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Design of Health Monitoring System based on Internet of Things Online-Live-Realtime (OLR)

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***Abstract*—The development of the goat farming business by goat breeders be the main reason that breeders really need real-time technology to be able to monitor livestock developments online. In addition, the expansion of the market area is also very important for the sustainability of the livestock business.The purpose of this research to develop a livestock development monitoring model, namely to monitor livestock development in real time via a website or Android. Method used in this research is monitoring the condition of the goat pen and the physical development of the goat using a camera, monitoring the temperature of the goat's health using the temperature sensor MLX90614 sensor. Monitoring in real time using the IoT platform through the Arduino Nodemcu ESP8266 device and a WiFi internet network connected to an Android device. Livestock monitoring includes body temperature, stable condition and physical condition of livestock.The end result of this research is a mAn Android-based model for monitoring the development of goat livestock in real time with a temperature sensor accuracy of more than 85% and an average speed of sending data to Android 5.11 seconds. This monitoring model provides real-time information on the physical condition of the stables and goats and the healthy temperature of the goats. This is to make it easier for goat breeders to monitor the development of their livestock.**

Keywords—Monitoring; cattle; sensors; IoT; goat

I. INTRODUCTION

Livestock is one of the supporting factors for the economy in Indonesia [1] and as a sector that supports national food availability [2]. Goats are one of the farm animals that have a fairly high adaptability. These livestock have high fertility, short calving intervals and are able to reproduce well in the tropics, temperate climates, mountains and deserts [3].. With these features, goats are one of the most promising livestock businesses because they are a source of animal protein in the form of meat or milk. Goats are now known by the community and are a business field to generate additional income, especially in rural areas [4].

Goat farming requires large areas of land outside residential areas so as not to disturb the cleanliness of the population's environment, livestock grow healthy and produce quality meat. The distance between the cages and the large area of the farm requires monitoring at any time, which includes monitoring the security of the cage, physical condition, healthy body temperature and healthy cage conditions so that productivity increases. Therefore, it will be very difficult for breeders if monitoring is still done manually. This prompted the design of a real time monitoring model wherever livestock owners are using an Android device supported by the Internet of Things (IoT) network.

Internet of Things (IoT) is a technology that makes it easier for users to obtain information via the internet network. IoT devices are designed to help make it easier for devices and objects to communicate from the virtual world to the physical world [8].With IoT monitoring the development of livestock in real time via a website or Android as well as livestock safety and current conditions can be easily monitored live so that livestock pens can be more controlled. IoT technology has been widely used for realtime cage monitoring [1][2][8]. Monitoring using IoT provides recommendations to owners to take certain actions based on data obtained from the monitoring system in the form of the latest temperature, humidity, and ammonia gas levels in the cage via a mobile application. The monitoring device consists of a microcontroller, sensors DHT22, MLX90614, MQ-135 and ESP266 automatically. The drawback in this study is the absence of a camera to see the current conditions in the cage [9].

II. RELATED WORK

Research on wireless and remote control application technology is progressing and is very popular today [5]. The speed of Internet of things (IoT) innovation can be applied to link different objects together via the Internet and to provide more information [6].IoT technology has more potential in the data-intensive modern age, such as medical care services to assist in monitoring epilepsy patients [7], measuring several quality parameters such as turbidity, pH value, water level in the tank, adjacent environmental humidity and water temperature [10], measures different qualities of water, namely pH, temperature, turbidity, and electrical conductivity. [11], helps in maintaining a safer and more balanced water body environment so as to reduce costs and time in determining the quality of water in water resources as part of environmental and ecological balance management [13]. Other IoT technologies such as those developed and utilized in plant protection from animal disturbances. By using wireless technologies such as 6LoWPAN, WiFi, and ZigBee with IoT gateway[14], motion sensors [15], a model of diversion of animals from fields using a convolutional neural network [16], proximity sensor [17], IoT components used such as PTZ (Pan-Tilt-Zoom) cameras, GSM modules, sensors, and the Arduino UNO microcontroller [18], and the use of Machine learning algorithms to protect farm fields

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from intruders[19]so that animals or pests that interfere with plants can be prevented.

