

IoT-based temperature, humidity, and ammonia control system for chicken coop

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ABSTRACT

This research has designed and developed an integrated IoT (Internet of Things)-based system for controlling temperature, humidity, and ammonia levels in chicken coops. The study involved several experiments to test the functionality and effectiveness of the built system. Based on the results obtained from the assembly process, programming, device construction, and comprehensive system testing, it can be concluded that this control system application is effective in improving farmers' work efficiency. The automated waste removal is capable for lowering ammonia levels, minimizing manual labor, and efficiently saving time. Furthermore, this device functions to monitor and maintain the temperature for the livestock inside the coop. The device, with inputs and outputs from DHT-22 and MQ-135 sensors, an ESP32 microcontroller, a heating element, a conveyor, and a DC motor, has been successfully operated and proven effective in regulating temperature and ammonia gas levels in chicken coops.

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1. INTRODUCTION

In today's world, technological progress has occurred very rapidly. More and more technology companies are building systems that can help work and even simplify daily human activities. Microcontrollers are devices in the field of electronics and computer technology that can perform various tasks programmed by programmers. Currently, microcontroller systems are developing very rapidly, and some of them can control electronic systems connected via smartphones. This technology originates from the Internet of Things (IoT). The livestock sector is one example of the use of this system [1]. To achieve good production results, chicken farms require regular temperature control. The ideal coop temperature for chickens varies depending on their age. The coop temperature must be adjusted to the chicken's growth phase, or generally. If the coop temperature is not increased according to the chicken's age, the chicken's environmental temperature will gradually decrease [2]-[4]. Farmers and chicken farm managers can use this coop temperature data as a basis for deciding what to do to maintain a comfortable coop temperature for the chickens. Temperature monitoring based on estimates without quantitative data tends to be less accurate. Temperature monitoring based on measuring instruments and recorded manually will require a dedicated person to perform the task of reading and recording temperatures, and this will also be quite time-consuming [5]. Utilizing IoT to monitor and control barn conditions has many advantages. To maintain the health and productivity of livestock, it is important to properly monitor temperature, humidity, and ammonia levels [6]-[10].

Several studies have been conducted on temperature, humidity, and ammonia gas control, including one conducted by [11] concerning the control and monitoring of ammonia gas in chicken farms. This study used an Arduino Mega as the microcontroller; however, this study encountered a limitation due to the inability to monitor remotely. Subsequent research was conducted by [12], using a temperature and humidity monitoring

device. This study used an Arduino Uno as the microcontroller and a DHT11 sensor to detect temperature. This study, however, still used a 16x2 LCD to display the data obtained from the sensor. Research conducted by [13] included a temperature measuring device using an infrared sensor and a temperature detection alarm. A limitation was the slow data transmission from the infrared sensor. Research conducted by [14] included a temperature and ammonia gas monitoring system in chicken coops. This study used an Arduino Pro Mini as the microcontroller; however, this study used the DHT11, which lacked accuracy in temperature detection. Research conducted by [15] included a prototype for ammonia gas control in broiler chicken farms. This study used the ESP8266 module as a microcontroller. The problem with this study was the lack of a temperature detector to stabilize the ambient temperature in the barn.

Based on the results of previous studies that still had several shortcomings and obstacles, such as the lack of sensor accuracy and only being displayed on a small LCD that could not be monitored remotely. Therefore, a tool was developed that is easier to monitor for farmers to save on livestock maintenance costs.

2. METHOD

Design is a crucial initial stage in the process of creating a temperature, humidity, and ammonia control system for a chicken coop. At this stage, a thorough analysis of the needs and conditions in the field is conducted to determine the appropriate equipment specifications. The purpose of this design is to provide a clear picture and thorough calculations regarding how the equipment can be designed, manufactured, and implemented effectively. Furthermore, this design also aims to ensure that the equipment developed can function optimally in the harsh and varied environment of the chicken coop and can adapt to dynamic operational needs.

This design stage also involves selecting the appropriate technology and materials to ensure long-term durability. The design process must consider the entire life cycle of the equipment, from initial design through testing to maintenance, to ensure that the equipment not only functions well at the outset but also remains reliable over the long term. Furthermore, the design also focuses on how the equipment can provide added value to farmers. With accurate, real-time temperature, humidity, and ammonia data, farmers can make more timely and informed decisions, ultimately improving productivity and animal welfare. Therefore, the design phase must consider user-friendliness and ease of integration with existing systems on the farm. Through careful planning, the author will develop an innovative system for controlling temperature, humidity, and ammonia levels in chicken coops. This tool is designed to improve coop management efficiency and reduce the workload of farmers. The development of this tool in this final project begins with the development of hardware and software.

