Design of Air Quality Monitoring Tool in Internet of Things (IoT) Based Chicken Coop

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Abstract: Chicken growth is greatly influenced by environmental factors that can affect the quality of chicken meat and eggs, such as temperature, humidity, and light intensity. This research aims to monitor the level of ammonia (NH3) in chicken coops with IoT technology via smartphone. This is necessary to maintain the right time for cleaning the chicken coop to improve health and productivity. The system generally consists of an mq-137 sensor for the ammonia gas sensor, an Arduino for the operator's brain or data processor, an LCD for ammonia gas output data, and the addition of a fan to make it more effective to suck ammonia gas in the area inside the cage. The mq-137 sensor data is in the form of ammonia gas that has been processed by Arduino, then connected to the internet network through the Wemos d1 mini-module to upload the sensor data to the Blynk application and can be monitored on a smartphone. The monitoring device system successfully provides cage cleaning information or an alarm to the breeder when the ammonia level exceeds 10 ppm. This tool effectively measures the change in ammonia levels in broiler chicken droppings with a maximum value of 11.45 ppm.

Keywords: *Ammonia, Chicken Coop, Internet of Things, Air Quality, MQ-137.*

1.0 INTRODUCTION

Broiler chickens are widely consumed, so many broiler chicken farms are currently growing very rapidly and have the highest demand compared to other types of poultry. The increasing demand for chicken meat by consumers will certainly lead to an increase in the broiler chicken population. The large demand for broiler chickens, and the increase in production will usually affect the pollution of dangerous gases, including ammonia (NH3) and methane (CH4). Chicken droppings that are piled up for a long time in large quantities will produce dangerous gases in the form of ammonia and methane gas (Patiyandela, 2013). Chicken manure mixed with the bedding and then undergoing a fermentation process will produce ammonia gas. The more chicken manure produced, the more ammonia gas will be released. One of the factors causing decreased productivity, including the death rate in chickens, is caused by high levels of ammonia gas in the cage (Renata et al., 2018). Based on government regulations regulated in Minister of Agriculture Decree No. 237/1991 and Minister of Agriculture Decree No. 752/1994 every large business is obliged to carry out environmental monitoring efforts on broiler chickens of more than 15,000 heads (DEPTAN, 1991)(DEPTAN, 1994).

A monitoring system for the dangerous gas ammonia in chicken coops that has been studied by several researchers is based on microcontrollers and the use of Internet of Things

technology to maximize monitoring (Supriyono et al., 2021)(Arifin et al., 2018)(Syarifudin et al., 2021). Automation system to control temperature, humidity, and ammonia levels in the cage by spraying cooling water and prebiotic fluid. In the spraying process, it is calculated using the fuzzy method to determine spraying decisions (Azis et al., 2023).

Based on the explanation above, ammonia gas is very dangerous for broiler chickens, so we need a tool that can monitor ammonia gas levels and can be monitored using IoT technology. With this system, it can be applied to broiler chicken coops to monitor air quality in chicken coops using smartphones.

2.0 LITERATURE REVIEW

The Effect of Ammonia on Animal Health

Excessive ammonia levels in chicken coops can affect the health of broiler chickens, leading to health problems and so on (Ritz et al., 2004). Triggers respiratory disease infections and reduces productivity, especially in chickens, due to the highly irritating power produced by ammonia gas. Ammonia levels can be detected by placing an ammonia measuring device about 10 cm from the bottom of the cage or at the level of the chicken's head. Following are some of the impacts on animal health of changes in ammonia levels(Zuprizal, 2009).

Table 2: Impact of ammonia levels on animal health.

