Borneo Engineering & Advanced Multidisciplinary International Journal (BEAM)

Volume 2, Special Issue (TECHON 2023), September 2023, Pages 134-139

Smart Monitoring System for Poultry Farming

Sylvia Ong Ai Ling[1]*, Wong Sie Woo[1], Priscilla Mashesha Jana[1]

[1]Department of Electrical and Electronic Engineering, Politeknik Kuching Sarawak, KM 22 Jalan Matang, 93050, Kuching, Sarawak, Malaysia

*Corresponding author: sylvia_ong@poliku.edu.my

Please provide an **official organisation email** of the corresponding author

Full Paper

Article history

Received

30 July 2023

Received in revised form

30 July 2023

Accepted

3 September 2023

Published online

30 September 2023

Abstract

The chicken poultry sector is critical to our country's long-term food supply. The coop's climate is one of the factors that ensures chickens grow in the best possible conditions. Without proper environmental management and oversight, heat stress and illness problems could possibly result in a decrease in the amount of chicken meat and eggs produced. To address the prospect of a shortage soon, it is critical to optimize chicken production through standardized farming management and practices. With the application of Wireless Sensor Network (WSN) and Internet of Things (IoT), its potential benefits to the poultry sector. It could serve as a foundation for low-cost, easy-to-implement solutions. The aim of this project is to develop a system that is linked to an application and serves as a monitoring assistance for chicken farms. This project employed a digital temperature and humidity sensor that can communicate and transmit real-time data to the ESP8266 microcontroller and display them via Android mobile phone from the Blynk Cloud system. This system also activates fans to control the air when the air quality dropped sensed using the temperature and humidity sensor module DHT22. This auto detection and monitoring system effectively implemented the quickest response time and accurate monitoring of an emergency, assisting in the speedier dissemination of the critical situation. Creating an intelligent poultry farm will make it easier to replace physical labour with poultry work. Human labour will also be reduced with this prototype, and intelligent work will be accomplished anywhere and anytime.

Keywords: - Smart monitoring system, ESP8266 microcontroller, DHT22, Blynk Cloud System

1. Introduction

One of Malaysia's most important industries for producing a sustainable food supply is the poultry industry. In Malaysia, chicken is a substantial and reasonably priced source of protein. In accordance with Ferlito (2020), the average annual intake of chicken meat increased from 35kg to 49 kg in 2019 and is projected to increase to 50 kg by 2025, whereas the average annual consumption of eggs is close to 20 kg. As a result, Malaysian poultry producers play a crucial part in preserving the health of chickens.

The implications of managing the chicken's welfare, care, comfort, and well-being have generated a lot of debates and extensive research. There are several factors that can affect the poultry's health, including housing design, stocking density, ventilation, temperature, and illumination (Karcher, 2021). Due to Malaysia's typical tropical environment, which includes hot, humid months throughout the year, a problem frequently occurs when temperature variations are not considered, leading to a hot day with insufficient ventilation. Very hot weather causes heat stress to the chickens. Chickens are prone to heat stress when the atmospheric temperature and humidity uncontrollably rise, which raises their core body temperatures. Because of the excessive humidity in the chicken coop, this often leads to an increase in respiratory issues. To cool their bodies, they will pant, expand their wings, drink more water, consume less food and eventually death. Additionally, the inappropriate humidity and temperature in the chicken coop may make the chickens more susceptible to illnesses like Coryza, which makes chickens' eyes swell and makes them lose their appetite (Budiarto et al., 2020).

Each age of chicken has a different optical temperature, and a coop should not be exposed to temperatures and humidity higher than 320C and 70% respectively (Budiarto et al., 2020 and Nalendra, 2021). Proper ventilation becomes crucial to help lower the risk of heat stress and is also important for the purpose of removing moisture, removing excess heat, exchanging the gases created by the litter, and providing fresh air. However, the temperature and air quality on a chicken farm are difficult to deal with, especially in traditional farming. In traditional farming, human labors must check the temperature and humidity readings manually and regularly. The effort of maintaining the poultry farm is exhausting for them. It is also challenging to keep an eye on the farm's condition around-the clock.