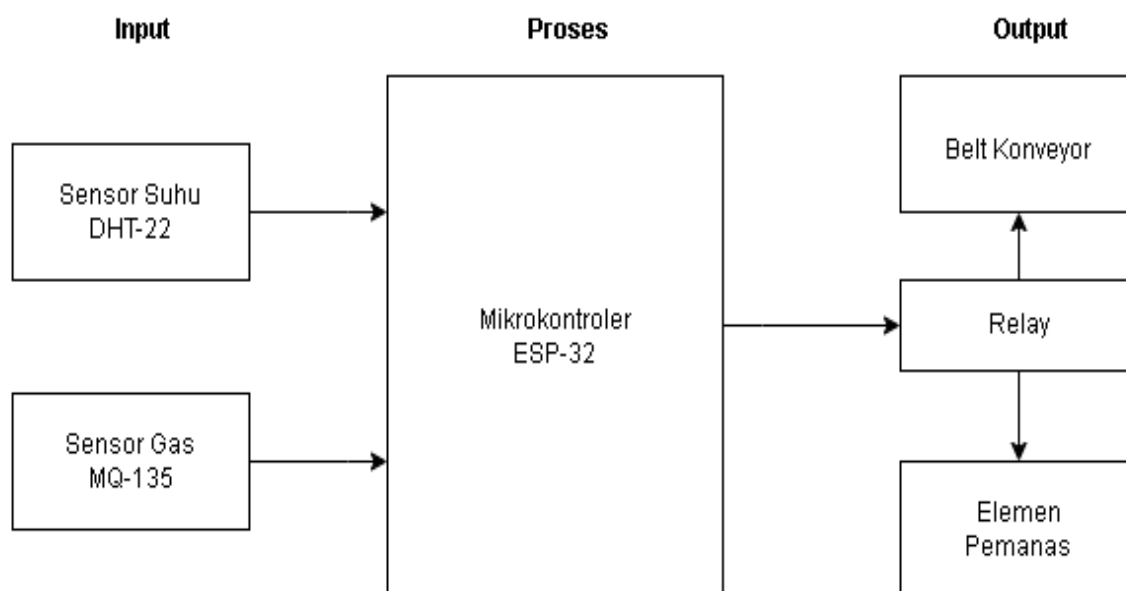


Figure 1. Block Diagram

The ESP32 microcontroller is a very popular and versatile microcontroller device, designed by Espressif Systems. The ESP32 is known for its powerful combination of features, including high processing

power, good wireless connectivity, and a wide range of peripheral options. The ESP32 is a very flexible and powerful microcontroller, suitable for a variety of applications that require data processing, wireless connectivity, and device control. This combination of features makes it a popular choice among developers and researchers in various technology fields. This IoT-based remote temperature, humidity, and ammonia control system works by integrating various components. The ESP32, which acts as a control center, connects to a WiFi network to send and receive data from the Blynk application accessed via a smartphone. The DHT22 sensor measures temperature and humidity, while the MQ-135 sensor detects ammonia concentration levels in the air. Data from these two sensors is forwarded to the ESP32, which then processes the information and sends it to the Blynk application for real-time monitoring. Relays are used to control electrical devices such as heating elements and conveyors based on data received from the sensors. If the temperature or ammonia concentration exceeds a predetermined limit, the ESP32 activates a relay to turn on the conveyor or heating element. The heating element can be used as an indicator or to increase the temperature in the coop, while the conveyor functions to reduce the ammonia gas concentration by removing chicken waste. The ESP32 is programmed via a PC using the Arduino IDE, which is also used for monitoring and debugging the system.

The Blynk smartphone app allows users to monitor temperature, humidity, and ammonia concentration in real time, as well as remotely control heating elements and conveyors. Users can manually turn devices on or off through the app or set the system to operate automatically based on sensor data. If abnormal environmental conditions occur, such as excessively high temperatures or dangerous ammonia concentrations, the Blynk app will send a notification to the smartphone, allowing users to take necessary action, such as turning on the conveyor. The system is designed to operate automatically and can be monitored and controlled remotely, ensuring a safe and comfortable environment.