A. *Internet of Things (IoT)*

Internet of Things (IoT) is a wireless application technology and remote control by applying speed, can be applied to link different objects together via the Internet and to provide more information [5][6].Internet of things (IoT) can optimize several tools such as media sensors (motion sensors [15], proximity sensor [17], and etc.), wireless sensor networks, surveillance media such as cameras [18], and other smart objects that allow humans to interact with all equipment connected via the internet network easily. IoT can help in many ways, such as medical treatment services [7], monitoring water quality [11],[13], environmental health [31], and protect agricultural land[19],[14]so that animals or pests that interfere with plants can be prevented.

Technologies for effective livestock monitoring should require consistent, high-quality and sound data for decision making. One of the technologies used to monitor animal health is using IoT by utilizing digital images to display the monitored object. This can be done by integrating information from several sources, so that it can assist in early identification and response to activities through animals and early control [20].In Fig. 1. Shows how the IoT architecture can automatically monitor livestock in cages that can be applied.

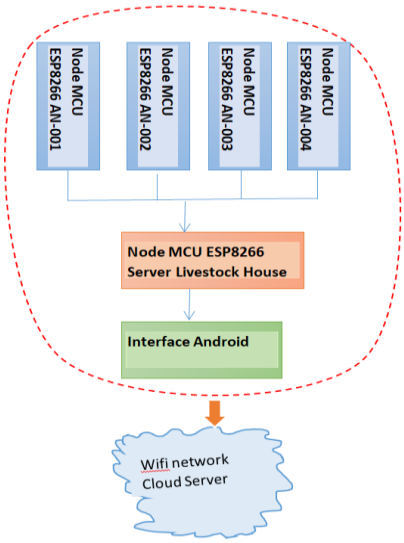


Fig. 1. Architecture implemented for animal health monitoring based on IoT [20]

Fig. 1 Shows equipment in the form of ESP8266 nodemcu for each goat, ESP8266 Nodemcu for goat pens, android interface, wifi network and cloud server. Nodemcu ESP8266 is a wireless communication module that sends data from sensors to a server on each goat and is equipped with a battery power supply. Monitoring camera nodes are placed in front of each livestock barn to obtain visual data in real time. Based on the visual data, the trained AI model available in the computing unit allows data processing and analysis for monitoring the body temperature conditions of the goats and the activity of the goats in the stables. Each node will deliver output from physical visual data of the barn, physical visual of goats and body temperature numbers of goats which are processed with the identity of each goat to monitor livestock. Information received with the identity will be communicated to the cloud server via internet connectivity made possible by the Wi-Fi module. On the cloud server, users can physically visualize the goat's body temperature so that it can be monitored via Android.

B. *Monitoring Camera*

In this study using a PTZ monitoring camera (Pan-Tilt-Zoom). This camera has the ability to zoom in if the image is too small due to the distance between the camera and the object. A pan-tilt-zoom camera is a camera capable of remote zoom and direction control. This makes it easy to get clear monitoring images. Camera Image. PAN TILT ZOOM or abbreviated as PTZ means that is :

a) PAN is the ability of the camera to be able to move left and right,

b) TILT capability of the camera can move up and down and

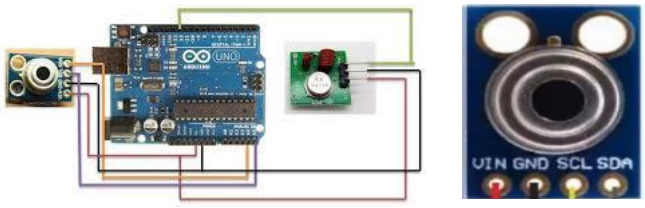
c) ZOOM the camera's ability to magnify images up to several times,

PTZ cameras are commonly used to monitor large areas using 1 camera, this makes it easier for CCTV supervisors to monitor using 1 camera, because PTZ cameras can rotate automatically or manually be moved through the controller. The PTZ camera image is shown in Fig. 2.