Thus, extensive research has been carried out to solve this issue. One of the preventive measures to overcome the monitoring of the poultry farm environment is to use an IoT based monitoring system. The proposed software-based devices can track conditions at chicken farms, including humidity and temperature. This research puts forth a fresh approach of bringing IR4.0 technology to traditional poultry farming to make it smarter. The coop is connected to smart equipment such a microcontroller, sensor, and application programme. This enables the automation of the chicken farm to circulate or exhaust the air within the coop according to the data sensed by the sensor. The system is made to be remotely controlled by the user(s) via an Android mobile application without the need for the poultry farmers to be there. This prototype will be very helpful at the poultry farm and at the same time it will reduce expenses, time as well as human labor while doing intelligent job in the chicken farming sector.

This manuscript describes the development of an automatic smart environment sensing particularly for poultry farms. The proposed system can also automatically control the parameters while monitoring the measured temperature and humidity. Additionally, the designed system is connected to a wireless network where real-time temperature and humidity readings may be viewed on mobile devices and personal computers running the Blynk Application. The organisation of this document is as follows: The proposed system is introduced in Section I. The related study done by earlier researchers is presented in Section II. In Section III, the proposed system is outlined, and in Section IV, the findings and conclusions are presented. The conclusions and suggestions are summarised in Section V.

2. Literature Review

Heat stress is the most important problem in poultry production. Hot and humid weather, combined with ineffective management approaches, increases flock mortality, limit growth, and reduces chicken output to an unprofitable level. In addition, these problems could disrupt hired labor and staff. Thus, much research has been done to control the chicken farms' environment. Automated chicken farms with controlled environments based on microcontrollers can help to monitor and review the air quality in place of the current monitoring technique (Nalendra et al., 2021; Ramadiani et al., 2021 and Enriko and Putra, 2021). The outcomes demonstrated that the electronic system could operate with high accuracy to record or display it in a storage device (Junaidi et al., 2022). Another study's findings, which were published in (Mitkari et al., 2019), demonstrated the use of an electronics system to track the air quality in terms of temperature and humidity. Given how crucial temperature and humidity are to chicken growth, it is imperative to constantly monitor those variables utilising an electronic based system. It is crucial to monitor closely on the chicken coop's primary indicators to lower the mortality rate of chickens, especially during the vulnerable period when the coop is in poor condition and the chicks are between the ages of one day and three weeks. It will lessen the losses experienced by farmers while boosting their profit by lowering the chick mortality rate. The research is continued to improve the monitoring of the chicken coop environment using a local network and controlling devices such as the ventilation system and moisturising devices (Mitkari et al., 2019). The study, however, revealed that implementing such method would only allow chicken farmers to statically monitor the environment variable using a specific computer.

Thus, there have been numerous research studies on the prototype of chicken coop automated mobile monitoring system using wireless technologies such Global System Messaging (GSM) and IoT technology. Ali et al. (2020) suggested detection and monitoring of air quality in chicken coop using MQ11 sensor and embedded with Arduino WeMo's D1 hardware that comes with a Wi-Fi module. Adinegoro et al. (2020) created an IoT-based chicken coop to retrieve environmental data such as temperature and humidity using the ESP8266 microcontroller. A DHT11 temperature sensor, a lamp, and a fan were used by the monitoring system as actuators for controlling reasons. In the study, Adinegoro tested the coop environment using three different treatments: light on, fan on and both on. The results showed controlled temperature and humidity in the range from 240C-320C and 61%-78%, respectively. Poultry farmers can view sensor retrieval data through Telegram in real-time and view historical data. A temperature control system for chickens was created by Sulistiyowati et al. (2019) using a gateway SMS system that provides the poultry farmer with information. The water pump and dc motor fan served as the actuators in this system, which also utilised an LM35 temperature sensor to detect changes in the coop's environment. Microcontroller Arduino UNO was used to operate the entire system. The studies showed acceptable performance through the wireless network environment. But if the battery draining curve drops below the operating voltage, the Arduino board, which has an operating voltage of 5V, may be unable to function due to running time when a battery is the power supply. In addition, the proposed prototype that employed GSM and

Telegram has no dashboard to monitor the trend of the environment in the chicken coops.

When these farms are built with highly automated systems of automatic temperature and humidity monitoring embedded with wireless technology, the atmosphere becomes more conducive to chicken production, resulting in continuous production.

3. Methodology

The main concept of developing this system is to monitor the temperature and humidity level detected by DHT22 for poultry farming. Fig. 1 illustrates the block diagram of the environment system development. In Figure 1, the developed system comprises of a DHT22 temperature and humidity sensor, a NodeMCU ESP8266 that is interconnected with the sensor and a 5V relay that is connected to fan(s) for regulating purposes.