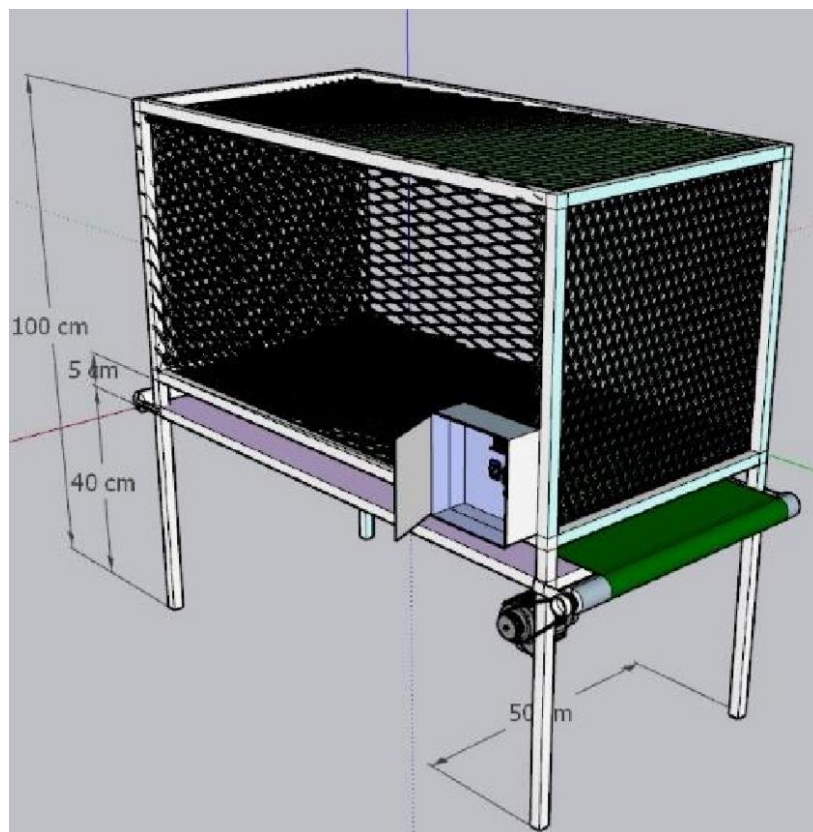


Figure 2. 3D Design

Figure 2 is a three-dimensional representation of an IoT-based temperature, humidity, and ammonia control device, providing a bird's-eye view from all angles. This 3D design clearly shows the dimensions, shape, and details of each component, helping to understand how the device will look and function in the real world, as well as how each component interacts with each other to form an efficient system.

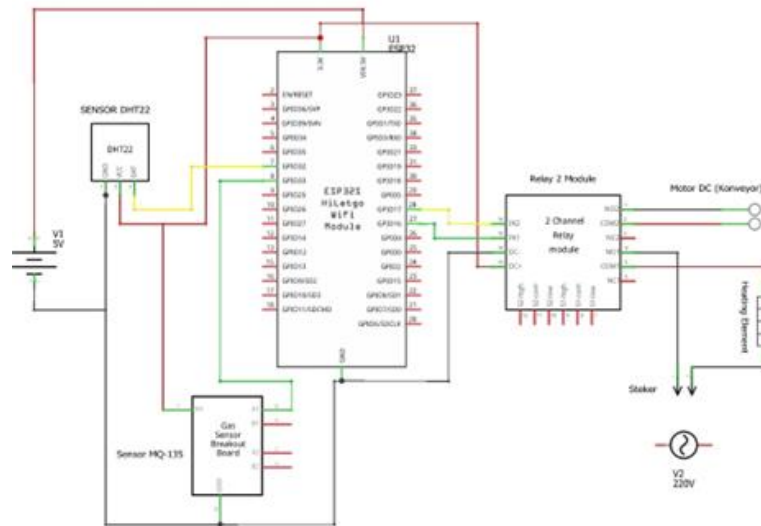


Figure 3. Overall series of tools

Figure 3 shows the overall design of the tool, which aims to determine the connection of each pin on the components used in this final project. After the hardware design stage, the next stage is the software design stage, which includes a flowchart. A flowchart presents the sequential actions and options required to execute a process in a computer program. The primary purpose of this diagrammatic representation is to provide a complete picture of how the program progresses from one process to another.

