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RESEARCH ARTICLE

# Design and Building of a Breeding House for IoT-based Goat Farming

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**Abstract:** Goat farming is an industry that supplies goat meat for food purposes. This makes goats have a high potential to improve the community's economy because everyone needs meat products. These conditions motivate farmers to improve the quality of livestock maintenance so that the livestock produced are of the highest quality. The development of information technology has facilitated a wide range of human activities, including monitoring activities in goat cages. The use of Information Technology helps farmers to improve the quality of livestock maintenance. The large cage area and the distance between cages and communal settlements are the main reasons for the planned IoT-based cage. The method used in this research is databased goat identity information, monitoring goat health through body temperature sensors, and cameras monitoring the physical condition of the breeding house. This research has developed an IoT-based goat cage design that can be used to monitor goat growth and development which can be accessed at any time via an Android gadget. The test results have shown that the average data transmission speed is less than five seconds and the access speed is less than five seconds.

**Keywords:** goat, iot, model, monitoring, sensor.

## 1 Introduction

Intensive farming is becoming increasingly popular with the application of modern farming technology. In these circumstances, the evolution of animals needs to be continuously monitored in real-time. One of the systems for monitoring the development of goats in the farm, with a combination of the Internet of Things and Machine Learning [1]. Monitoring and surveillance systems have an increasingly important role today in ensuring a high level of animal health and development, securing export positions, and protecting public health by ensuring animal and product safety [2]. A method of controlling goats without a physical fence that is visible and monitors their condition. Monitoring is carried out by affecting goats by using one or more sound signals and electrical shocks when they try to enter the prohibited zone. One of the best classifications of Machine Learning (ML) called Support Vector Machines (SVM) is used to observe conditions. The virtual fence can be geometrically shaped whatever it forms. A smart necklace on a goat's neck can be detected using a virtual fence application. Each of the smart necklaces consists of a global positioning system (GPS), an XBee communication module, an mp3 player, and an electric shock. The stimulus and classification results are presented from field experiments with a goat equipped with a smart necklace [3].

Farming is one of the important components of the economy of the people in Indonesia [4] and it is a national food adequacy support sector [5]. It is supported by the characteristic physique of the goat cattle that has a high ability to adapt to the environment. The goats have several advantages, namely being able to live well in hot areas or deserts, temperate climates, tropical areas, and cold areas in the mountains, and short time intervals for breeding [6]. Such reliable physical characteristics make goats one of the most potential livestock suppliers of animal protein sources such as meat or milk. Goat farming is now an enterprise to generate additional income, especially in rural areas because people already know how to maintain it [7].

A healthy farm area that does not interfere with the hygiene of the environment is essential for the cattle to have normal growth and quality meat. It requires large land and far away from the settlements so as not to interfere with the health and hygiene of the community. Intensive monitoring gives optimum results. The distance from the cage to the settlement and the extent of the farm area always require monitoring. Monitoring includes cage safety, the physical condition of goat livestock, a healthy body temperature and a normal body weight are essential for increased productivity. This condition will make it difficult for farmers to carry out intensive monitoring if monitoring is still done manually. It is crucial to monitor models with Android smartphones that are connected to the Internet of Things (IoT) network.

Real-time communication between objects and monitoring devices can run well using IoT technology. Based on IoT technology makes it easy for users to obtain information online based on Android [8]. Goat cattle monitoring can be accessed in real-time via Android or a website. This monitoring is intended to ensure the latest safety and physical condition of the goat farm. The real-time access is based on live monitoring to enhance cage control. Real-time monitoring of goat pens requires IoT technology [8–10]. Through a mobile application, IoT-based monitoring gives the owner information to take particular measures based on data acquired from the monitoring system, body weight, and physical condition of the breeding house. Some of the sensors installed for monitoring are DHT22, MLX90614, MQ-135, and ESP266.

