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SMART CHICKEN FARM MONITORING AND INTERNET OF THINGS-BASED AUTOMATION SYSTEM

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A B S T R A C T

The use of intelligent technology in the modern era is widely used in all types of work. Technological developments in the livestock sector are so rapid, for example, with smart farming. Boiler chickens require temperatures of 29 – 35oC and humidity of 60 – 70% to maintain the life span and quality of the chickens. This study aims to build a Smart Chicken Farm monitoring system with automatic control based on the Internet of Things (IoT) with the fuzzy mamdani method as a decision-making system and mobile-based applications as monitoring media. After carrying out the testing process 5 times, the value generated from the sensor with fuzzy mamdani logic as decision making gives very good results characterized by no errors during the decision making process by fuzzy logic in setting ON and OFF on fans and heating lamps to maintain quality of temperature and humidity in smart chicken farm. The process of controlling and monitoring the smart chicken farm is applied in the form of a mobile-based application and runs well.

Keywords: Internet of Things (IoT), Fuzzy Mamdani, Smart Chicken Farm and Mobile Application.

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1. Introduction

The use of smart technology in the modern era is widely used in all types of work, such as animal husbandry, traffic safety and medical. The rapid development of technology in the field of animal husbandry creates a change in the process. For example, in the chicken farming system, a closed livestock system has begun to be implemented with complete technology that is more directed towards smart farming due to the high demand for chickens [1]–[7].

Chickens are warm-blooded animals. The temperature needed by chicks is 29-35°C with humidity of 60-70%. Chicken coops greatly affect the quality of chickens with the criteria needed by a good chicken coop, namely getting light from the morning sun and not against the wind and good air circulation. Lighting and heating of the cage also need attention [8]–[17].

Broiler chickens are a type of chicken produced from a combination of cultivation and technological developments with a distinctive feature, namely a very fast growth process. The thing that needs to be considered in raising livestock is maintaining environmental maintenance by maintaining temperature and humidity in the chicken coop so that the chickens are not stressed resulting in decreased quality of the chickens [18]–[26].

The Internet of Things (IoT) is a network connection with devices and sensors that store and exchange information with each other. There are so many benefits of IoT including communication, automation so that the flow of information requires less effort and time usage. IoT makes a big innovation for human survival, one of which is as a supporting role in the world of work to maximize the level of work efficiency [27]–[53].

In the study of Idofitraramadhan et al. by the title "Perancangan Smart System Ternak Ayam berbasis IoTmengunakan Arduino UNO [IoT-based Smart System Design for Chicken Livestock using Arduino UNO]" get results that are in accordance with what is expected but in application, the system is still in web form and does not apply methods in making decisions in the implementation process [54].

This research will use the mamdani fuzzy logic method to make intelligent control in making decisions to adjust the fan and lights to maintain humidity and temperature. While the system implementation will be applied to a mobile-based application so that it is more practical in carrying out the process of monitoring temperature and humidity in chicken coops and the use of IoT in the development of the world of technology can help the success rate of chicken farmers in their livestock process.

2. Methods

2.1. Data Collection Techniques

Smart Chicken Farm Monitoring and Control of Internet of Things (IoT) Based Automation Systems is a tool used to help chicken farmers to manage chicken farms automatically. Mamdani Fuzzy Logic is used to determine the grouping of categories based on the range of values of the temperature in the chicken coop. If the temperature of the chicken coop is

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at a value of 0 – 20oC with humidity of 0 – 20%, then the chicken coop belongs to the cold temperature category with very less humidity, so the temperature needs to be increased. If the temperature in the chicken coop is at a value of 21 – 25oC with humidity of 21 – 40%, then the temperature is classified as cool and the humidity is lacking so the temperature and humidity need to be increased again. If the temperature in the chicken coop is 26 – 30oC with humidity 41 – 60%, then the temperature and humidity are in the normal category so that this range keeps the chickens from stressing so it helps maintain the quality of the chickens. However, when it is above the 30oC range for temperature and 60% for humidity, it needs to be lowered again so that the temperature and humidity return to normal. How the system works will be explained in Fig. 1. and Fig. 2.