Fig. 2. Situation Monitoring Camera for Goat Cages and Livestock Physical Conditions

C. *Temperature Sensor MLX90614*

One of the general criteria for being called a healthy animal is having a normal body temperature of around 38.70C – 40.70C depending on environmental conditions, type of animal and so on [21][22]. Information on animal body temperature can be obtained by using a temperature sensor in the form of an infrared sensor with the type MLX90614 shown in Fig. 3.



(a) (b)

Fig. 3. (a) Temperature Sensor Circuit, (b) Temperature Sensor type MLX90614 [23]

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The MLX90614 sensor is a non-contact temperature sensor that measures temperature based on the infrared radiation emitted by an object. The sensor can sense electromagnetic waves in the range of 700 nm to 14,000 nm and can accurately measure human body temperature at a distance of 5 cm. The MLX90614 sensor can measure object temperature with a measuring range of -70 ºC to 380 ºC [24]. Retrieval of temperature data using real-time sensors can reduce stress on animals that can experience sudden changes in temperature. Body temperature sensors can send information in real time to the cloud.

The MLX90614 sensor can work by connecting Arduino with the MLX90614 sensor which has 4 pins namely Vin, GND, SCL, SDA. The Vin pin is connected to the 5V pin on the Arduino, the GND pin is connected to GND on the Arduino, the SCL pin is connected to A5 on the Arduino, and the SDA pin is connected to the Arduino A4 pin. This circuit can be simulated by connecting it to a laptop to monitor detected temperature changes based on the distance of the object from the sensor.

Several studies have used the MLX90614 sensor to monitor steel plate temperature [25].. The sensor is enabled to detect the plate temperature in the field by detecting radiation emission from the test object. The sensor has been equipped with an ADC so that the data generated is already in the form of digital data. In another study, the MLX90614 sensor was used to monitor and control lubricating oil temperature in diesel engines. If the lubricating oil works at a temperature that is too high continuously, it can cause the oil quality to quickly decrease or be too dilute. To find out the temperature of the engine oil, the operator must check the temperature continuously every one hour. Based on the design results, the thermometer can detect temperatures with a distance of 0 – 180 cm. The test results and comparison of the MLX90614 temperature sensor with the thermostat have an average difference of 0.17 ºC [26].Research with the title design of a liquid temperature control and monitoring system using the MLX90614 infrared sensor was carried out because there were problems related to the effect of temperature changes on liquids or solutions. The MLX90614 sensor will monitor the temperature rise of the heated liquid and display it on the LCD in real time. Furthermore, the buzzer will sound as a warning alarm when the liquid reaches the reference temperature. The heating device in the form of a hotplate is controlled via a relay so that it can automatically turn off if the user forgets or does not turn it off within the allotted time [23].

D. Body Temperature of Goats

Goats have many types so it is interesting for researchers to use them as objects. To get the maximum productivity of goats is often influenced by genetic and environmental factors [27].. One of the determinants of the productivity of goats is the environment. The comfort zone area for goats ranges from 18˚C to 30˚C [28], the relative humidity for sheep and goats to grow is 60--80% [29]. Environmental conditions that are too hot and high humidity can affect the physiological response and productivity of livestock. Goats exposed to heat stress have lower growth, compared to goats reared at comfortable environmental temperatures [30]. While the body temperature of a normal goat is between 36 ˚C – 39 ˚C, if the goat's body temperature is less than 36 ˚C or more than 38 ˚C then it is categorized as unhealthy. Assessment of livestock behavior expression related to physiological variables, namely heart rate, respiratory rate and body temperature. Rectal temperature is one measure to determine the response of livestock to the influence of the surrounding climate [32]. Cattle body temperature is usually determined by inserting a thermometer into the rectum. The average rectal temperature of goats under normal physiological conditions is 39 ˚C.

