Temperature Monitoring System using Arduino Uno and Smartphone Application

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ABSTRACT

This study discusses about temperature monitoring system in the goat pen via smartphone. In addition to monitoring, temperature control is also needed to maintain temperature conditions in the goat pen. This system is useful so that goat cultivation produces well by getting a healthy temperature during its growing period. Manual monitoring is time consuming, so a more practical monitoring application is required. This monitoring application is built using Internet of Things (IoT) technology so that it can be monitored remotely. The temperature data is taken from the DHT22 temperature sensor which is collected on a microcontroller which is then sent to the internet wirelessly. To control the temperature in the goat pen using an SSR relay. Based on the results of this study, the application of temperature monitoring in the goat pen via smartphone with the Internet of Things (IoT) is able to read the temperature value in the goat pen, and can adjust the SSR to turn on and turn off the heating element remotely using a smartphone.

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1. INTRODUCTION

Based on data from the Directorate General of Petroleum and Animal Health, in Indonesia the total population of goats is 18,720,706. From that data, there are around 1,888,584 goats that are slaughtered every year. The high demand for goat meat in Indonesia will make goat production continue to increase every year. Most people in Indonesia raise local goats, these goats are kept by the community with an open goat pen. Based on Indonesia's labor statistics, according to the main employment status of the livestock sub-sector, only 848,754 out of 3,839,162 survive as a goat farming business. From these data, Indonesian people have not fully focused on caring for goats, especially on the micro climate of the pen [1].

Goats are mammals, even hoofed, have curved horns, and are capable of reproducing and surviving in all agroecological zones. According to the products produced, goats are grouped into 4 groups, namely producers of meat (types of meat), producers of milk (types of milk), producers of hair (types of hair), and producers of meat and milk. a comfortable place for goats between 18 - 30°C, and body temperature of goats in normal conditions 38.5 - 40°C. For the micro climate, a healthy goat pen during the growing period of the goat ranges from 24°C to 28°C. In order for goats to produce well and healthily, we must also maintain a balance of normal body temperature in goats. If the normal body temperature of goats is not reached, it will have a negative impact on goat productivity and society can also experience losses in livestock production [3].

Monitoring is the process of collecting and analyzing information based on determined indicators systematically and continuously about activities or programs so that corrective actions can be taken for further improvement. This monitoring provides information about the status and tendency of repeated observations and evaluations over time. Monitoring is generally carried out to examine a process, object, and evaluate certain conditions. The monitoring system is an effort made to find out something about the actual planning or information feedback system. This monitoring provides information about the status and tendency of repeated observations and evaluations over time. Monitoring is generally carried out to examine a process, object, and evaluate certain conditions [7]. This system is also used to take corrective action to ensure that all resources are used as effectively and efficiently as possible. The monitoring process is the routine process of collecting data and measuring the progress of the program or activity objectives [9].

Previous research has conducted research using Internet of Things (IoT) technology to monitor the temperature in an egg incubator. In this study, temperature data was taken from the sensor and then collected to a microcontroller which was then sent to the internet. The test results show that the temperature value can be read in real time using the IoT with the Blynk platform accessed using a smartphone. Internet of Things (IoT) is a concept in which an object has the ability to transfer data across a network without requiring human-to-human or human-to-computer interaction. IoT is a concept that aims to expand the benefits of continuous internet connectivity that connects machines, equipment and other physical objects with network sensors and actuators to acquire data and regulate their own performance (independently) [13].

Seeing the problems of the microclimate conditions of the goat pen above, this research is designed to make a tool that is able to make the microclimate conditions of the goat pen that are healthy for goat growth. Where this tool is able to monitor the temperature in the goat pen and can control the temperature in the goat pen when the temperature in the goat pen is not suitable. These devices can be monitored and controlled remotely via a smartphone using the blynk application which can be accessed using IoT technology.

2. RESEARCH METHOD

The temperature monitoring system in the goat pen is designed to help humans find out the temperature conditions in the goat pen. So that it makes it easier for humans in the process of raising, especially goats. Where when there are other activities or other work, breeders do not need to be afraid to leave their livestock in the pen because with this tool breeders can monitor temperature conditions in their own livestock pen. Measurement of cage temperature parameters using the DHT22 sensor is processed by a NodeMCU ESP8266 microcontroller with a program to determine the temperature value in the goat pen. Then the on or off switch parameter to activate the SSR is also generated and linked to the NodeMCU module so that it can be adjusted. These parameters will be displayed on the smartphone screen with the blynk application via the NodeMCU ESP8266 communication using the internet network.