Figure 1. Flowchart System

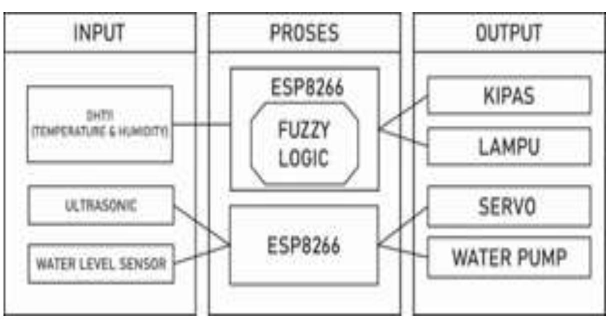

Figure 2. System Workflow

2.2. Database Design

The database to be built in this study is as follows :

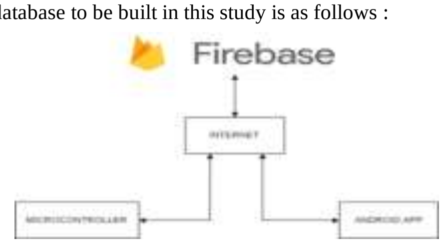

Figure 3. Database Design

The designed Android-based application will use Firebase as the database system. The microcontroller will provide monitoring data and display it in the Android application via Firebase as a Google product that provides realtime database services. here is the workflow :

1. The microcontroller used is ESP32/ESP8266 with the advantage of having a WI-FI module.
2. The arduino firebase library is used as a microcontroller connection protocol with firebase.
3. The microcontroller will send monitoring data to firebase using a WI-FI connection
4. Firebase sends monitoring data to the android application. Conversely, when the operator performs an order, it will be sent to the database and then to the plant, which will be processed by the controller.

2.3. Software System Design

The system will be implemented using an Android-based application with a design like Fig. 4.

Figure 4. Software System Design

Fig. 4. Is a design plan of the application to be made. Here is an explanation :

1. DHT11 = provides humidity and temperature information on the plant shown in monitoring temperature and humidity.
2. Water sensor = provides water level data in the water container, with a water level sensor.
3. Feed sensor = using an ultrasonic sensor to detect feed height for an automatic feed system.
4. Switch = used to activate and deactivate or perform actions on the plant.

2.4. Hardware Design

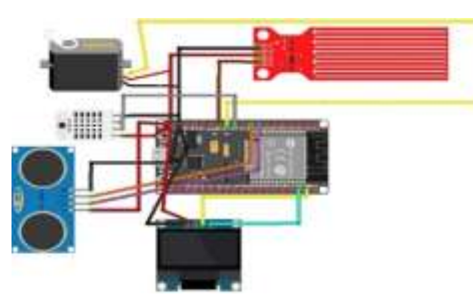

Figure 5, Hardware Design

Fig. 5. Is a circuit schematic and system prototype design. The microcontroller used is the ESP8266 which is a WI-FI module as well as a device that can work as a microcontroller and can be programmed using the Arduino IDE software. The input consists of a DHT11 sensor, Water Level

Sensor and Ultrasonic. While the output consists of an OLED integrated with I2C, a fan and a lamp as a heater connected to a relay. The connections used to connect components with the ESP8266 are as follows :

Table 1. Pin Every Compenent

***PIN* ESP8266**	**DHT11**	***Ultrasonic***	**OLED I2C**	***Water Level***	***Servo***	***Relay***
VCC	VCC	VCC	VCC	VCC	VCC	VCC
GND	GND	GND	GND	GND	GND	GND
SDA			SDA			
SCL			SCL			
PIN DIGITAL	2	5,6		7	8	10,11,12

3. Result

3.1. System Implementation

Smart Chicken Farm Monitoring and IoT-Based Automation Systems apply fuzzy mamdani logic with a system focus on controlling smart chicken farms automatically. Mamdani fuzzy logic is useful in the decision-making process to control fans and lights automatically which aims to maintain temperature and humidity.

The fuzzification process on the DHT11 sensor input is temperature and humidity and will be converted into a fuzzy variable consisting of input and output. Implementation in this IoT-Based Smart Chicken Farm Monitoring and Automation System, the temperature variable is the result of DHT11 which is divided into four membership functions, namely cold, cool, normal and hot. Fig. 6. Is a membership function rather than temperature.

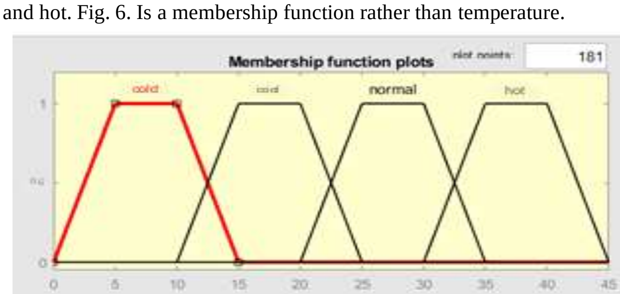

Figure 6. Temperature Category

The DHT11 temperature input value membership function is formed from a trapezoidal curve representation. Because the range used is more than 2 variables and the temperature value is from 0 to the variable input limit set by DHT11, namely 45oC. The following is the value of the temperature membership parameter :

Table 2. Temperature Fuzzy Membership DHT11

NO	MEMBERSHIP FUNCTION	PARAMETERS VALUES
1	Cold	[0 5 10 15]
2	Cool	[10 15 20 25]
3	Normal	[20 25 30 35]
4	Hot	[30 35 40 45]

Then, the input of the humidity value from the DHT11 sensor is formed using the same representation as the temperature, namely the trapezoid as can be seen in Fig. 7.