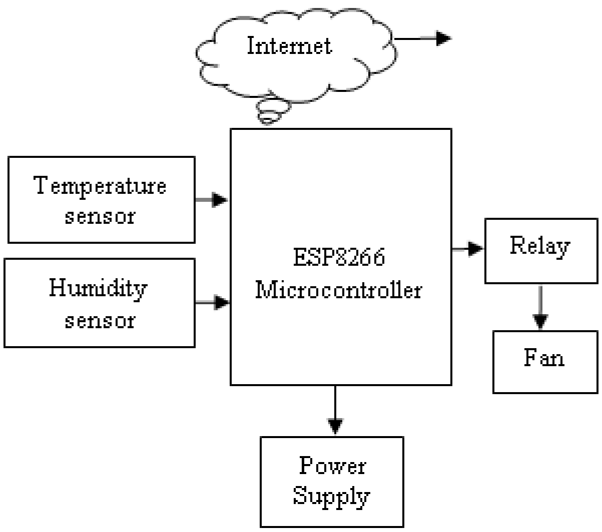

Fig. 1. Block diagram of chicken poultry farm monitoring system

This system employs DHT22 temperature and humidity sensor It is a factory calibrated digital temperature and humidity sensor; it consists of a microprocessor that uses a capacitive humidity sensor to measure the relative humidity of the air; the closer the value is to 100%, the more humid the measured environment; it also includes a thermistor to measure the surrounding air and calculate the temperature of it; and it displays the data via a digital signal on the data pin. The benefits of these devices are their inexpensive cost and the ability to digitally perceive two analog quantities such as temperature and humidity because the sensor performs the conversions. In addition, the DHT22 is a low power consumption sensor capable of sensing 0-50oC temperature with ±2oC precision as well as 20-80% humidity measurements with 5% accuracy (Nalendra et al., 2021).

A relay is a form of circuit element that uses electromagnetic induction to work. When a current flows through it, it works as an electrical switch, allowing the attached fan to be turned on and off. The switching concept is based on the electromagnetic principle, and the three components that comprise a relay are the coil, pallet, and contact. The coil serves as the relay's input and is not electrically connected to the pallet or contact section. The relay provides massive current and voltage control without being impacted by the load frequency by using modest currents and voltages.

In this system, NodeMCU ESP8266 is the main microcontroller unit which connects to sensor(s) and other output(s) for data logging. The microcontroller is integrated with Arduino Integrated Development Environment (IDE) as it offers a simple user interface for creating, compiling, and uploading code to an Arduino microcontroller. It is an authorised application for controlling and uploading software to Arduino boards. Input device, temperature sensor, DHT22 will sense the surrounding temperature and moisture continuously and always compare with the desired value suitable in the chicken coop. Simultaneously, the humidity sensor, DHT22 will also sense the level of moisture from the surrounding. If there is a sudden increase of heat and moisture level in the chicken coop or a location where the devices are installed, DHT22 will automatically detect and immediately send a signal to the NodeMCU ESP8266. Upon receiving the signal, the microcontroller processes the signals and sends the data to the users via Blynk Cloud system.

Blynk Cloud system is an IoT platform for iOS or Android smartphones that allows users to remotely operate devices like Arduino, Raspberry Pi, and NodeMCU. Using this application, the right address on the various widgets to construct a graphical interface or human machine interface (HMI) can be compiled. For use with the Internet of Things, Blynk was created. It can store data, visualize it, display sensor data, remotely operate hardware, and perform many other fascinating things.

In the event when the signal exceeds the predetermined threshold values of, the system will automatically activate the other external devices, consisting of fans and mobile phones, as a sign of warning to inform the users and to control the temperature and humidity level in the chicken coop. To evacuate the warm air from the coop, fans are used. It facilitates the movement of hot air about the rooms. There will also be an automatic messaging generating operation that sends and displays notifications to the predefined cellphone numbers as well as through the Blynk application.

Fig. 2 depicts the overall system's block diagram. First, the temperature and humidity values are set. The Wi-Fi connection will then be validated. The sensor is connected to the NodeMCU ESP8266 wherein the VDC pin is connected to the 3V pin on the controller, DAT pin is connected to D5 and GDN pin is connected to the ground. The sensor will read and send data to Blynk as soon as the Wi-Fi is connected to the project. In this system, the predetermined range for temperature is 33oC-35oC and 60%-80% for humidity, respectively. It is shown that when the value surpasses the temperature threshold of 35°C, the fans will switch on. The fans will switch on if the measurement reaches the humidity threshold of 80%. If either of the conditions is met, the fans will activate. Through the Blynk application, the temperature and humidity values are shown simultaneously.