Tool components are made in a container so that the tool functions optimally. The placement of components is adjusted to the use of these components. The sensor module components, NodeMCU ESP8266, the relay module and the power supply can be placed in a housing adapted to the conditions. After the components are arranged, a circuit scheme is made for the temperature monitoring system in this goat pen. Schematic design of this circuit is an important part because it will be wiring the components used such as the ESP8266 NodeMCU Microcontroller, DHT22 module, SSR Relay, as for the circuit image of the system created is as follows.

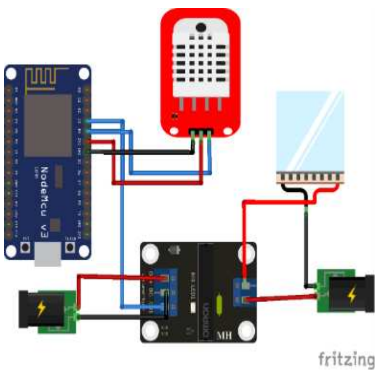

Figure 1. Series Whole System

2.1. Internet of Things (IoT)

IoT has grown rapidly from a combination of wireless technology, micro-electromechanical systems (MEMS), and the Internet. IoT uses several technologies that are combined into one unit, including sensors as data readers and internet connections. The way IoT works is by utilizing argument programming, where argument commands can produce interactions between connected machines automatically without human intervention and without being limited by long distances [13]. The way IoT works is by utilizing argument programming, where the argument command can generate interactions between connected machines automatically without human intervention and without remote adjustment. As shown in Figure 2, the internet is a link between two machine interactions. Humans in IoT are only responsible for controlling and controlling machines that work directly.

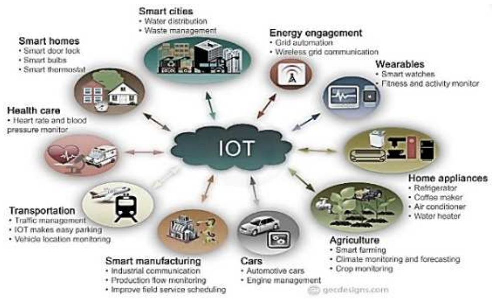

Figure 2. Iot Groove Image

2.2. Blynk

Blynk is a platform for mobile operating system (OS) applications that aim to control Arduino, Raspberry Pi, ESP8266, Wemos D1 and similar modules over the internet. This application can be used to control hardware, display sensor data, store data, visualize, and more. The ability of this application can store data and display data visually using numbers, colors or graphics remotely using internet or intranet data communications. The blynk application makes it possible to create interface projects with various input output components that support sending and receiving data and representing data according to the selected component. The Blynk server is a cloud-based backend service facility that is responsible for managing the communication between the smartphone application and the hardware environment. The ability to handle dozens of hardware devices simultaneously makes it easy for IoT system developers [6].

2.3. NodeMCU ESP8266

The ESP8266 is a smartly designed Smart on Chip (SoC) that uses multiple external circuits. The SoC can communicate over a wifi infrastructure using IPv4, TCP / IP, and http protocols. The processor used is a Tensilica L106 diamond series with a 32-bit speed and has Static Random-Access Memory (SRAM). Inside the ESP8266 has a wifi radio, CPU, memory, flash, and peripherals. This chip has the ability to be used alone (standalone) or become a microcontroller access point.

NodeMCU is an open source IoT platform and development kit. NodeMCU consists of hardware in the form of a system on the ESP8266 chip made by Espressif System whose main source is the ESP8266, especially the ESP-12 and ESP-12E series. NodeMCU is a standard ESP8266 board equipped with a micro-USB port for programming and power supply. In addition, NodeMCU is also equipped with a push button for reset and flash. Programming the ESP8266 was a bit of a hassle at first as it required some additional wiring techniques and a USB to serial module to download the program. Now NodeMCU has packed the ESP8266 into a board that supports various features such as a microcontroller and can access wifi. NodeMCU uses the Lua programming language which has the same program structure as C but has a different syntax [13][18]. As for the picture from NodeMCU ESP8266 is as follows.

