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IoT-Based Temperature Monitoring System For Smart Cage

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***Abstract*—There are several broiler breeders in Indonesia, but an essential part of its maintenance is paying attention to the chicken coop's temperature and humidity. This is still a shortage and complaint for farmers. So the solution to overcome these problems in this study is to develop an intelligent chicken coop. The smart chicken coop is made to monitor and maintain the temperature and humidity of the chicken coop by utilizing advanced Internet of Things technology and integrating several embedded systems such as the NodeMCU microcontroller, DHT22 sensor, relay, and blynk application as control. The results of the study, with several tests, succeeded in creating a smart chicken coop prototype that could control and monitor the condition of the chicken coop. Monitoring can be carried out remotely through the blynk application and set the cage condition by detecting the cage temperature of more than 30 degrees Celsius. The fan will turn on, and vice versa. If the temperature decreases, the fan automatically turns off.**

Keywords—Internet of Things, Monitoring, Smart Cage, Temperature

I. Introduction

Chicken is a livestock product that is widely cultivated and very popular in Indonesia. However, procedures and care for livestock need to be developed to improve livestock quality and good results [1]. Data from the Indonesian Central Statistics Agency (BPS) in 2020 shows that the total population of broilers in all provinces of Indonesia reached 2,970,493,660, with the highest populations in West Java, Central Java, and East Java, respectively. The high livestock population can identify that the number of breeders in Indonesia is relatively high [2], [3]. In the treatment, the temperature in the chicken coop must be maintained, namely from the age of one to the seventh day, which is 35°C, while on the 8th to 15th day, the temperature is between 32°C to 29°C, on the 16th to 23rd day the temperature is between 27-29°C, and from day 24 to day 31 at 26°C.

The growth of broiler chickens is speedy, but the effect of humidity on chickens is fatal, which can make them susceptible to viruses or diseases [4]. From these problems, it is necessary to apply advanced technology in chicken coops to monitor and maintain the temperature in the cage so that humidity is maintained.

This industrial era 4.0 encourages various advances in various sectors, which impacts supporting technology that must be able to face Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) [5]. One of the advanced technologies that are trending related to this research in the face of uncertainty is the internet of things (IoT) [6], [7]. IoT can monitor [8], communicate and integrate with the entire set of hardware and software via the internet network [9]. In addition, embedded systems are widely used in this age of advanced technology, namely microcontrollers, replacing old electronic circuits. With IoT, every electronic device can be monitored and controlled remotely [10], [11].

Many applications of IoT have been carried out, including for home automation [12], to detect movement and send camera captures in the form of photos via email notifications. This smart motion detection system has been used in research [13]. In addition, it has also been successfully implemented for monitoring the nurse's activities [14] so that the nurse's position can be known. Then another IoT research was carried out on monitoring bus passengers [15] and detecting bus positions so that passengers and bus positions can be known. Monitoring can be done through a mobile application.

Several IoT studies to overcome problems in the cage have also been carried out, including the monitoring system created by [4], in this study using DHT11 sensors, relays, and lights. Then it is equipped in research [16] to transmit and control IoT devices via telegram. Based on research [17] on temperature monitoring and supporting smart farms, innovation was carried out using the DHT22 sensor [18] as a temperature detection sensor in this study. The use of relays to control the smart fan that can turn on and off automatically [19], [20], as well as the use of the blynk application so that temperature monitoring in the smart enclosure is expected to be more effective and efficient.

This research was conducted to create a smart chicken coop as a new form of innovation by using DHT22, nodeMCU esp 8266, relay, RTC, blower, and blynk. So that the smart chicken coop is integrated and can provide information via smartphones, it is hoped that the results of research on smart chicken coops can help breeders produce better quality livestock and compete in the industrial era 4.0.

II. Related Work

The results of research carried out by [4] have succeeded in making a chicken coop monitoring system capable of monitoring. However, the use of sensors they use is still considered ineffective. So, in this research, innovations will be carried out using the DHT22 sensor, which is expected to provide more optimal results.