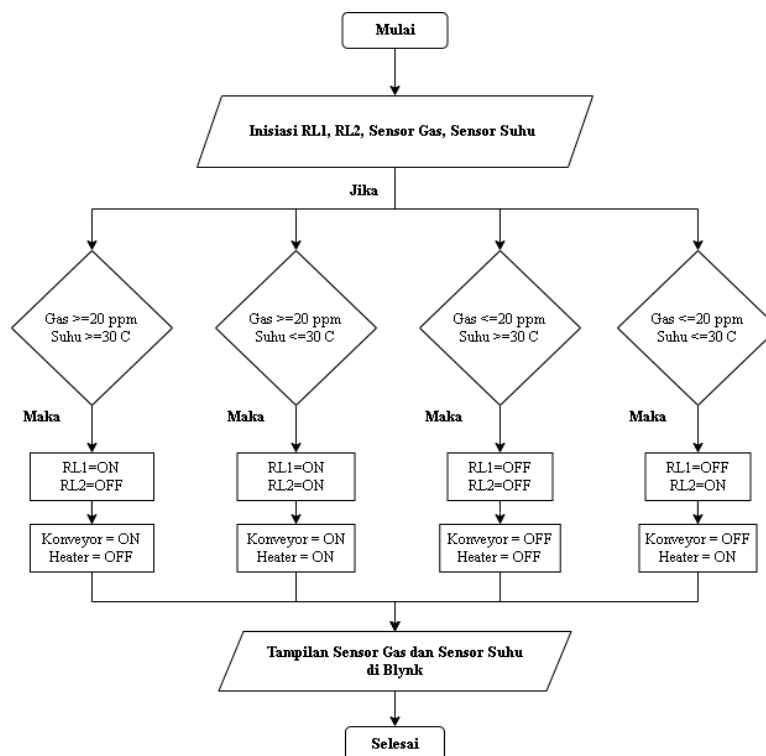


Figure 4. Flowchart

Figure 4 shows the steps of the program designed in this study, which begins with system initialization, where hardware such as the ESP32 microcontroller, temperature sensors, and gas sensors are activated. After initialization, the system enters a main loop that runs continuously as long as the system is powered on. Within the main loop, the system first reads the adjusted temperature data, which is then analyzed to determine whether the temperature and ammonia levels are within acceptable ranges.

3. RESULTS AND DISCUSSION

This tool was tested to obtain concrete data and evidence that the hardware and software were working properly. The results of the hardware design for the entire automatic feces disposal system for chicken farms can be seen in the figure. The design includes the shape and layout of the components used in the tool, such as the ESP32, temperature sensor, gas sensor, heating element, 24-volt DC motor, and conveyor belt.



Figure 5. Overall design of the tool

Figure 5 shows the design results of an IoT-based temperature and ammonia control device that essentially uses iron as the main frame and uses iron wire mesh as a protective layer on the top, base, and sides. There is a main part, namely the conveyor belt, which uses iron material on the tubes on both sides and uses conveyor cloth as a base for collecting the waste.

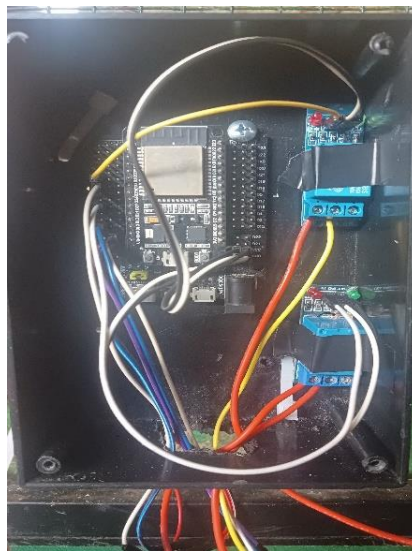


Figure 6. Results of a series of hardware designs

Figure 6 above shows the complete circuit of this device. This circuit is arranged in a box so that it is well-organized and allows farmers to easily control or repair it if any problems arise. After the design phase, the next stage is testing the components used in the IoT-based temperature and ammonia control device. The purpose of this component testing is to ensure and analyze whether all components of the system are functioning properly according to their respective functions.