Figure 3. NodeMCU ESP8266

2.4. DHT22

DHT22 sensor is a sensor that can measure two environmental parameters at once, namely temperature (temperature) and humidity (humadity). DHT22 has an analog voltage output so that it can be processed using a microcontroller. These sensors are classified into resistive elements such as temperature and humidity gauges. DHT22 is a temperature and relative humidity measuring sensor with digital signal output. The advantage of this sensor module compared to other sensor modules is in terms of the quality of sensing data readings that are more responsive and have speed in terms of sensing object temperature and humidity, as well as reading data that is not easily disturbed. The DHT22 sensor generally displays a fairly accurate temperature and humidity reading calibration and the calibration data is stored in the OTP program memory which is also called the calibration coefficient. DHT22 has better accuracy than DHT11 with a relative error of 4% temperature measurement and 18% humidity [5]. As for the picture from DHT22 Sensor is as follows.

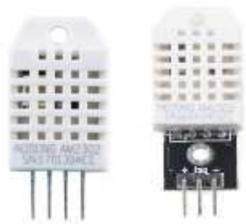

Figure 4. DHT22 sensor

2.5. Heater

The heating element is a device that converts electrical energy into heat energy through the Joule heating process. The working principle of this element is to convert the electric current flowing in the element into heat energy in the element. The heating element is anything that gets hot. When a hot object is touched with a cold object, the temperature of the hot object immediately drops, while the temperature of the cold object rises. This happens because hot objects give heat to cold objects [25].

2.5. Relay

Relay is a switch which is an electromechanical (electromechanical) component which consists of 2 main parts, namely electromagnet (coil) and mechanic (contact switch) which is operated electrically. Relays are used in electronic circuits as executors as well as interfaces between loads and electronic control systems with different power supplies. Relays use electromagnetic principles to drive switch contacts so that a small (low power) electric current can conduct higher voltage electricity.

2.6. Solid State Relay (SSR)

Solid state relay (SSR) is an electronic switch that differs from an electromechanical relay in that it has no moving parts. SSR is built with an insulator to separate the input and output parts. SSR can avoid splash and imperfect connection due to porous contactors as in conventional relays. SSR for jobs requires relatively low energy control or vice versa. This control energy is much lower than the output power controlled by the relay at full load (power gain). In other words, the sensitivity of SSR is much higher than the sensitivity of electronic mechanical relay (EMR) with the same output value [29][30]. As for the picture from SSR relay is as follows.

Figure 5. Image SSR

Block diagrams are made to make it easier for writers to make hardware. This block diagram illustrates the input data to the output section. The input section contains a DHT22 sensor as a parameter for measuring temperature values. The output section consists of a heating element to control the temperature when it drops and a smartphone with the Blynk app to display the measurement results. The connecting part of the input and output is the ESP8266 NodeMCU microcontroller. Figure 6 is a block diagram of the system carried out in this study:

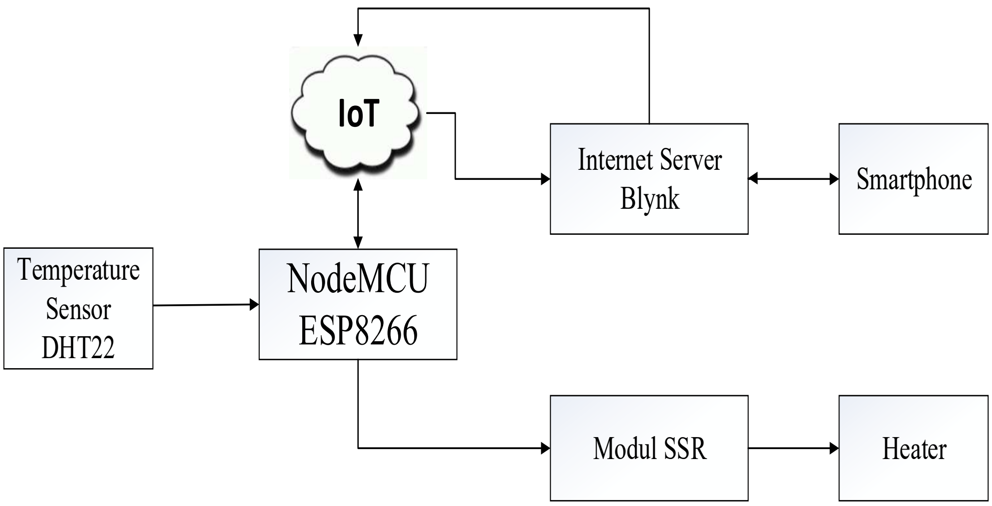

Figure 6. Block Diagram System

When the tool is working, the DHT22 sensor will read the temperature parameters then through the blynk application the temperature value can be read on a smartphone with IoT technology using NodeMCU ESP8266 and can also be controlled via a smartphone using the SSR relay.