Ammonia levels (ppm)	Impact
10	Mucous membranes, and chicken breathing are damaged
20	The lungs do not function normally
50-70	Decrease feed intake
100	Damage to the cornea of the eye and blindness
125	The respiratory tract is damaged, and productivity drops

source: Zuprizal, 2009

3.0 METHODOLOGY

The design of air quality monitoring for ammonia gas on chicken farms based on the Internet of Things includes software and hardware design. The designed system can also provide information regarding the status of ammonia gas levels in the broiler chicken cage. The input part of the block diagram is the reading of the MQ-137 sensor to detect ammonia gas (NH3) with specifications of 5 – 1000 ppm. The process part consists of MQ 137 sensor data in the

form of analog data which is processed to be able to read ammonia levels in ppm units. The use of an Arduino microcontroller in this research is to help process MQ 137 sensor data, because the Wemos d1 mini only has a maximum voltage of 3V for analog digital conversion (ADC). Next, the output section functions to display sensor data on the LCD, turn on the fan blower which functions to inhale the smell of chicken droppings, and forward the sensor data processed on the Arduino to the Wemos d1 mini with an I2C system and continue to the Blynk application. The block diagram of an air quality monitoring device in a chicken coop can be seen in Figure 1 below.

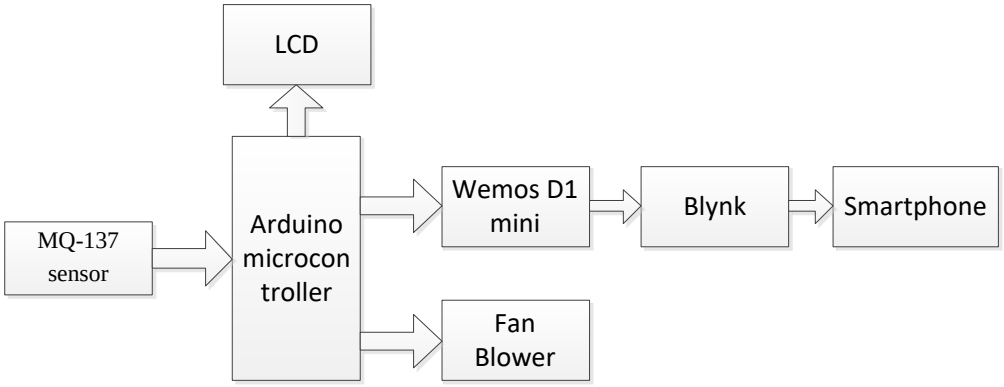


***Figure 1**: Block Diagram Design*

Software Design

Based on Figure 2, the workflow of the air quality monitoring system in the boiler chicken coop using the Internet of Things starts with initializing the sensors and LCD. Arduino processes the MQ 137 sensor analog data into ammonia data in ppm units and then displays it on the LCD. The MQ 137 sensor data is then forwarded to the Blynk application which can then be displayed on the smartphone. If the ammonia level is < 10 ppm, the LCDs character that the condition of the chicken coop is safe, and conversely if the ammonia level is > 10 ppm, the LCDs character that sometimes the chicken needs to be cleaned. This process continues to be repeated to monitor ammonia levels in broiler chickens in a safe condition.