Subsequent research from [16], which can control IoT devices through the telegram application by utilizing the telegram bot, inspired this research. Another innovation in this research is to utilize a mobile-based application to control and monitor smart chicken coops.

Some of these studies are also supported by research [17] on full support for smart farms' internet of things devices. So the research that will be conducted is a development of previous studies by adding innovations to create a smart chicken coop system that is more optimal. So that the quality of the livestock produced will be better and the breeders can compete in this 4.0 industrial era.

III. Methodology

The stages of this research consist of four main stages, namely, information gathering, design, implementation, and testing. Figure 1 shows the stages of the study.

Fig. 1 Methodology

A. *Information Gathering*

In this first stage, we are conducting a literature study on theories and references related to the research to be carried out. In addition, to carry out literacy on current conditions and those that have been carried out by previous research.

B. *Design*

After collecting the necessary data and materials, the next stage is to design the system. We are starting with the architecture design, system flow, and interrelationships between systems.

C. *Implementations*

This third stage is the implementation stage of the planning and design that has been done—from coding to merging connectivity between devices.

D. *Testing*

Testing is the last stage after the system building process is completed. This stage aims to ensure that all devices can connect and work properly. As well as conducting monitoring tests on mobile-based applications.

IV. Result and Analysis

A. *Information Gathering*

Information and data collection related to creating a smart chicken coop monitoring system include several related studies and the tools used by previous research. Then the analysis results for this study using several tools, namely in table I.

TABLE I. TOOLS

No	Tools
1	NodeMCU
2	Sensor DHT22
3	Relay
4	Fan/blower
5	Jumper Cable
6	RTC
7	Blynk

NodeMCU is an open-source internet of things (IoT) platform. This microcontroller is equipped with an ESP8266 WiFi module, so NodeMCU is the same as Arduino, but the advantage is that it already has WiFi. At the same time, the DHT22 sensor is a digital sensor that can read temperature and humidity.

The relay is used to turn the fan on and off. At the same time, the Real-time clock (RTC) is electronic in the form of a chip that can calculate the time from seconds to years. Finally, the use of the Blynk application as a medium to display data from nodeMCU for temperature monitoring in smart chicken coops in real-time.

B. *Design*

In general, the prototype design of a smart chicken coop monitoring system is explained through the block diagram in Figure 2. However, this study's prototype of the smart cage is still limited to a small box measuring 30 x 25 cm, and it has yet to be applied to the original physical chicken coop.

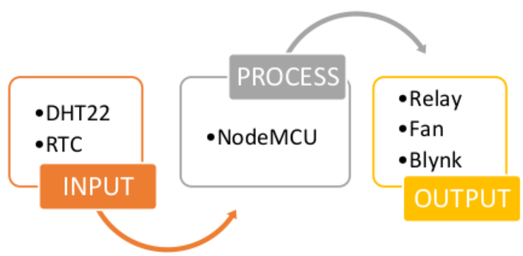

Fig. 2 Block Prototype Diagram

The first design is a flowchart which can be seen in figure 3. The smart chicken coop system will detect the temperature in the coop. If the coop temperature is high >30°C, the fan is turned on, and vice versa. If the low temperature is <30°C, the fan is turned off. In general, the process run on this smart cage is quite simple. These conditions are recorded in real-time and sent so that they can be monitored and viewed on the blynk application—IoT smart cage connected to the internet via WiFi.

While the design of the system architecture can be seen in Figure 4, the architecture is made to describe the connectivity between devices and data linkages.