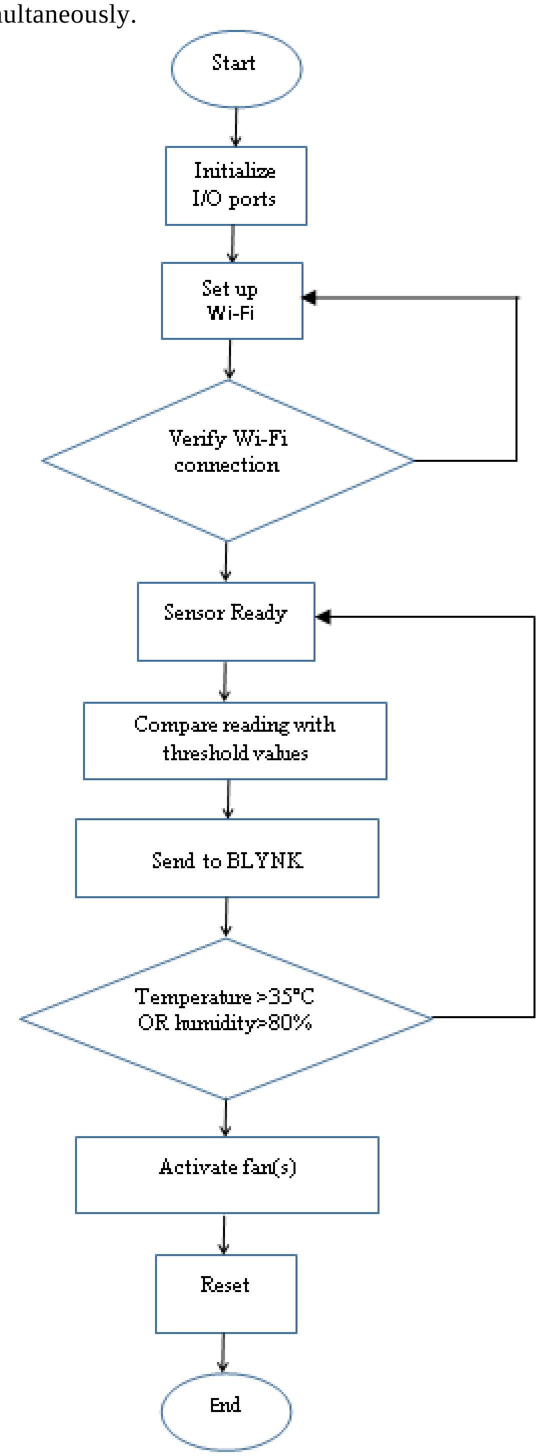

Fig. 2. Flow chart of the monitoring system

Fig. 3 shows the circuit diagram of the temperature and humidity detection system. The prototype chicken coop design incorporating sensors, fans and a NodeMCU ESP8266 is shown in Fig. 4. Different ages of chicken require different environmental conditions, such as coop size and temperature. The right temperature must be maintained to produce chicken of the highest calibre. The primary group of chickens on which attention will be paid are young chicks. For newly hatched chicks, a healthy growth range is between 33oC and 35oC. In modern chicken farming, covered coops are utilised to protect the birds from harmful weather, insects, predators, and diseases. The 33" x 20" x 20" prototype chicken coop made of wood is intended to accommodate 5 to 10 young chicks.