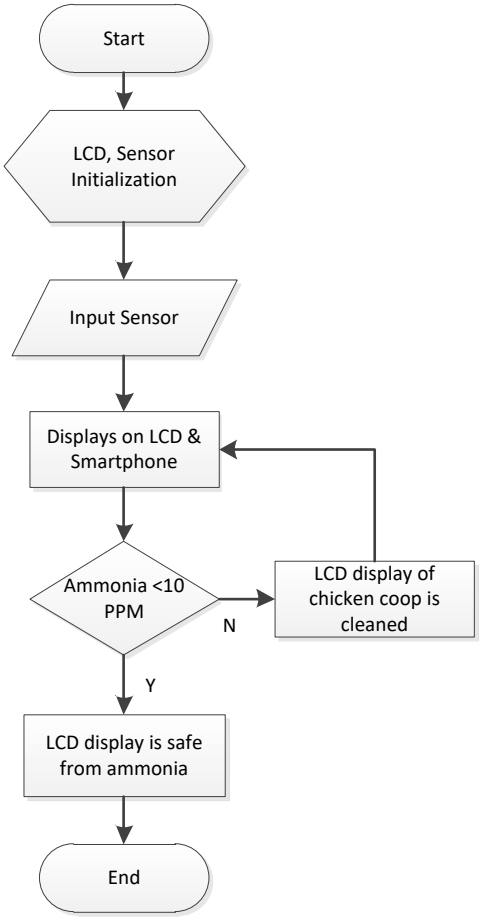
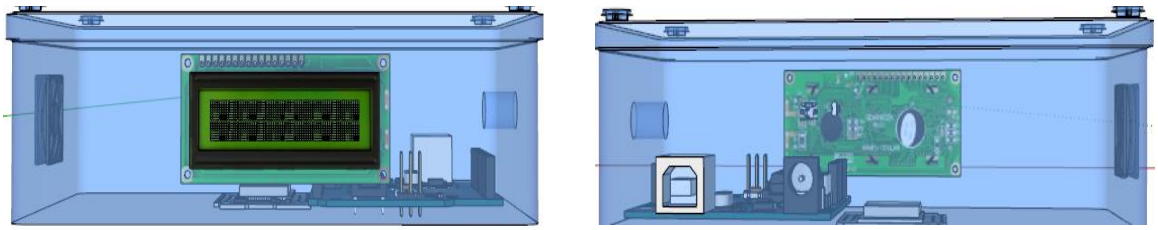


***Figure 2**: Flowchart of air quality monitoring system in broiler chicken coops*

Mechanical Design



(a) (b)

***Figure 3:** Design of air quality monitoring equipment in broiler chicken coops, a. Front view, b. Back view*

The tool design system in this research measures 18x11x6 cm, set in such a way that all the electronic circuits fit in one box. Some of the components included in the box include the MQ-137 sensor, Arduino Uno, LCD, Wemos d1 mini, and fan blower. This design is used as a reference for the process of making this tool. The design of the air quality monitoring tool in the chicken coop can be seen in Figure 3.

4.0 DATA ANALYSIS AND FINDINGS

Measurement and testing of air quality monitoring tools in chicken coops based on the Internet of Things aims to determine the extent to which the tools can work well according to the design system. The tools that have been made can be seen in Figure 4. Some information in the picture is (1) LCD, (2) Arduino Uno, (3) MQ-137 Sensor, Wemos d1 mini, and (5) Blower Fan.

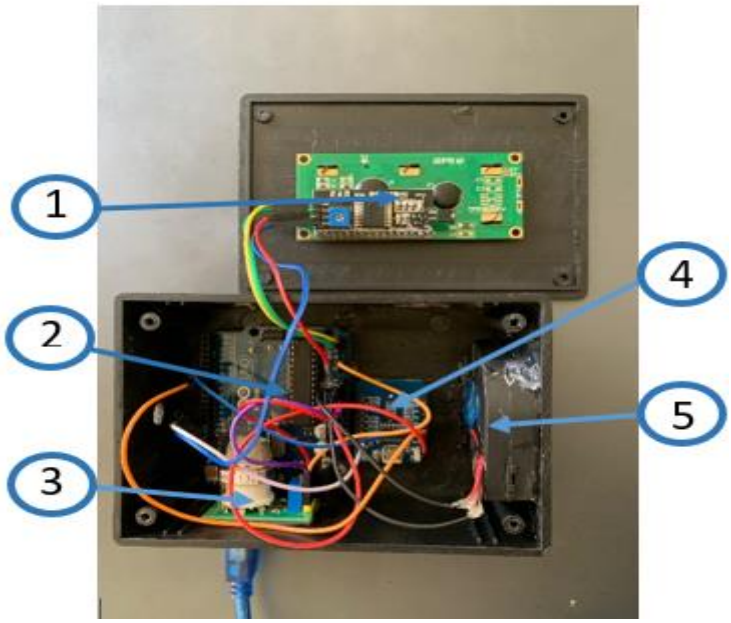


Figure 4: *Photo Setup of an IoT-based air quality monitoring system in a chicken coop.*