III. METHOD

A. Research Stages

This study aims to design a model for monitoring the development of goats in real time using temperature sensor parameters and IOT-based monitoring cameras online-live-real time via android and web applications. The stages of the research are shown in Fig. 4.

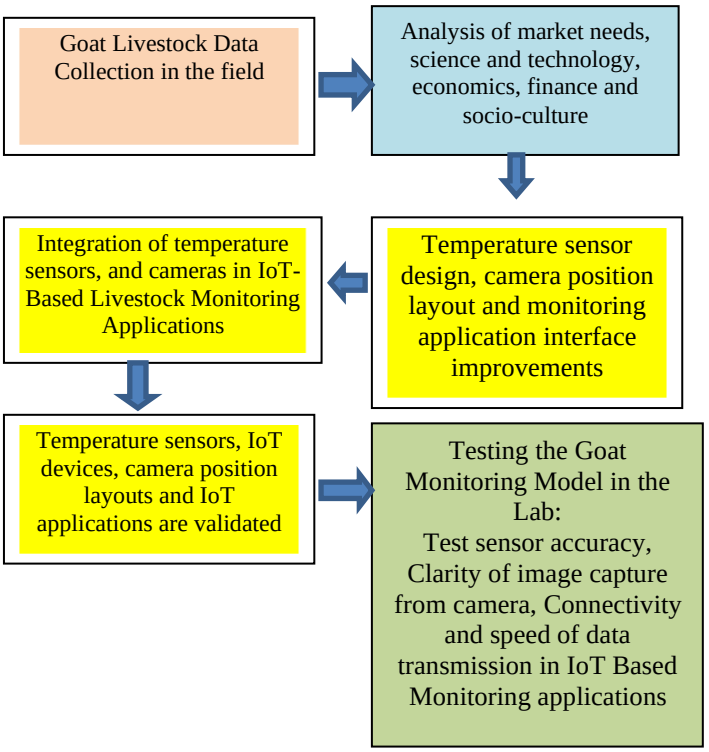

Fig. 4. Research Stages

In Fig. 4 are the stages of the process in carrying out the research which begins with data collection, analysis of market needs, sensor design and monitoring model testing.

a) Retrieval of Goat Livestock Data in the Field, namely surveying livestock data and cage location data to design a goat monitoring model which includes goat identity data, cage location data, healthy goat behavior data and healthy goat temperature data

b) Needs Analysis, namely analyzing survey data according to user needs regarding the information needed in monitoring goat livestock

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c) Layout design for the installation of monitoring devices and sensor shapes, namely designing the layout for installing monitoring devices in this case the layout for installing cameras, internet access points, the shape of temperature sensor devices mounted on the goat's neck and the android application interface that is easy to operate by breeders who have limited mastery of information technology.

d) Integration of Input and Output Devices, namely Sensors and Cameras and monitoring applications, namely integrating all input devices and output devices and ensuring connectivity between devices

e) Temperature sensors, IoT devices, camera position layouts and IoT applications are validated. Ensure that all Android-based input, output and IoT applications are running and valid.

f) Testing of the Monitoring Model includes testing device connectivity, speed of data transmission, clarity of image data from cameras and accurate goat body temperature data.

B. Monitoring Model Architecture

The architecture of the Online-Live-Real time (OLR) monitoring model and the model flow are shown in Fig. 5. Fig. 5 shows the flow of the model for monitoring the condition of goat livestock, starting from:

a) Goat cages and goat livestock are the objects of this study. Monitoring of the goat pen and the physical condition of the goats is carried out by installing a PTZ (Pan-Tilt-Zoom) monitoring camera, which is a camera that can control direction and zoom remotely.

b) Sensors and IoT Devices. Goat health monitoring is done by measuring the goat's body temperature using a temperature sensor. The temperature sensor uses the MLX90614 sensor.