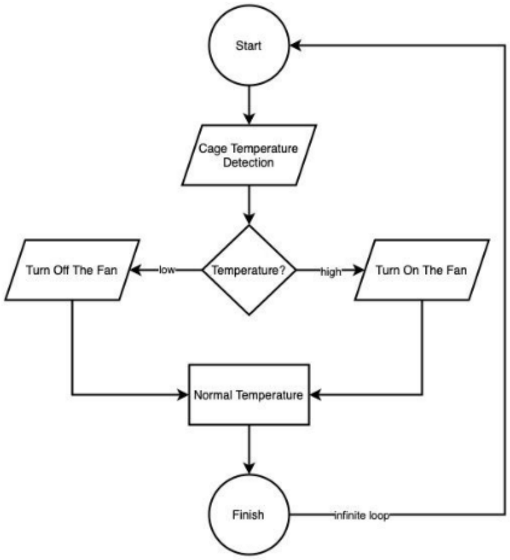

Fig. 3 Flowchart

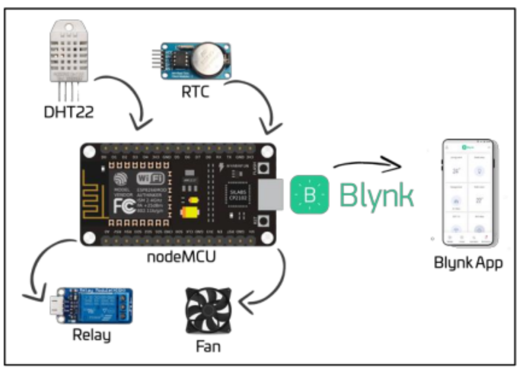

Fig. 4 Architecture System

Figure 4 is a design for a smart chicken coop consisting of a nodeMCU as an IoT device, then a DHT22 sensor to measure temperature and humidity, RTC as a timer, and a relay as a trigger to turn the fan on and off. All IoT activities will be sent and monitored via the internet on the Blynk application. Blynk can be accessed via Android or IOS, which aims to view and control nodeMCU modules via the internet.

C. Implementation

The initial implementation was programming and updating the NodeMCU sketch or firmware via the Over The Air (OTA) Arduino IDE, which can be seen in Figure 5.

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "DHT.h"
#include <TimeLib.h>
#include <WidgetRTC.h>
#define DHTPIN D6
#define DHTTYPE DHT22
#define relay D8
DHT dht(DHTPIN, DHTTYPE);
BlynkTimer timer;
WidgetRTC rtc;
char ssid[] = "soswife";
char pass[] = "123456789";
float t;
int pilihan;
BLYNK_READ(V0) {
  Blynk.virtualWrite(V0, t);

BLYNK_WRITE(V2) {
  switch (param.asInt())
  {
    case 1:
      Serial.println("Item 1 selected");
      pilihan = 1;
      break;
    case 2:
      Serial.println("Item 2 selected");
      pilihan = 2;
      break;
    default:
      Serial.println("Unknown item
selected");
  }
}
void setup()
{
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  pinMode(relay, OUTPUT);
  Serial.println(F("DHTxx test!"));
  dht.begin();
```

Fig. 5 Sketch/Firmware WiFi and Blynk

The sketch in figure 5 describes the WiFi configuration so that it can be connected and connected to the same network between NodeMCU and the Blynk application, an explanation of the sketch's pin-out configuration functions as a connection between components to the NodeMCU microcontroller.

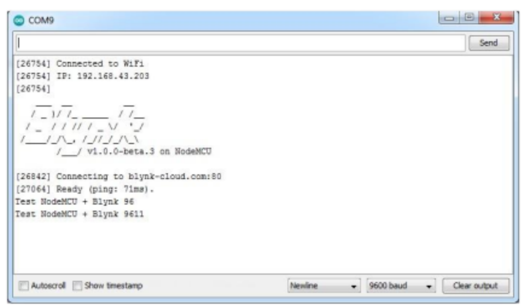

Fig. 6 NodeMCU Sketch/Firmware Update Results

Next update sketch for DHT22 sensors, relays, RTC, and others. The source code snippet can be seen in Figures 7 to 9.