Testing of the MQ-137 sensor on changes in broiler chicken manure aims to determine the level of the sensor's ability to detect the ammonia gas content in broiler chicken manure for each addition of 500 - 3000 grams of chicken manure placed in the testing container. The test results show that the more chicken manure, the higher the measured ammonia level value. The test results can be seen in Table 2 and Figure 5.

Table 2: Test results of the MQ-137 sensor on changes in chicken manure.

No	Chicken manure (gram)	Concentration ammonia (ppm)
1	500	8.28
2	1000	9.48
3	1500	10.69
4	2000	11.08
5	2500	11.34
6	3000	11.49

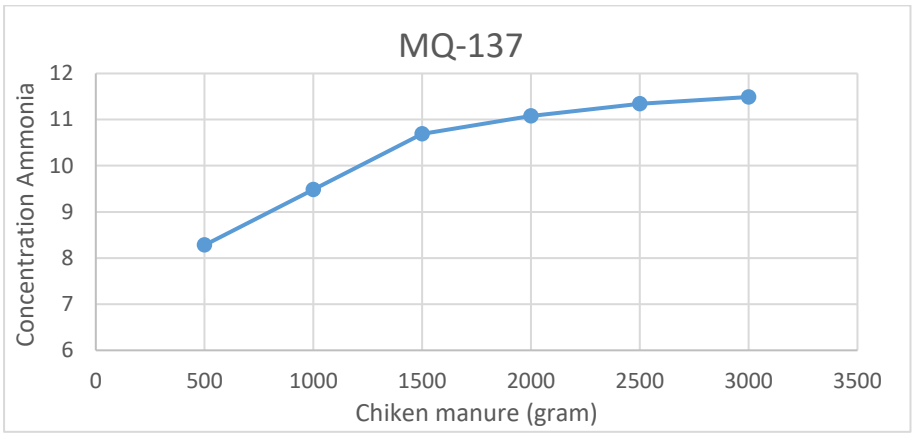
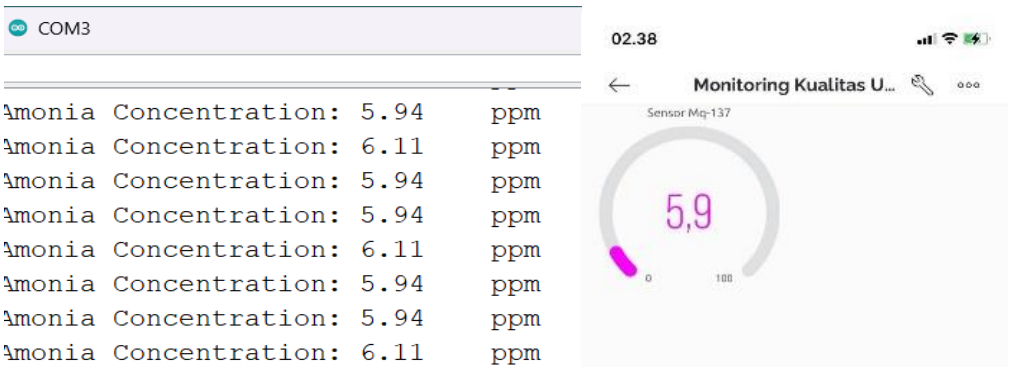


Figure 5: *Graph of Ammonia Measurement Results in Broiler Chicken Manure*

The function of testing sending sensor data from the Wemos d1 mini to Blynk is to see whether the data sent in real-time has the same results between the Wemos d1 mini and what Blynk receives. From the test results on the Wemos d1 mini serial monitor, the data matches the display on the Blynk application which can be seen on the smartphone. The test results for sending Wemos d1 mini data to the Blynk application can be seen in Figure 6.



