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IoT Based Poultry Cage Quality Monitoring System

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ABSTRACT

This research aims to create a better cage quality monitoring system in poultry farms, the parameters observed in particular are ammonia gas, where this gas greatly affects the health and productivity of laying hens, the data taken is processed in percentage terms and a comparison of several conditions in the location where the equipment is placed. The system is made using ESP32 microcontroller as the main board, DHT22 as a temperature and humidity sensor, MQ135 as a sensor to detect ammonia gas levels, GY302/BH1750 as a light sensor, light sensor or light meter sensor is used to optimize the circadian cycle of laying hens, the monitor system uses data sent by the main board to the database and taken as output by the mobile application. At the implementation stage, the system is able to function properly where the monitor system can send and receive data with the database as an intermediary between hardware and software. The DHT22 sensor can detect temperature and humidity changes with minimal error, the error rate obtained for DHT22 sensor reaches 2.26%, the MQ135 sensor can detect ammonia gas levels according to set program, the GY302/BH1750 sensor can detect changes in light with quite optimal accuracy, all sensor activities can be monitored through the software that has been created, when the system is used for a long period of time periodically the main board will stop sending data to the database, This can last 30 to 40 minutes, with a reboot solution.

Keywords: *Ammonia Gas, Poultry, Laying Hen, Quality Control*

1. INTRODUCTION

Poultry farming technology in Indonesia aims to obtain results from the line breeding of these poultry [1]. The quality of the product is very dependent on the environment in which the livestock are placed, especially the pen. In its maintenance, optimal steps are needed to maintain the quality of the pen, so that the livestock being kept can produce good products [2].

In 2019, poultry farming in Indonesia contributed to supplying 65 percent of animal protein needs and employed 10 percent of the national workforce [3]. Chicken is the type of poultry that is most widely cultivated in Indonesia. In 2022, poultry in Indonesia was dominated by broilers, with a percentage of 80.39 percent of the poultry population in Indonesia, followed by laying hens and kampung chickens with a percentage of less than 10 percent each [4], the existence of this business creates demands for its owners to maintain the cleanliness of the cages, in general livestock owners must monitor the quality of the cages manually which involves the sense of smell, this activity is very risky, because high levels of ammonia gas can cause serious health problems even for humans [5], with a better monitoring system this can be avoided, while increasing livestock productivity, not only the surrounding environment, a clean pen is very necessary to maintain good livestock productivity..

The livestock industry in Indonesia is rarely touched by technology, even if there is technology that touches it, this technology requires a higher cost than general facility maintenance, by using DHT22, MQ135 sensors, and GY-302 sensors, a practical system can be created to monitor the quality of the cage, this system uses IoT technology that uses internet network infrastructure as a data transmission medium, users can monitor remotely so that health problems can be avoided, user mobility will not be hampered and with the presence of a light measuring sensor, users can monitor the livestock circadian cycle more optimally.

2. LITERATURE REVIEW

2.1 IOT

Internet of Things is a sophisticated technology that basically refers to the many devices and systems throughout the world that are connected to each other using the internet [6]. IoT or Internet of Things is a concept that connects physical devices, such as sensors, electronic devices, and everyday objects, with the internet to send and receive data without the help of humans and computers. IoT extends the benefits of internet connectivity and combines it with everyday life. IoT requires a platform or software that connects hardware, access points, and data networks. Examples of IoT are smart lamps, smart ac, IR remote blasters, and smartphones.

The Internet of Things is highly dependent on internet services, where most of the functions of this concept are remote control and monitoring, basically this concept increases user mobility, so that users can freely manage their time and energy for higher priorities.

2.2 Ammonia Gas

Ammonia (NH_3) is a form of gas produced from the decomposition of nitrogen residues by decomposing bacteria (ureolytic bacteria) originating from chicken feces or manure. Ammonia gas is a gas that has no color and the odor it produces is very pungent.

Commonly used chicken feed ingredients contain protein, where this protein produces waste in the form of urea and uric acid which are excreted together with chicken feces. Both urea and uric acid contain nitrogen (N) which will be converted into ammonia (NH_3 in gas form) or ammonium (NH_{4^+} dissolved in feces) by decomposing bacteria (ureolytic bacteria) in the environment.