- Goat Body Temperature Sensor Design

Goats have a normal body temperature between 36 – 38 degrees Celsius which is one measure of livestock health in addition to their agility. If the body temperature exceeds 38 degrees Celsius then the condition is not healthy so it needs monitoring and treatment to restore health. This body temperature sensor is attached to each of the goats, which in turn will monitor the temperature data of the goats via an Android device connected to the internet network. The design of the goat body temperature sensor device is shown in Fig. 6.

Description of Fig.6 there are:

1) Nodemcu ESP8266, is an electronic board based on the ESP8266 chip with the ability to perform microcontroller functions and also an internet connection in the form of WiFi. This board also has several Input / Output pins that can be developed to create IoT projects. In this Mobi system, Nodemcu is used as the main microcontroller which is used to initialize sensors and send data to the server via a wifi connection.

2) Sensor MLX90614, is a sensor used to measure temperature by utilizing infrared wave radiation.

3) Step up module, used to increase the battery voltage (3.7v), to 5v / according to the needs of the microcontroller and sensor.

4) Charger module, used as a charging port to the battery.

5) On/off switch, used to cut off DC electricity in the battery system, used as a storage medium for electrical energy as well as being the main source of the system.

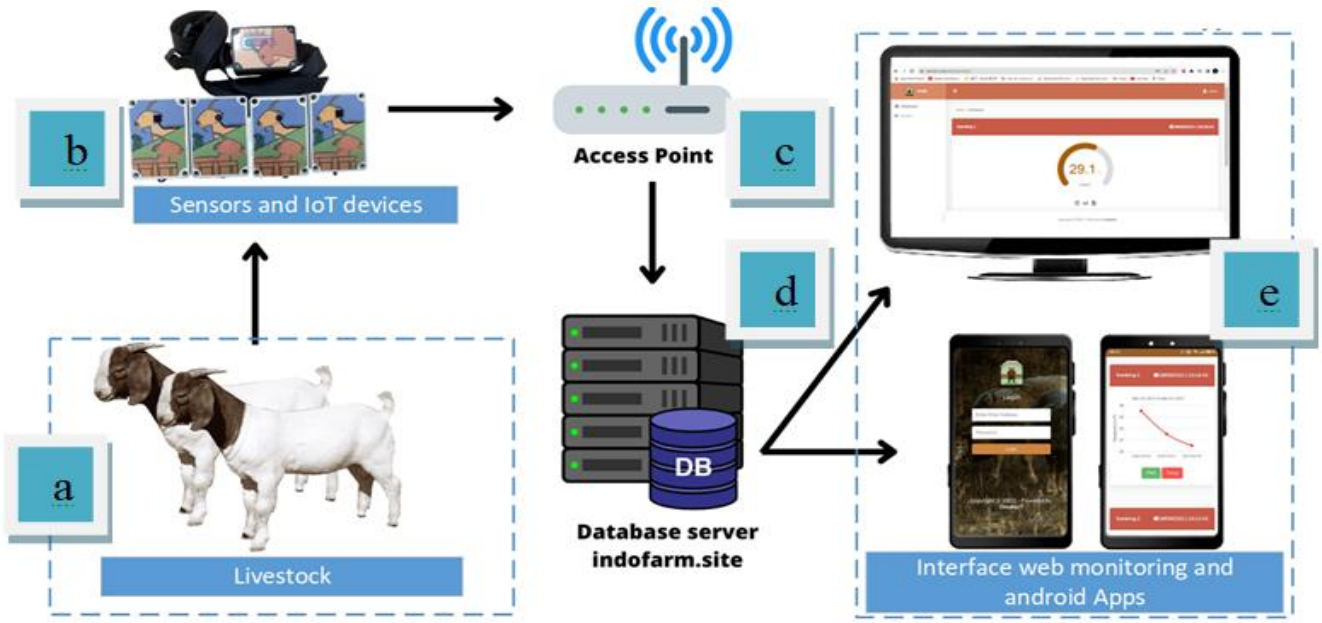

Fig. 5. Architecture of the Goat Monitoring Model

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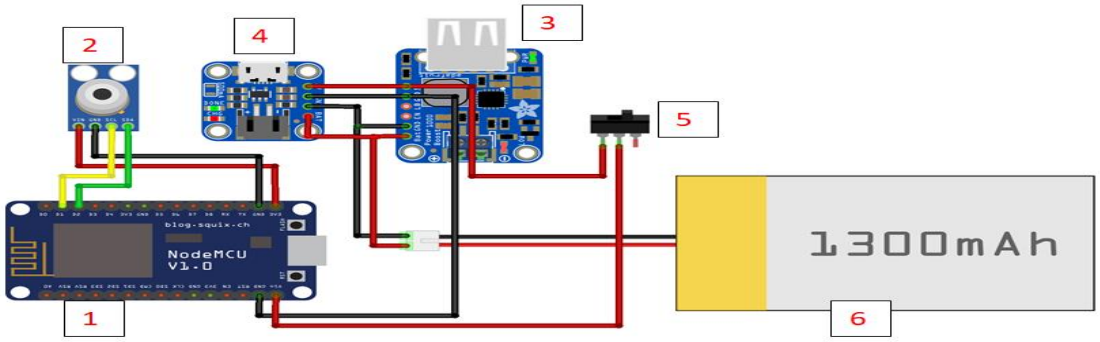

Fig. 6. Goat Body Temperature Sensor Circuit

c) Access Point is a wifi device as a means of internet network.

d) The database is a data store that is sent from sensors, cameras to servers so that the data is stored as material for analysis and evaluation of monitoring the development of goat livestock.

e) The interface on the Gadget is an interface display on Android that makes it easier for breeders to monitor the situation of barn conditions, movement agility, physical conditions and temperature in order to monitor the development of goat livestock.

Monitoring the development of goats is carried out by monitoring the condition of the pen, body temperature, agility and physical condition of the goats in real time, all data is sent via sensors using the IoT (Internet of Things) network. Measuring the temperature of goats and their cages using the MLX90614 sensor works to record the temperature of goats.Goat body temperature sensors are worn on each goat. Another monitoring device is in the form of a camera that is connected to a wifi signal as a link for transferring monitoring data to the server. The information obtained can be analyzed and processed by the system [12].