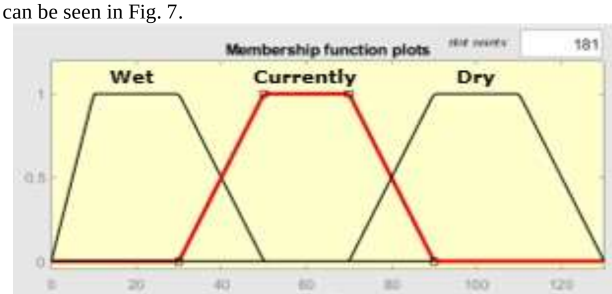

Figure 7. Humidity Category

Fig. 7. Visualize that the humidity input value from the DHT11 sensor has a value from 0 to an input limit of 130. The membership functions formed are Wet, Medium and Dry.

Table 3. DHT11 Moisture Fuzzy Membership

No.	MEMBERSHIP FUNCTION	PARAMETERS VALUES
1	Wet	[0 10 30 50]
2	Currently	[30 50 70 90]
3	Dry	[70 90 110 130]

The output generated from fuzzy logic is to turn on and turn off actuators in the form of fans and lights. Following is the membership function of the fan output in Fig. 8.

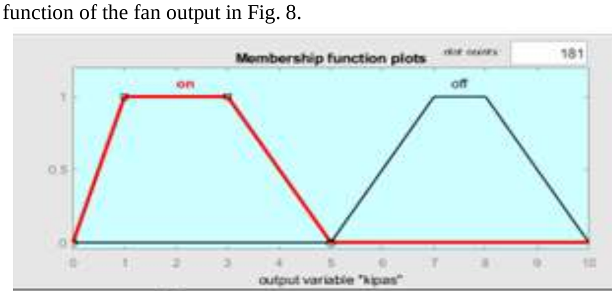

Figure 8. Fan Membership Function

In addition to the output from the fan, this system also has an output value from the heating lamp whose membership function is shown in Fig. 9.

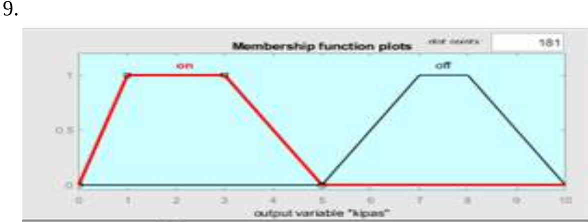

Figure 9. Lamp Membership Function

Fans and heating lamps have the same limits, namely at a value of 0 to 10. Values 0 – 5 are used for the turning on process, while values 5 – 10 are used for turning off the acuator. The values of these parameters are represented in Table 4.

Table 4. Membership Functions of Fan and Heater Lamp

NO.	MEMBERSHIP FUNCTION	PARAMETER VALUE
1	On	[0 1 3 5]
2	Off	[5 7 8 10]

After going through the fuzzification stage, a rule evaluation is needed to compare the fuzzy input with the fuzzy rule base. The method used is IF-THEN whose arrangement is the same as IF and AND which produces THEN. The following is the arrangement of fuzzy logic :

Table 5. Rule Base

NO	TEMPERATURE	HUMIDITY	FAN	HEATING
1	Cold	Wet	OFF	ON
2	Cold	Currently	OFF	ON
3	Cold	Dry	ON	ON
4	Cool	Wet	OFF	ON
5	Cool	Currently	OFF	ON
6	Cool	Dry	ON	ON
7	Normal	Wet	OFF	ON
8	Normal	Currently	OFF	OFF
9	Normal	Dry	ON	OFF
10	Hot	Wet	ON	ON
11	Hot	Currently	ON	OFF
12	Hot	Dry	ON	OFF

3.2. Test Analysis

To analyze the data, a test was carried out to obtain an accurate value on the DHT11 sensor input and to implement mamdani fuzzy logic against the established rule base. The test was carried out using an application from MATLAB with 5 trials.