Ammonia gas has a tolerance limit for chickens that can affect productivity. Gas can start to be smelled at around 20 ppm. While the maximum level of ammonia that can be tolerated by the body for 8 hours is 25 ppm. At a concentration of 20-25 ppm, the ammonia gas that is formed can actually trigger respiratory diseases in chickens. Where ammonia production of more than 25 ppm can cause livestock to experience oxidative stress so that it can affect meat quality [7].

2.3 DHT22 Sensor

DHT22 is a digital humidity and temperature sensor. This sensor uses a capacitor and a thermistor to measure the surrounding air and outputs a signal on the data pin. DHT22 is claimed to have good reading quality, assessed from the fast data acquisition process response and its minimalist size, and at a relatively cheap price when compared to a thermohygrometer. The DHT22 sensor is very easy to apply to an Arduino type microcontroller because it has a reliable level of stability and a calibration feature that has very accurate results. Comparing the accuracy value of the DHT11 sensor to the

DHT22 in measuring temperature and humidity when used both indoors and outdoors [8].

2.4 MQ135 Sensor

MQ135 is an air quality sensor. This sensor can be used to measure gases such as NH3 (Ammonia), alcohol, benzol, smoke (CO), and CO2, this sensor works by calculating the change in the value of resistance in semiconductor materials when exposed to gas, measurement adjustments for each gas can be configured manually to get optimal results [9]. The gas value measured according to the standard is Parts per Million (PPM), "Parts Per Million" (PPM) is a unit of measurement used to measure the concentration of a substance in a mixture or solution.

2.5 GY-302 Sensor

GY-302 is a module in its circuit using the BH1750 sensor. The function of the GY-302 sensor module circuit is to facilitate the use of the sensor and minimize damage to the BH1750 sensor. The BH1750 sensor itself is an Integrated Circuit (IC) sensor used to measure light intensity in lux units [10]. The BH1750 module is commonly used on smartphones, the ability of this module to detect light can be used to manipulate the brightness level of the screen, in addition, the power required by this module is quite small.

3. METHODS

This research was conducted experimentally, where in this research the author aimed to research and solve a problem, while simultaneously implementing the theory.

3.1 Block Diagram

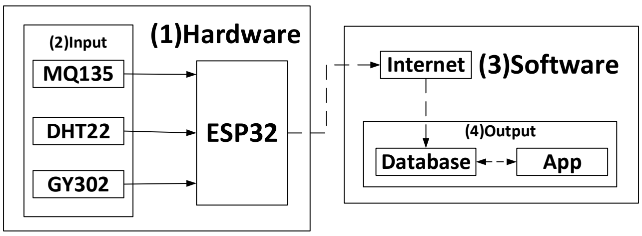

Figure 1. System Block Diagram

The hardware (1) consists of an ESP32 as the main board, the selection of the ESP32 takes into account the integration of the wifi module so that the device can easily access the internet network, all sensor data is obtained from input (2) which consists of the MQ135 sensor to measure the intensity of ammonia gas, the DHT22 sensor to measure temperature and humidity, and the GY302 sensor to measure light intensity.

The software (3) used is made using Kodular, a simple application that uses program blocks to form various commands, sensor output (4) will be stored in a database via the internet, then the IoT application can take data from the database as output.

3.2 System Flowchart

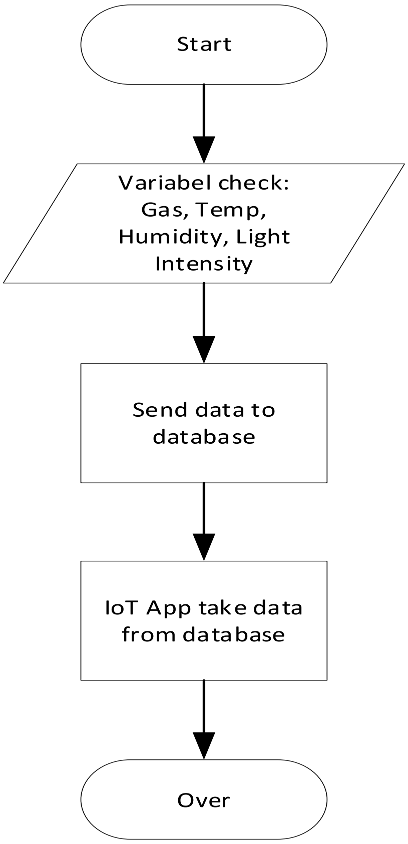

Figure 2. System Flowchart

The system starts by initializing the sensor, after the initialization is complete the main board will connect to the database so that the DHT22, MQ135 and GY302 sensor data can be sent via the internet, the database used is Google Firebase, this database is used because of its simple structure and does not require costs for a small part of its storage, the data stored in the database can be accessed with IoT applications to monitor changes in conditions in the environment around the device, when the device is not turned off the device will continue to send data to the database periodically.