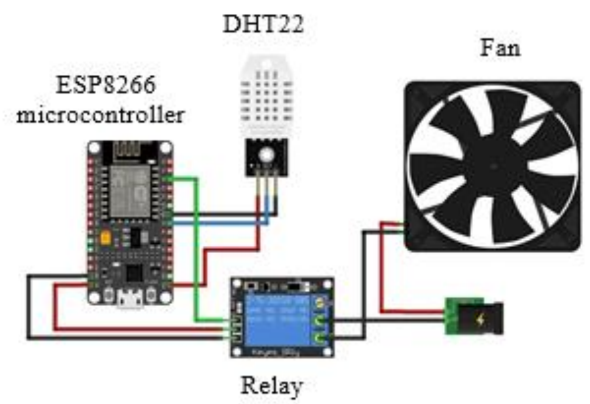

Fig. 3. Circuit diagram of the temperature and humidity detection system

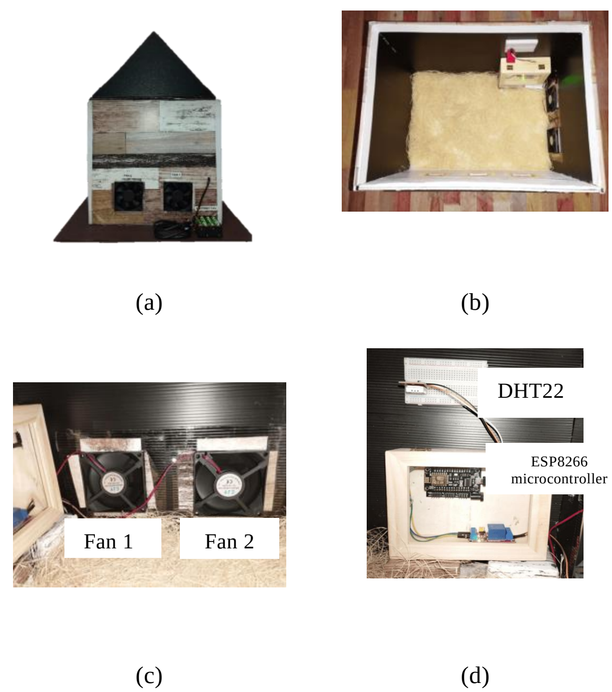

Fig. 4. (a) Prototype front view, (b) Prototype internal view I, (c) Prototype internal view II and (d) Prototype internal view III

4. Finding and Analysis

The temperature and humidity were measured using a thermometer and a DHT22 via the Blynk interface, as shown in Table 1. Every five minutes, measurements are obtained for the parameters of temperature and humidity. The thermometer serves as a reading reference for the coop's temperature and humidity. Based on the results, it can be concluded that the DHT22 sensor used in this system has a good degree of measurement accuracy because its reading is comparable to the temperature reading.

Table 1. Results of thermometer and DHT22 readings

Duration	Thermometer		DHT22	
Minutes	Temperature (ºC)	Humidity (%)	Temperature (ºC)	Humidity (%)
5	29	69	29.6	70
10	29	69	29.6	70
15	29	69	29.6	70
20	29	69	29.6	70
25	29	68	29.7	70
30	29	68	29.7	70

Table 2 shows the system's testing for temperature and humidity levels. Fan 1 and Fan 2 will automatically turn on in order to regulate the coop's temperature when either the temperature or humidity levels were found to be higher than the predefined range. This also applies when temperature and humidity levels exceeded the threshold values. The fans will automatically turn off when both temperature and humidity level drop to the predefined range.

Table 2. Testing of temperature and humidity level detection system

Temperature (ºC)	Humidity (%)	Output (Fan)	Condition
28	86	Fan 1 and 2 activate	Humid
33	79	Fan 1 and 2 activate	Warm
33	88	Fan 1 and 2 activate	Warm and Humid
27	79	Fan 1 and 2 inactivate	Normal

When the ambient temperature and humidity are within the usual range, neither Fan 1 nor Fan 2 activated. The real-time temperature and humidity data are simultaneously transmitted to the users remotely via mobile devices and personal PCs, as shown in Fig. 5.

Fig. 5. Temperature and humidity display on Blynk application

Fig. 6. Fan activation

In Table 3. chicken age of 12 days test results for a day. From Table 3, it can be seen that the temperature of the cage can be maintained between the temperature ranges of 26 to 32^0C. Only in the range of 12 noon to 15 hour, the temperature of the cage reaches a temperature of 28.4^0C and 32.1^0C. This is due to the large value of the ambient temperature greatly affecting the temperature of the cage so that the fan cannot maintain the temperature of the cage at the specified temperature value. The fan will automatically turn on when the temperature of the cage is above 33^0C as shown in Figure 6 and will turn off automatically when the temperature reaches below the temperature of 33ºC.

Table 3. Temperature and humidity measurement results

Time	Temperature (ºC)	Humidity (%)	Status
00:00	26.0	68	Fan Deactivate
03:00	25.5	68	Fan Deactivate
06:00	26.5	67	Fan Deactivate
09:00	28.7	69	Fan Deactivate
12:00	32.1	70	Fan Deactivate
15:00	30.4	70	Fan Deactivate
18:00	28.4	69	Fan Deactivate
21:00	27.0	68	Fan Deactivate

Fig. 5 shows the temperature and humidity display via Blynk when the DHT22 sensor is activated. Even when the users are outside, they can easily track and monitor their farm condition remotely. People have benefited greatly from this system as an early warning system against potential dangers. From data collection to the actual processing of temperature and humidity, this device runs smoothly. Under Industry 4.0, this networking environment has a mechanism that allows for the transfer of necessary information, especially emergency at today's industry communication speeds.