Monitoring the physical condition of livestock and their cages in real time using a room monitoring system equipped with room monitoring notifications to record data, monitor activities in the room. Notifications can be received via email and the website as notification media as well as the desired data controller. Efficient monitoring can be realized using an IoT (Internet of Things) based system, which is an internet-based information system that can send image data automatically. Using the Raspberry Pi as the main controller, the HC-SR501 PIR sensor as a device that senses infrared radiation from objects, the Universal Serial Bus as a photographer for the real conditions of livestock and their cages. All data is recorded every 60 minutes and stored in the (HDC) History Database Cloud.

IV. RESULT AND DISCUSSION

Testing the goat livestock monitoring model using monitoring cameras and IoT-based temperature sensors using 4 goat objects. Each goat was placed in a 1.5 meter x 1.5 meter cage with a monitoring camera and temperature sensor installed. The temperature sensor is worn around the goat's neck as shown in Fig. 7. In this goat monitoring work system, it consists of 3 important parts, namely the physical device in the form of an IoT Module which has been designed with a design that can be worn on goats. Installation of devices connected to the internet such as access points and Cloud Servers that function to store goat monitoring data. The temperature sensor is equipped with an IoT device mounted on the goat's neck which can be seen in Fig 7.

(a) (b)

Fig. 7. (a) Body Temperature Sensor, (b) Installation of IoT-based temperature sensors in goats

A. Login Page

Furthermore, a picture of the condition of the barn and goat livestock as well as body temperature data of the goats is sent to the cloud server via an IoT device, in this case using the ESP8266 nodemcu. All data will be recorded or stored in the database every 30 minutes for the purpose of history. The data in the database can be used to evaluate the monitoring of the development of goat livestock and also to monitor the condition of the stables. Access to all data sent to the server can be done via an Android device by first entering a username and password as a precautionary measure for system and data security. The login interface can be seen in Fig. 8. Login Page Design.