```
#include "DHT.h"
#define DHTPIN
DHT dht(DHTPIN, DHTTYPE);
        void setup() {
```

```
        Serial.begin(9600);
        Serial.println(F("DHTxx test!"));
        dht.begin();
        }
        void loop() {
        float h = dht.readHumidity();
        float t = dht.readTemperature();
        float f = dht.readTemperature(true);
        if (isnan(h) || isnan(t) || isnan(f)) {
        Serial.println(F("Failed to read from
        DHT sensor!"));
        return;
        }
        float hif = dht.computeHeatIndex(f, h);
        Serial.print(F("Humidity: "));
        Serial.print(h);
        Serial.print(F("%  Temperature: "));
        Serial.print(t);
        Serial.print(F("°C "));
        Serial.print(f);
        Serial.print(F("°F  Heat index: "));
        Serial.print(hic);
        Serial.print(F("°C "));
        Serial.print(hif);
        Serial.println(F("°F"));
}
```

Fig. 7 Sketch/Firmware DHT22

The sketch that can be seen in Figure 7 is the setting and configuration of temperature and humidity in a smart chicken coop that has been adjusted to the rules of chicken age. The Blynk app is used to view the display of temperature rising or falling in the cage.

```
#define relay D8
void setup() {
  // put your setup code here, to run
once:
  pinMode(relay, OUTPUT);
  // digitalWrite(relay, 1);
}
void loop() {
  // put your main code here, to run
repeatedly:
  digitalWrite(relay, 0);
  delay(5000);
  digitalWrite(relay, 1);
  delay(5000);
}
```

Fig. 8 Sketch/Firmware Relay

The hardware implementation scheme in Figure 9 contains a series of pins that connect components to the NodeMCU microcontroller, as shown in Table II.

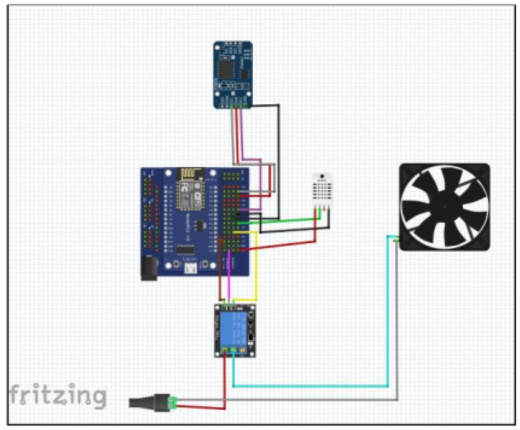

Fig. 9 Hardware Schema

TABLE II. PIN SERIES

No	Component	PIN	NodeMCU
1.	DHT22	VCC	3V (Vin)
		GND	GND
		SCL	D6
2.	RELAY	GND	GND
		Data	D8
		Input	3V
3.	RTC	GND	GND
		Input	3V
		Data	D1
4.	Fan	Input	12v

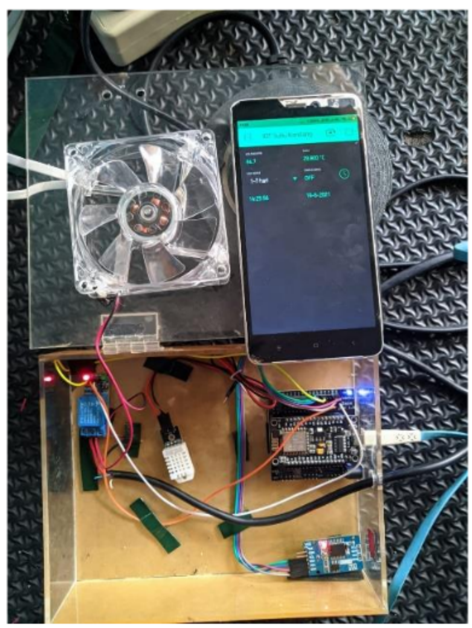

Fig. 10 The temperature is below 30^0, and the fan does not turn on.

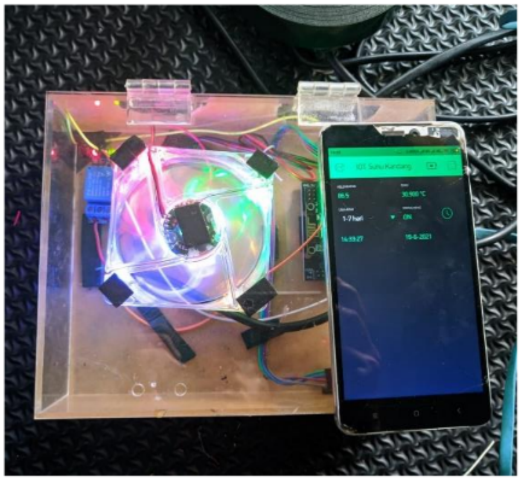

Fig. 11 The temperature is above 30^{0}C, and the fan is on

The prototype of the smart chicken coop is arranged as shown in Figures 10 and 11. The fan is successful when the condition of the chicken coop is more than 30^0 C, as shown in Figure 11, and vice versa in Figure 10. The fan turns off because the temperature is less than 30^0 C.

Fig. 12 Display on the Blynk App

Figure 12 is a display on the blynk application, and can see the humidity, the cage, the temperature of the cage, the age or age of the chickens, the status of the fan on or off, and the time and date.

D. Testing