1. First Test

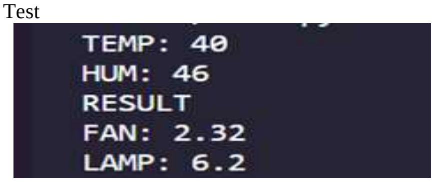

Figure 10. First Test Arduino Result

Figure 11. First Test Application Results

Fig. 10. Displays the results of the DHT11 sensor with a temperature value of 40°C and 46% humidity, while the fan gives a result of 2.32 and lights 6.20. This value is inputted into MATLAB to get proof of the accuracy of implementing fuzzy logic. Here are the results :

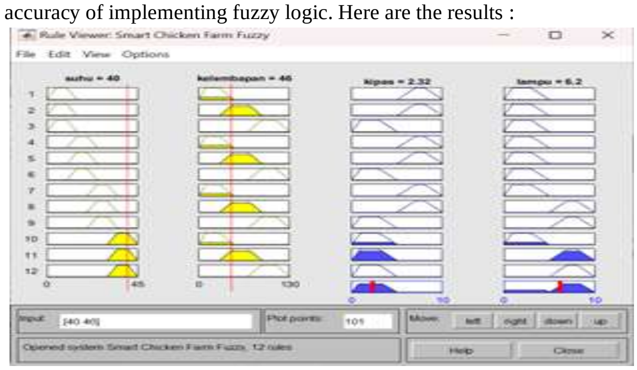

Figure 12. First Test MATLAB Results

Fig. 12. The results in the first test show that the fans and lights are 2.32 and 6.2. This indicates that the fan is ON and the lamp is OFF.

2. Second Test

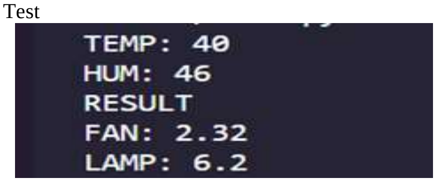

Figure 13. Second Test Arduino Results

Figure 14. Second Test Application Results

Fig. 13. This is the result of the second experiment on Arduino with the experiment brought close to the surface of the ice. The temperature and humidity obtained are 10°C and 94%. While fans and lights produce a value of 2.29. Then tested in MATLAB with the following results :

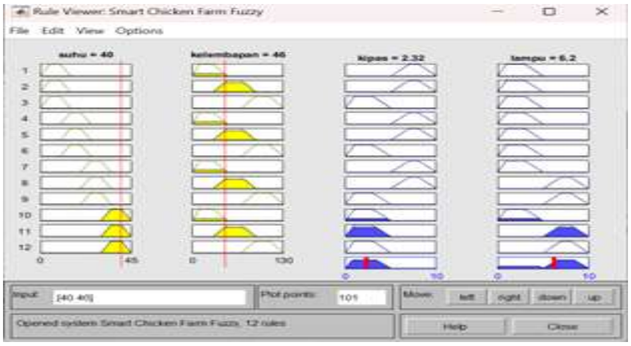

Figure 15. Second Test MATLAB Results

With the temperature value obtained is 10°C and 94% humidity and the output value is 2.29 on the fan and lights, the status of the fans and lights is ON.

3. Third Test

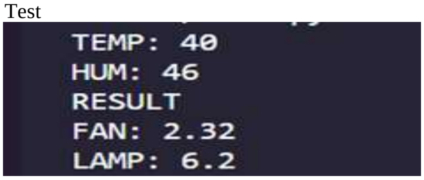

Figure 16. Arduino Trial Results Third

Figure 17. Third Trial Application Results

Fig. 16. Shows the results from Arduino with the values obtained, namely temperature 36°C and humidity 62%. The value of the fan is 2.29 and the lamp is 7.50. Then the process is carried out to the MATLAB application, the following is the result :

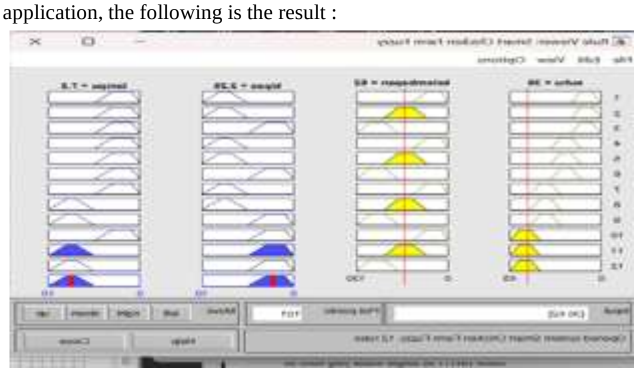

Figure 18. MATLAB Results of The Third Test

With a temperature value of 30°C and 62% humidity, the fan value is 2.29 and the lamp is 7.5, indicating that the status of the fan is ON and the lamp is OFF.