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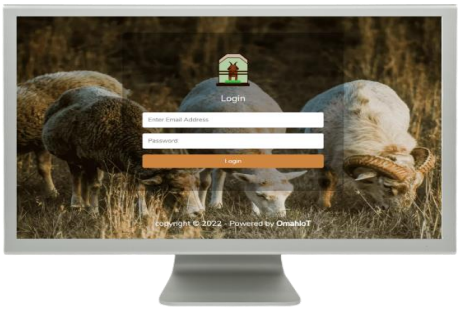

Fig. 8. Login Page Design

All data sent by the temperature sensor to the server from each goat is displayed in graphical form so that it is easy to read. The interface for viewing goat body temperature information is shown in Fig. 9.

B. Goat Temperature Monitoring Page

The goat body temperature sensor produces body temperature numbers displayed in graphical form as shown in Fig. 9.

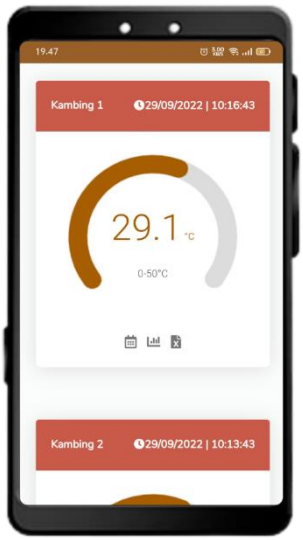

Fig. 9. Temperature monitoring page design

In Fig. 9 an experiment was carried out to measure the body temperature of goats in night and rainy weather conditions, where the goat has a temperature of 29.1˚C.

C. Menu Page And Livestock Temperature Data Visualization

The main menu display on the android application and visualization of goat body temperature can be seen in Fig. 10.

Fig. 10. Design of livestock temperature data visualization

Fig. 10 shows that the main page of this application has several display options that can be accessed, including the goat's body temperature in graphical form and visualization of the increase in body temperature. Apart from that, you can also access the monitoring menu for the physical condition of stables and livestock as shown in Fig.11.

D. Situation Page For Goat Cages And Livestock Conditions

Display of camera test results to monitor the situation and condition of goat pens and livestock in the form of real time images.

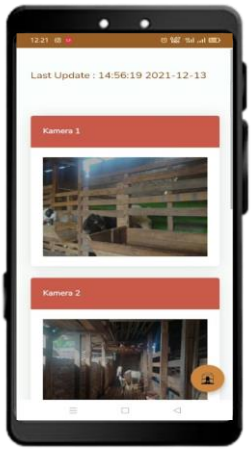

Fig. 11. Display of the results of monitoring goats using a camera

In Fig. 11 Shows real time images in the pen so that breeders can ensure the safety of livestock and the development of livestock and the health of their livestock without having to come directly to the location of the goat pen. The goat monitoring work system consists of 3 important parts, namely the physical device in the form of an IoT Module which has been designed in such a way that it can be worn on goats. Devices that are connected to the internet such as access points and Cloud Servers that function to store goat monitoring data.

The physical item in the form of an IoT Module consists of two pieces, namely the first tool attached to a goat which is used to read goat body temperature data, this tool uses a strap or hook like on a sling bag so that it can be used on goats then turn on the tool by pressing the existing switch, if the red