Table 1. Temperature Sensor Testing

Day th-	Time	Temperature ($>30^{\circ}\text{C}$)	Humidity	Element Status Heating
1	08.00	28 $^{\circ}\text{C}$	60%	Active
	12.00	30 $^{\circ}\text{C}$	65%	Non-active
	14.00	26 $^{\circ}\text{C}$	55%	Active
	17.00	31 $^{\circ}\text{C}$	63%	Non-active
2	08.00	26 $^{\circ}\text{C}$	58%	Active
	12.00	32 $^{\circ}\text{C}$	60%	Non-active
	14.00	25 $^{\circ}\text{C}$	59%	Active
	17.00	28 $^{\circ}\text{C}$	57%	Active
3	08.00	26 $^{\circ}\text{C}$	57%	Active
	12.00	26 $^{\circ}\text{C}$	60%	Non-active
	14.00	26 $^{\circ}\text{C}$	62%	Non-active
	17.00	26 $^{\circ}\text{C}$	59%	Non-active

In table 1 above, it can be seen that this tool can warm the cage automatically if the temperature pen is at under 30 $^{\circ}\text{C}$. The minimum temperature limit can be set as desired. breeders, because offspring chickens need warmer air from chicken adult because of feathers from offspring chicken is thinner than chicken mature

Table 2 Gas Sensor Testing

Measurement Time	O'clock	Gas Concentration (Ppm)	Disposal Status
07-06-2025	08.00	24 ppm	Active
	12.00	16 ppm	Non-active
	14.00	22 ppm	Active
	17.00	18 ppm	Non-active
08-06-2025	08.00	17 ppm	Non-active
	12.00	25 ppm	Active
	14.00	12 ppm	Non-active
	17.00	18 ppm	Non-active
09-06-2025	08.00	23 ppm	Active
	12.00	14 ppm	Non-active
	14.00	17 ppm	Non-active
	17.00	19 ppm	Non-active

The test results in Table 2, gas concentration measurement data can be presented, when the gas concentration shows above 20ppm then conveyor will be active to dispose of accumulated dirt in the cage. The manure that has been accumulation can create high gas concentrations so that it makes chicken easy stress that can affect the quality of chicken. Below you can see the graph comparison from temperature sensor testing.

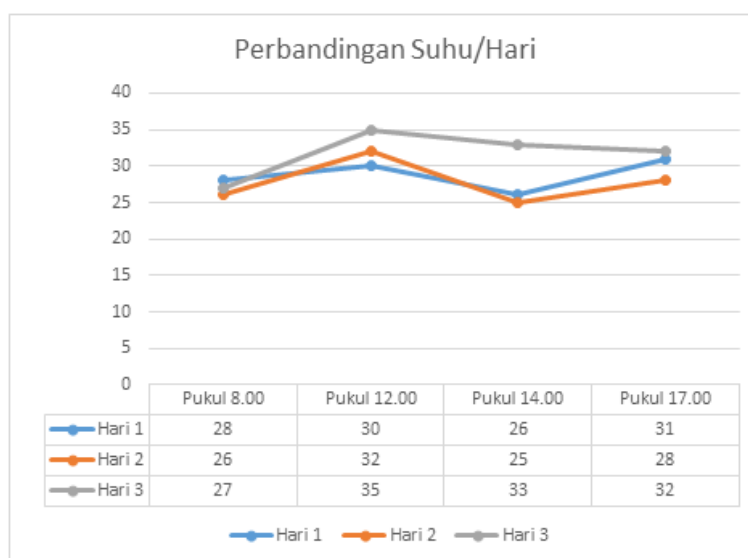


Figure 7. Temperature Comparison Graph

Based on the temperature comparison graph from three different times, data analysis shows that on the first day of the temperature test, the peak temperature reached 31°C at 5:00 PM WIB, and on the second day, the highest point reached 32°C at 12:00 PM WIB, while on the third day, it reached 35°C at 12:00 PM WIB. This comparison shows that the temperature inside the cage fluctuates due to one factor, namely the weather. Weather is the biggest factor influencing the temperature in the cage. The following is a comparison graph of the gas sensor test.

