PM and turn off at 05:30 AM. Editing can be done two times if the user wants it, for example, ON: 05.00 PM and OFF: 09.00 PM for the first set and the second setting ON: 04.00 AM and OFF: 07.00 AM

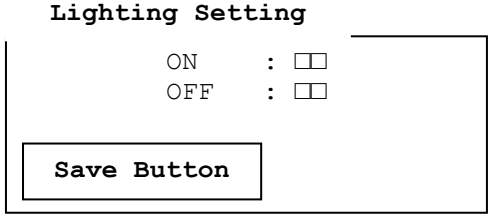

Figure 17. Program Interface Lighting Control

V. CONCLUSION

The results of this research produce tools that can regulate and automate sound, temperature, humidity, lighting, and windows in swiftlet houses with the following description:

1) Temperature and humidity control system through the misting method. So the temperature and humidity can be controlled automatically. The duration of the extraction can be adjusted based on the desired time/timer interval so that the tool lasts longer
2) The device has a sound player to call swallows with the distinctive sounds of birds according to their natural habitat independently, which consists of calling sounds, pulling sounds, staying sounds, and sound combinations of the sounds mentioned.
3) The sound player that is made can be set ON-OFF and the volume simultaneously, independently, and automatically so that it does not disturb the environment but attracts swallows to arrive in colonies.
4) The sound amplifier on the sound player is made using the TDA7866 IC, which is low energy, high quality, and cheap, produces clear sound with little energy, and can get around 3200 twitters, but the price is affordable.
5) Open and closing of windows are arranged automatically. So that predators cannot enter the swallow house; Lighting can be adjusted automatically, making it easier for swallow chicks to enter and access spaces in the building; this can add new swallow colonies to stay overnight.
6) Within the swiftlet house building, temperature, humidity, and population conditions can be monitored so that swallow farmers do not need to enter the building, which can disturb the swallows and leave the building.
7) The operation of tools that are easy to set, control and monitor via a web browser that is accessed via the internet.
8) The resulting tools can be monitored directly through the LCD on the tool products that have been made.

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