(a) (b)

Figure 6: *Display (a) Wemos d1 mini serial monitor, (b) Blynk on smartphone*

The overall test results in Figure 7 have also been tested directly in broiler chicken coops in Lampageu Village, Peukan Bada District, Aceh Besar. From the results of the placement of the tool, the tool can display ammonia levels in PPM form. This is very helpful for broiler chicken breeders in monitoring and cleaning chicken coop droppings.

Figure 7: *IoT-based air quality monitoring tool in chicken coops*

5.0 CONCLUSIONS

Based on the test results and analysis of the monitoring system created, several conclusions were obtained, namely that the MQ-137 sensor was able to detect the ammonia gas content produced from broiler chicken droppings of 8.24 ppm – 11.49 ppm. Apart from that, air quality monitoring equipment in chicken coops has been placed by broiler chicken farmers. This helps broiler chicken farmers monitor the cleaning of chicken droppings to improve health and productivity.

REFERENCES

Arifin, M. N., Hannats, M., Ichsan, H., & Akbar, S. R. (2018). Monitoring Kadar Gas Berbahaya Pada Kandang Ayam Dengan Menggunakan Protokol HTTP Dan ESP8266. *Jurnal Pengembangan Teknologi Informasi Dan Ilmu Komputer*, *2*(11), 4600–4606. https://j-ptiik.ub.ac.id/index.php/j-ptiik/article/view/3020

Azis, T. A. I., Rosikin, M. K., & Amalia, N. (2023). Implementasi Sistem Otomatisasi Monitoring Suhu, Kelembapan, dan Amonia pada Kandang Ayam Petelur Menggunakan Metode Fuzzy. *Jurnal Pendidikan Informatika Dan Sains*, *12*(1), 1–10.

DEPTAN. (1991). *Surat Keputusan Menteri Pertanian, SK Mentan No. 237/Kpts/RC. 410/1991, Departemen Pertanian RI, Jakarta*.

DEPTAN. (1994). *Surat Keputusan Menteri Pertanian. SK Mentan No. 752/Kpts/OT.210/10/94. Departemen Pertanian RI, Jakarta.*

Patiyandela, R. (2013). *Kadar NH3 dan CH4 serta CO2 dari Peternakan Ayam Broiler pada Kondisi Lingkungan dan Manajemen Peternakan yang Berbeda di Kabupaten Bogor. Institut Pertanian Bogor*.

Renata, R., Sarjana, T. A., & Kismiati, S. (2018). Pengaruh zonasi dalam kandang closed house terhadap kadar amonia dan dampaknya pada kualitas daging broiler di musim penghujan. *Jurnal Ilmu-Ilmu Peternakan*, *28*(3), 183. https://doi.org/10.21776/ub.jiip.2018.028.03.01

Ritz, C. W., Fairchild, B. D., & Lacy, M. P. (2004). Implications of ammonia production and emissions from commercial poultry facilities: A review. *Journal of Applied Poultry Research*, *13*(4), 684–692. https://doi.org/10.1093/japr/13.4.684

Supriyono, H., Suryawan, F., Bastomi, R. M. A., & Bimantoro, U. (2021). Sistem Monitoring Suhu dan Gas Amonia untuk Kandang Ayam Skala Kecil. *ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika*, *9*(3), 562. https://doi.org/10.26760/elkomika.v9i3.562

Syarifudin, S., Mubarok, R., & Armin, E. U. (2021). Rancang Bangun Sistem Monitoring Suhu dan Pakan Pada Kandang Ayam Berbasis Internet of Things mengunakan NODEMCU ESP8266. *Journal of Electronic and Electrical Power Application*, *1*(2), 29–35.

Zuprizal. (2009). *Menyiasati Bau Tak Sedap dari Kandang.Trobos Edisi 257*.