4. RESULTS AND DISCUSSION

4.1 Input/Output Delay Testing

Input output delay testing involves the entire set of tools, from applications, databases, to microcontroller boards, the delay is calculated from the sensor output from the main board to the receipt of data on the IoT application, data is taken ten times and the average delay is calculated.

Table 1. DHT22 I/O Delay

Trial	Input Output Delay (Seconds)
1	2.8
2	9.0
3	10.9
4	3.4
5	6.4
6	8.6
7	5.4

8	4.1
9	8.7
10	5.7
Average	6.5

Table 1 shows various delay variations that occurred during testing, the highest value of the DHT22 sensor delay reached 10.9 seconds, with the lowest delay reaching 2.8 seconds, from this test an average delay of 4.7 seconds was obtained.

Table 2. MQ135 I/O Delay

Trial	Input Output Delay (Seconds)
1	5.3
2	11.3
3	11.6
4	10.1
5	5.8
6	8.3
7	2.6
8	2.9
9	4.9
10	9.6
Average	7.2

Table 2 shows the MQ135 sensor delay test, the results show a fairly high delay, three trials reached a value of more than 10 seconds with the highest value of 11.6 seconds, with the lowest value reaching 2.6 seconds, the average value obtained on the MQ135 sensor was 7.2 seconds.

Table 3. GY302 I/O Delay

Trial	Input Output Delay (Seconds)
1	8.4
2	11.6
3	6.3
4	11.7
5	9.5
6	3.8
7	8.5
8	3.1
9	9.3
10	2.1
Average	7.4

Table 3 shows the results of the GY302 sensor delay test, the results show the highest average delay of all sensors, the highest delay value obtained on the GY302 sensor reached 11.7 seconds, where the lowest value obtained reached 2.1 seconds with an average delay of 7.4 seconds.

Signal strength greatly affects the duration of data transmission, all tests are carried out with the same signal quality, so that the data obtained is optimal.

4.2 Access Point Signal Strength Testing Against Main Board

The IoT system that is created is very dependent on the existence of an internet network, in this test the system will be observed for its ability to capture internet signals from access points, the system is tested at various distances as follows:

Table 4. Received Signal Strength

Distance (m)	Received Signal Strength (dBm)
2.5	-43
5	-48
7.5	-48
10	-59
12.5	-61
15	-65
30	-70
60	-77

Table 4 shows that the further the access point position, the worse the signal strength obtained, where the lowest signal strength was at -77dBm and the highest at -43dBm, in data transmission, poor signal strength will affect the duration of data transmission.

4.3 System Efficiency Testing

In this test the system is turned on for more than 24 hours, the result is that within 24 hours there is a moment where the main board stops communicating with the database, this moment can last for 30 to 40 minutes, the fastest way to handle this problem is to reboot the main board, but because during this period the main board cannot read commands from the database, the reboot must be done manually on the device.

CONCLUSION

Through the tests that have been carried out, the following conclusions can be drawn:

There are various ways and media to design a Poultry Cage Quality Monitoring System, one of which is using IoT technology, this system is designed in such a way as to be able to monitor the condition of the chicken coop by prioritizing user mobility through an application installed on a mobile device.

This IoT-based Poultry Cage Quality Monitoring System has taken into account the circadian cycle of laying hens, with this users can adjust the lighting in the cage better.

There are many ways to minimize the levels of ammonia gas in livestock pens, one of which is with a good sanitation and air control or ventilation system. The IoT-based Poultry Pen Quality Monitoring System can be used as an early warning system to predict changes in conditions in the pen.

The system is able to function very well, the system can send and receive data on the database via internet so that users always receive the latest data.

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