Before the program is created, a flow chart is required. Flow diagrams are used to describe the flow of the program to be made. The program flow is preceded by initialization of program input and output. The outline of this flowchart is based on software programming. The overall program flow chart can be seen in Figure 7 below:

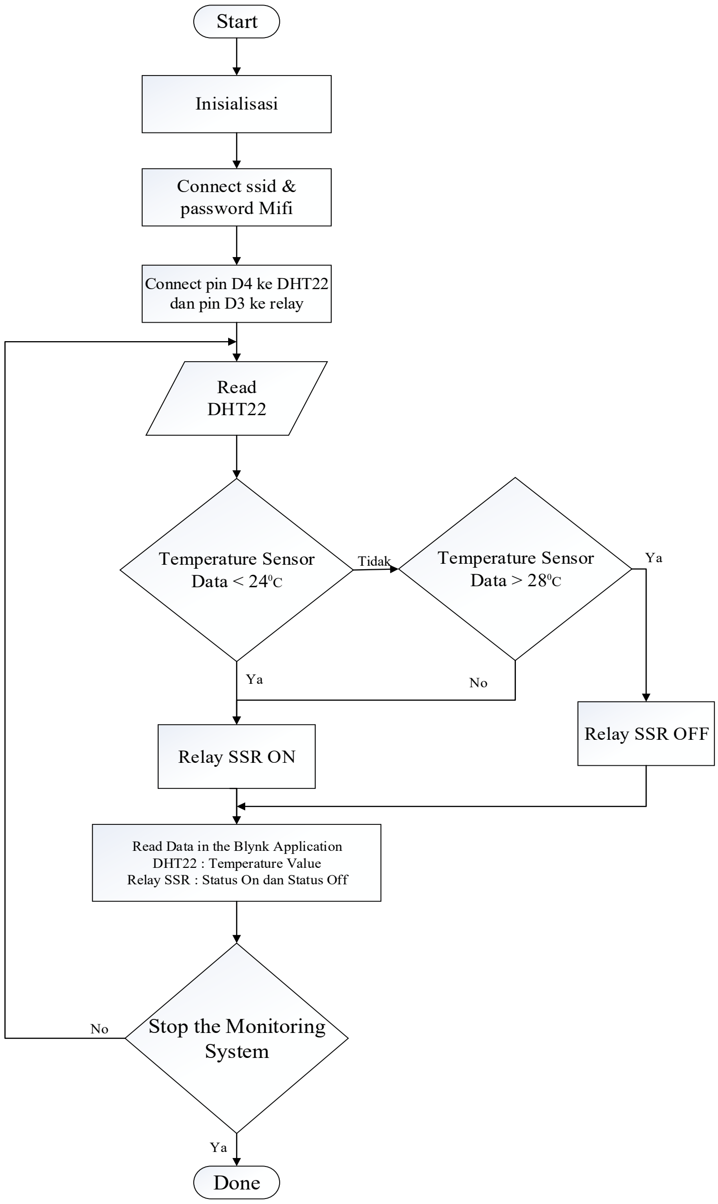

Figure 7. Program Flow Chart

The program performance first initializes the system, then connects the SSID and WiFi password. Then connect the NodeMCU pin to the DHT22 sensor and SSR Relay. After that DHT22 will read the temperature value, where if the temperature value is small from 24℃ to 28℃ then the relay will turn on to warm the cage, and if the temperature exceeds 28℃ then the relay will turn off. The relay can also be controlled with a smartphone in case of an error in the work system.

3. RESULTS AND DISCUSSION (11 PT)

3.1. Result

As for this research, this research has produced a temperature monitoring system prototype in a goat pen based on the Internet of Things (IoT). Then the monitoring application is made through the Blynk application on the smartphone, so that this tool can be monitored in real time and can also be controlled remotely using the internet network.

The form of the results of making a system tool prototype can be seen in Figure 8 consisting of a power supply, temperature sensor, NodeMCU ESP8266 and a relay. All components are assembled and assembled in a system case made of transparent acrylic.

Based on the results of this study, the resulting display of the monitoring system tool in the Blynk application is produced. The form of display of the work of the tool can be seen in Figure 9 below. The results of the monitoring display of this final project produce a graphical display of the temperature value every second, then the temperature value is in the form of a number. The next display is that below the temperature value, there is a button to turn on and off the relay from the desired distance.