5. Conclusion

In conclusion, this intelligent system makes it possible to collect and track environmental data for chicken production. Maintaining chicken coops at the ideal temperature and humidity level is made possible by well-designed temperature sensing circuits. In terms of detecting the temperature and humidity, all employed sensors have performed satisfactorily. The Blynk Cloud system, an IoT platform, receives all the readings and processes them for display via personal computer and Android mobile application. Additionally, a remote actuator system has been developed to adjust temperature and humidity. The health and productivity of hens are now improved due to intelligent environmental condition monitoring via a sensor network. Poultry farmers may now remotely monitor their farms because of the system implementation and the Blynk application's capability to read temperature and humidity measurement. This system is incredibly efficient and cost-effective, which will appeal to all poultry farmers. The system can be further enhanced by integrating other devices such as automated feeding system as well as adding solar panels to provide sustainable and green energy.

References

Adinegoro, P., Habbani, M. H., Karimah, R. A., & Laksono, Y. A. (2020). The design of a telegram IoT-based chicken coop monitoring and controlling system. *JPSE (Journal of Physical Science and Engineering)*, *5*(2), 56-65.

Ali, M. L., Rahman, M. A., & Taujuddin, N. S. A. M. (2020). Smart Chicken Farm Monitoring System. *Evolution in Electrical and Electronic Engineering*, *1*(1), 317-325.

Budiarto, R., Gunawan, N. K., & Nugroho, B. A. (2020, July). Smart chicken farming: monitoring system for temperature, ammonia levels, feed in chicken farms. In *IOP Conference Series: Materials Science and Engineering* (Vol. 852, No. 1, p. 012175). IOP Publishing. https://doi.org/10.1088/1757-899X/852/1/012175.

Enriko, I. K. A., & Putra, R. A. (2021). Automatic temperature control system on smart poultry farm using pid method. *Green Intelligent Systems and Applications*, *1*(1), 37-43. https://doi.org/10.53623/gisa.v1i1.40.

Ferlito, C. (2020). The poultry industry and its supply chain in Malaysia: challenges from the Covid-19 emergency. *Res. J*, 1-37. https://doi.org/10.13140/RG.2.2.23221.91367.

Junaidi, J., Siagian, T., Ritonga, D. A. A., Siregar, I., & Rahmadsyah, R. (2022). Analysis of Chicken Temperature Control Using a Control System. *Journal of Mechanical, Civil and Industrial Engineering*, *3*(3), 42-48. https://doi.org/10.32996/jmcie.2022.3.3.5.

Karcher, D. (2021). Basic housing and management. *Backyard Poultry Medicine and Surgery: A Guide for Veterinary Practitioners*, 45-55. https://doi.org/10.1002/9781119511816.ch3.

Mitkari, S., Pingle, A., Sonawane, Y., Walunj, S., & Shirsath, A. (2019). IOT based smart poultry farm. *system*, *6*(03).

Nalendra, A. K., Priyawaspada, H., Fuad, M. N., Mujiono, M., & Wahyudi, D. (2021, June). Monitoring System IoT-Broiler Chicken Cage Effectiveness of Seeing Reactions from Chickens. In *Journal of Physics: Conference Series* (Vol. 1933, No. 1, p. 012097). IOP Publishing. https://doi.org/10.1088/1742-6596/1933/1/012097.

Ramadiani, R., Widada, D., Widiastuti, M., & Jundillah, M. (2021). Temperature and humidity control system for broiler chicken coops. *Indonesian Journal of Electrical Engineering and Computer Science*, *22*(3), 1327-1333. http://doi.org/10.11591/ijeecs.v22.i3.pp1327-1333.

Sulistiyowati, I., Haris, R. A., & Suprayitno, E. A. (2019, September). Temperature Control System Design Chicken Coop Using Gateway SMS. In *Journal of Physics: Conference Series* (Vol. 1232, No. 1, p. 012029). IOP Publishing. https://doi.org/10.1088/1742-6596/1232/1/012029.

Supriyono, H., Bimantoro, U., & Harismah, K. (2020, March). Design, construction and testing of portable systems for temperature, humidity and ammonia monitoring of chicken coop. In *IOP Conference Series: Materials Science and Engineering* (Vol. 771, No. 1, p. 012003). IOP Publishing.