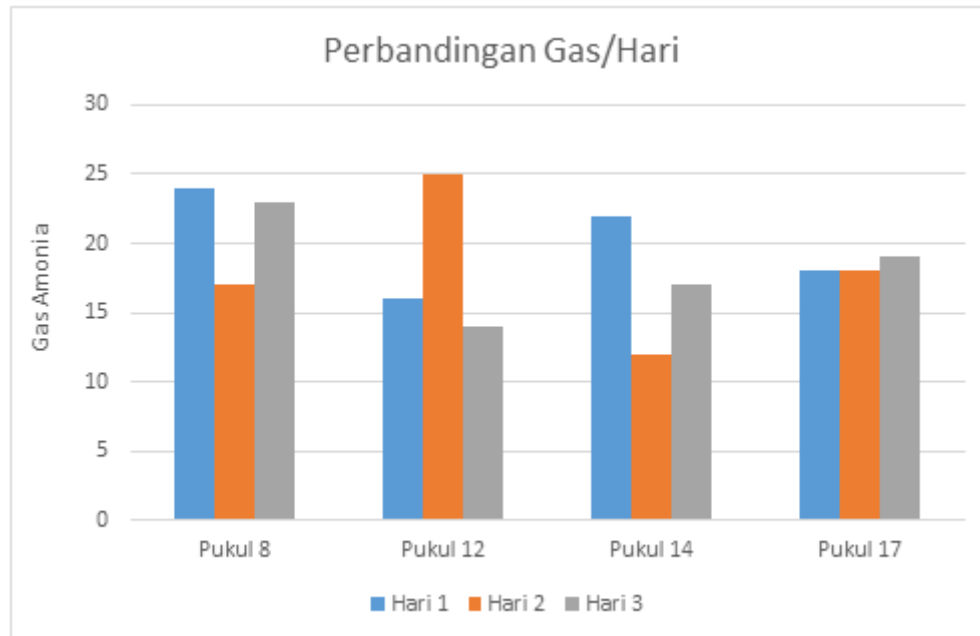


Figure 8. Gas Sensor Comparison Chart

Based on the comparison graph of ammonia gas from 3 different days, data analysis shows that in the first day of ammonia gas testing, the peak concentration of ammonia gas occurred at 08.00 WIB reaching 24 ppm and on the second day the highest point reached 25 ppm while the third day reached 23 ppm at 08.00 WIB. With this comparison, it can be seen that each level of ammonia gas obtained is different. This indicates significant fluctuations over time that can be influenced by various factors, such as environmental conditions, the amount of waste produced.

Table 2 Temperature and Gas Sensor Testing

Measurement Time	O'clock	Temperature	Status Element Heating	Gas Concentration (Ppm)	Disposal Status
07-06-2025	08.00	28 °C	Active	24 ppm	Active
	12.00	30 °C	Non-active	16 ppm	Non-active
	14.00	26 °C	Active	22 ppm	Active
	17.00	31 °C	Non-active	18 ppm	Non-active
08-06-2025	08.00	26 °C	Active	17 ppm	Non-active
	12.00	32 °C	Non-active	25 ppm	Active
	14.00	25 °C	Active	12 ppm	Non-active
	17.00	28 °C	Active	18 ppm	Non-active
09-06-2025	08.00	27 °C	Active	23 ppm	Active
	12.00	35 °C	Non-active	14 ppm	Non-active
	14.00	33 °C	Non-active	17 ppm	Non-active
	17.00	32 °C	Non-active	19 ppm	Non-active

The data analysis in the table shows how the system can monitor temperature and gas levels in real time and control the output of the heating element and conveyor based on the detected conditions. The heating element turns on based on the temperature of the cage. If the temperature is below 30°C, the element will automatically turn on and will deactivate if the temperature is above 30°C. Like the heating element, the conveyor will turn on based on the gas concentration in the cage. If the gas concentration is above 20 ppm, the conveyor will automatically turn on and will deactivate if the gas concentration is below 20 ppm.

4. CONCLUSION

Based on the results of the assembly, programming, tool making, testing and testing of the IoT-based temperature, humidity and ammonia control system in the chicken coop that has been carried out, it can be concluded that the application of the IoT-based temperature, humidity and ammonia control system has proven effective in simplifying the work of farmers by automating the process of removing manure to reduce ammonia levels, thereby reducing manual workload and saving time. This system also functions to monitor the temperature to maintain the comfort of livestock in the coop. Therefore, the use of sensors, conveyors and heating elements as the main input and output on this tool has proven to be able to work effectively in regulating the temperature and ammonia gas levels in the coop.

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