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LED indicator light is on then the tool is on. Wait for 30 seconds and the tool can send data in the form of body temperature to the cloud server. The second is a camera module tool that is attached to the wall of the goat pen, this tool uses an adapter that is connected to an existing power source, waits for 30 seconds and then the tool can send data to the cloud server in the form of camera image data. Each tool has previously been connected to a wifi access point network so that temperature and image data can be sent to the cloud server in real time for every 30 minutes. Furthermore, temperature and image data as well as all necessary data such as date and time, hereinafter referred to as big data, will be sent and stored in a database on the cloud server. The database contains various kinds of data tables which contain temperature data, image data and other data needed. Furthermore, the data is processed so that it can be displayed through a website-based system and an android app so that managers can monitor the condition of the pen and condition of the goats anywhere and anytime. Furthermore, temperature and image data as well as all necessary data such as date and time, hereinafter referred to as big data, will be sent and stored in a database on the cloud server. The database contains various kinds of data tables which contain temperature data, image data and other data needed. Furthermore, the data is processed so that it can be displayed through a website-based system and an android app so that managers can monitor the condition of the pen and condition of the goats anywhere and anytime. Furthermore, temperature and image data as well as all necessary data such as date and time, hereinafter referred to as big data, will be sent and stored in a database on the cloud server. The database contains various kinds of data tables which contain temperature data, image data and other data needed. Furthermore, the data is processed so that it can be displayed through a website-based system and an android app so that managers can monitor the condition of the pen and condition of the goats anywhere and anytime.

E. Goat Body Temperature Testing

Tests are carried out to measure the performance of hardware and software devices that will be applied in the field or in goat pens. The results of temperature sensor testing on four goats are shown in Table 1.

TABLE I RESULTS OF TEMPERATURE SENSOR PERFORMANCE TESTING ON GOAT OBJECTS

No	time	Goat AN-001	Goat AN-002	Goat AN-003	Goat AN-004	Notified Servers
1	10.20.15	38.32˚C	38.45˚C	38.35˚C	38.31˚C	sent
2	10.50.15	38.35˚C	38.55˚C	38.37˚C	38.36˚C	Sent
3	11.20.15	38.51˚C	38.56˚C	38.54˚C	38.55˚C	Sent
4	11.50.15	39.12˚C	38.67˚C	39.05˚C	39.18˚C	sent
5	12.20.15	39.22˚C	38.77˚C	39.15˚C	39.28˚C	sent

Table 1 shows that the temperature of the four goats has increased as the temperature of the cage has risen because the temperature in the tropics is getting higher during the day. The goat's body temperature still shows normal temperature so it is categorized as healthy.

Testing of sending image data through a camera installed in a goat pen is shown in Table 2.

TABLE II TEST RESULTS FOR SENDING DATA FROM MONITORING CAMERAS

No	camera	Base 64 image
1	Cam 1	http://indofarm.site/input.php?sn=2021110012/data:image/
2	Cam 2	http://indofarm.site/input.php?sn=2021110012/data:image/
3	Cam 3	http://indofarm.site/input.php?sn=2021110012/data:image/
4	Cam 4	http://indofarm.site/input.php?sn=2021110012/data:image/

Table 2 shows that image data has been sent and recorded in the system database. Data transmission access speed can be seen in Table 3.

TABLE IIIRESULTS OF TESTING THE SPEED OF SENDING DATA TO ANDROID DEVICES

No	Test the Speed of Data Transmission	Time (second)
1	test 1	5.10
2	test 2	5.05
3	test 3	5.07
4	test 4	5.25
5	test 5	5.10
Time Average		5.11

From the results of testing the speed of sending data from the monitoring device to the server accessed by Android, it has an average speed of 5.11 seconds. This shows that data transmission is relatively fast.

V. CONCLUSION AND FUTURE WORK

This research produced a monitoring model for the development of the condition of goats Online-Live-Real time (OLR). The system was built using IoT technology to determine the physical condition of the stables and goats, health conditions through monitoring cameras and body temperature sensors respectively. This model makes it easier for breeders to monitor the development of goats both physically and health development in real time. The use of android applications in monitoring has an impact on lower monitoring costs and improving the quality of livestock. The test results show that the access speed is not more than 6 seconds and the average data transmission speed is 5.11 seconds so that monitoring can be categorized in real time.

From this study also obtained information that the goat's body temperature will rise in proportion to the ambient temperature, namely from morning to noon the goat's body temperature will increase and decrease at night or when it rains. The increase and decrease in body temperature ranges from 0.02 ˚C to 0.20 ˚C point so that it does not significantly affect sensor performance.

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