Based on table 3, the test results show that the condition of the chicken coop prototype was successfully monitored by showing the results of humidity, temperature, and heat in real time. The data will be sent via the internet and can be monitored on the blynk application.

From several tests, it can be shown that the development of a prototype of a smart chicken coop monitoring tool has been successfully carried out. Temperature and humidity measurements can be monitored in real-time. They can be accessed by everyone who is connected to the internet through the blynk application. Besides, the costs required are relatively low.

TABLE III. DISPLAY HUMIDITY, TEMPERATURE, AND HUMIDITY

Humidity	Temperature	Heat
91.50%	29.80^{0}C 85.64^{0}F	40.53^{0}C 104.96^{0}F
91.90%	29.90^{0}C 85.82^{0}F	41.04^{0}C 105.88^{0}F
92.30%	30.00^{0}C 86.00^{0}F	41.56^{0}C 106.81^{0}F
92.40%	30.10^{0}C 86.18^{0}F	41.98^{0}C 107.57^{0}F
92.50%	30.20^{0}C 86.36^{0}F	42.41^{0}C 108.33^{0}F
92.90%	30.30^{0}C 86.54^{0}F	42.95^{0}C 109.31^{0}F
93.00%	30.40^{0}C 86.72^{0}F	43.38^{0}C 110.09^{0}F
92.80%	30.50^{0}C 86.90^{0}F	42.71^{0}C 110.68^{0}F
92.60%	30.70^{0}C 87.26^{0}F	44.47^{0}C 112.04^{0}F
92.90%	30.80^{0}C 87.44^{0}F	45.01^{0}C 113.02^{0}F
93.10%	31.00^{0}C 87.80^{0}F	45.96^{0}C 114.73^{0}F
93.50%	31.10^{0}C 87.98^{0}F	46.57^{0}C 115.84^{0}F
93.20%	31.30^{0}C 88.34^{0}F	47.33^{0}C 117.20^{0}F
93.30%	31.40^{0}C 88.52^{0}F	47.83^{0}C 118.09^{0}F
92.80%	31.50^{0}C 88.70^{0}F	48.05^{0}C 118.49^{0}F
91.00%	31.60^{0}C 88.88^{0}F	47.66^{0}C 117.79^{0}F
90.00%	31.60^{0}C 88.88^{0}F	47.20^{0}C 116.97^{0}F

V. CONCLUSIONS

The prototype for monitoring the temperature and humidity of a smart chicken coop based on the internet of things has been successfully implemented. The state in the enclosure can be monitored in real-time by the DHT22 sensor as input, then processed by the NodeMCU and sent a trigger via a relay to turn the fan on or off. For example, if the temperature is more than 30^{0}C, then the fan will turn on automatically, and vice versa, the fan will turn off automatically. In addition, monitoring data will be sent via the blynk application so that it can be monitored remotely.

The results of this study were very influential in the development of the field of information technology by adding significant improvements to the traditional techniques of chicken farmers. In addition, the prototype developed can help farmers in terms of accuracy, detection, and monitoring in real-time, to save energy, time, and costs.

This research still has many shortcomings and needs to be developed, including the application of this smart chicken coop, not only in the form of a prototype but also in some real chicken coops.

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