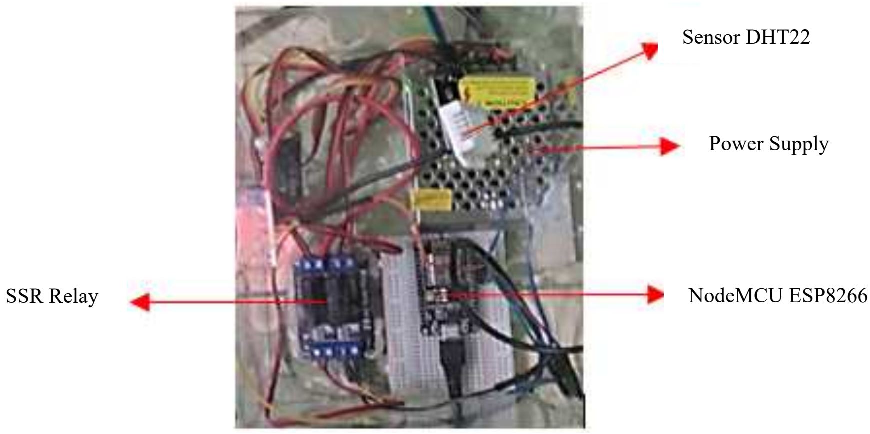

Figure 8. System Hardware

Figure 9. Application Display Monitoring

After the process of making the temperature monitoring system tool in the goat pen is complete, then testing the monitoring system is carried out. In this test, five tests were carried out, where the tests carried out were the reading of the temperature value, the SSR work response remotely using the blynk application on a smartphone. In this test, various types of Provider networks were also used for the connection between the monitoring system and the hardware that was built, which consisted of Smartfren, Telkomsel and Indosat Ooredoo networks.

From the test results, the overall data obtained from the temperature monitoring system in the goat pen can be seen in the following table. The test is carried out five times.

Table 1. System Testing

No.	Temperature (°C)	SSR	Mobile Wifi	Phone	Information
1	31.5	ON	Smartfren	Telkomsel	Good
2	31.6	ON	Smartfren	Telkomsel	Good
3	31.7	ON	Smartfren	Indosat Ooredoo	Good
4	31.6	ON	Smartfren	Indosat Ooredoo	Good
5	31.7	ON	Smartfren	Indosat Ooredoo	Good

From Table 1, it can be seen that the overall testing of the goat pen monitoring tool system. There are 3 types of providers used, namely Telkomsel, Indosat Ooredoo, and Smartfren where the mobile wifi provider is not replaced, namely the Smartfren provider. This experiment was carried out 5 times.

From Table 1, it can be seen that the experiments were carried out 5 times, resulting in a different IP address with the network connection and the SSR relay condition is on so that it can be said that the relay is working normally. Likewise with the reading of the DHT22 sensor, where the sensor can read the temperature value from 5 experiments, so it can be said that this temperature monitoring system works in accordance with the wishes of the researcher.

3.2. Discussion

Based on the test results of the temperature monitoring system in the IoT-based goat pen, it can be obtained the results of monitoring the temperature conditions in the goat cage prototype made. DHT22 sensor testing works normally by displaying the results of the value data in the form of temperature in the goat cage prototype room.

This SSR relay work system when we press the live command button on the smartphone monitor display, the relay will get a command signal to turn on the heating element. Meanwhile, when we press the shutdown command button on the smartphone monitor, the relay will get a command signal to turn off the heating element. Based on the results of this test, the SSR heating element and relay can function properly.

NodeMCU ESP8266 is used to monitor the temperature of the goat pen and control the operation of SSR relays that can be connected to the internet. NodeMCU ESP8266 is the center of the entire work system on this tool, where NodeMCU ESP8266 receives a signal from the DHT22 sensor to be transferred to a smartphone so that the measurement results can be viewed on a smartphone monitor using the blynk application. Likewise with the relay work system when NodeMCU ESP8266 receives a live command signal from the monitor on the smartphone, the signal is transferred to the SSR relay and the SSR relay will turn on and vice versa.

4. CONCLUSION

Based on the results of this study, the application of temperature monitoring in the goat pen via smartphone with the Internet of Things (IoT) is able to read the temperature value in the goat pen, and can adjust the SSR to turn on and turn off the heating element remotely using a smartphone.

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