4. Fourth Test

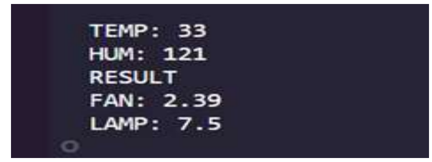

Figure 19. Fourth Test Arduino Results

Figure 20. Fourth Test Application Results

Fig. 19. This is the fourth experiment by testing the sensor closer to the heat source and slightly cold. This causes the temperature to drop to 33°C and the humidity to rise to 121%. The fan rating is 2.39 and the lamp is 7.50. This value is entered into the MATLAB application with the following results :

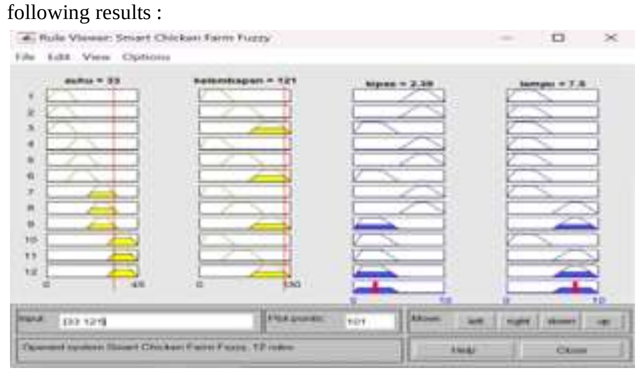

Figure 21. MATLAB Results of the Fourth Test

With the obtained temperature value of 33oC and 121% humidity and the fan and lamp values are 2.39 and 7.5 indicating that the status of the fan is ON and the lamp is OFF.

5. Fifth Test

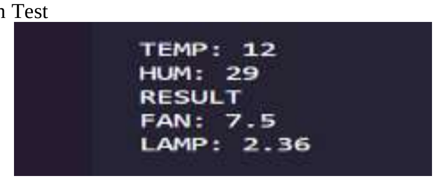

Figure 22. Fifth Test Arduino Results

Figure 23. Fifth Test Application Results

Fig. 22. This is the fifth test by trying to bring the sensor closer to a cold source and the results obtained are a temperature of 12oC and 29% humidity with a fan value of 7.5 and a lamp of 2.36 so when it is inserted into the MATLAB application the results are as follows :

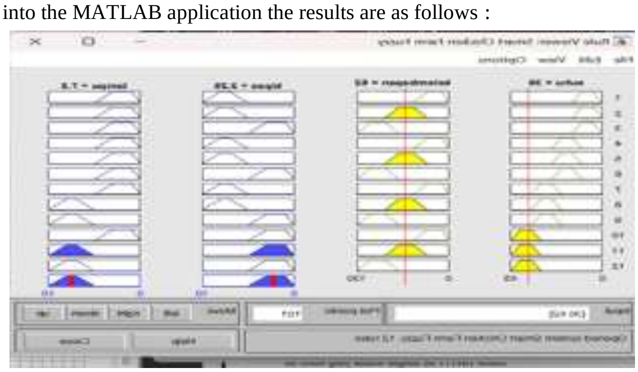

Figure 24. Fifth Test MATLAB Results

With a temperature of 12oC and 29% humidity and the output value of the fan is 7.5 and the lamp is 2.36 indicating that the status of the fan is OFF and the lamp is ON.

After successfully obtaining data from the five tests on actuators, it can be concluded that the system complies with the rule base that has been set in the MATLAB application. The following is a recap of the results during the testing process :

Table 6. Test Analysis Recap

NO	TEST	SYSTEM VALUES		COMPATIBLE OR NOT SUITABLE
1	FAN ON AND LAMP OFF	ON	OFF	COMPATIBLE
2	FAN AND LAMP ON	ON	ON	COMPATIBLE
3	FAN ON AND LAMP OFF	ON	OFF	COMPATIBLE
4	FAN ON AND LAMP OFF	ON	OFF	COMPATIBLE
5	FAN OFF AND LAMP ON	OFF	ON	COMPATIBLE
KEAKURATAN 100%				

4. Conclusion

After carrying out 5 test scenarios by applying fuzzy mamdani logic to making decisions on fans and automatic lights to maintain the temperature and humidity of the smart chicken farm and implementing a mobile-based monitoring application, it went very well. In sensor testing, it is proven by the absence of errors in decision making by the mamdani fuzzy logic in adjusting the fan and lights on.

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