## 2 Research Method

Studies of wireless application and automatic control are growing and popular at now [5]. Using the speed generated by the innovation of the Internet of Things (IoT), we can connect objects through the Internet and share data [6]. In a modern age of data-intensive, Internet of things technology has more potential, such as medical care services that can help monitor epileptic patients [7], measure ruggedness, pH values, water height in tanks, environmental humidity, and water temperature [11], measure various water qualities, like pH, temperature, rugosity and electrical conductivity [12,13], help keep the water body environment safer and more balanced, which can reduce the cost and time needed to evaluate water quality in the context of managing ecological and environmental balance [14]. Other Internet of Things technologies are also used to protect plants from animal interference by using wireless devices and sensors equipped with data transmission modules [15], motion sensors [16], models that use convolutional neural networks to direct animals out of the field [17], distance sensors [18], IoT parts that are utilized, like GSM modules, sensors, PTZ cameras (Pan-Tilt-Zoom), and Arduino UNO microcontrollers [19], and the use of MLA (machine learning algorithms) to monitor breeding houses for theft or loss to prevent pests and animals that interfere with plants [20].

## 2.1 Internet of Things (IoT)

IoT applications utilize speed to connect objects via the Internet and provide information, Internet of Things is a wireless application technology that can be accessed or controlled remotely online [5,6]. Devices such as sensor media, or motion sensors, can be optimized by the IoT [16], distance sensors [18], and so on [16], surveillance media such as cameras, wireless sensor networks [19], and similar smart devices that make it easier for people to communicate with all Internet-connected devices easily. There are many benefits of IoT, one of which is providing medical services [7], controlling water quality [12,14], environmental health [10], agricultural supervision [15,20] thus preventing pests and animals that interfere with crops.

For effective livestock monitoring technology, decision-making requires consistent, high-quality, and sensible data. IoT uses digital images to track animal health. This condition can be achieved by combining data from various sources, which can help identify and control animal activity responses from an early stage [21]. Figure 1 shows how the process of monitoring livestock in the cage is applied.

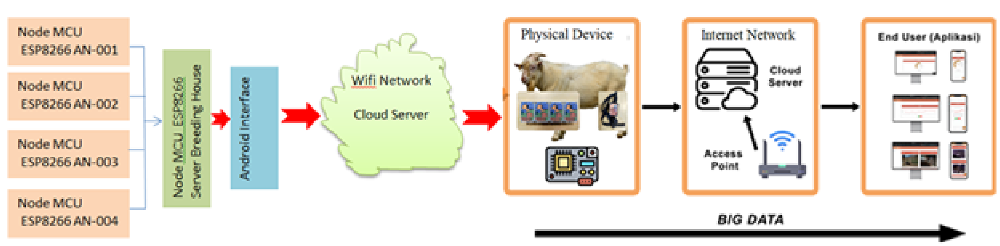



Figure 1: IoT-based process monitoring stream.

In Figure 1, shows the process of monitoring an IoT device. The equipment needed is an Android device, wireless network, server, and Node MCU ESP 8266 module in each goat body and goat cage. The Node MCU ESP8266 wireless communication module is equipped with a battery power supply. This module can send data from the sensor to the server on any goat. Each livestock cage has a monitoring camera node placed in front of the cage so that it is possible to transmit video data in real time. Based on video data, trained

(a) (b)

Figure 2: (a) Physical condition monitoring camera of the basement, (b) Goat livestock.

AI models stored in the database enable data processing and analysis to monitor body temperature and activity in the breeding house. The cage's visual physical data will be sent to each node, as well as goat identity data, goat visual physics data, the goat's weight number data, and body temperature and goat identity data are managed for monitoring purposes the evolution of goats. With the Wi-Fi module, identity data can be connected to the cloud server. Users can visualize the cage physique condition, the cattle physique state, the goat's weight, and the goat's body temperature on a cloud server, which can be monitored by the android.

## 2.2 Monitoring Camera

As for the physical state surveillance camera at the location of this study, it's a PTZ surveillance camera. (Pan-Tilt-Zoom). if the image size is small, it is because the camera is far from the object, this camera can zoom automatically. Pan-tilt-zoom cameras can control direction and remote zoom, which makes it easier to capture monitoring objects clearly. PTZ cameras are PAN camera capabilities to look left and right, TILT camera capability to go up and down, and Zoom camera ability to zoom out up to several times. PTZ cameras are typically used to monitor large areas with a single camera. This makes it easy for CCTV monitors with only one camera to perform surveillance, PTZ cameras can be set manually or automatically to view objects in certain positions as a monitor of the real condition of the object. PTZ cameras can be seen in Figure 2a, whereas in Figure 2b is a goat animal physics surveillance camera installed in each goat cage room.

## 2.3 Weight Sensor with Loadcell

Monitoring of the weight progress of goat cattle in dormal is carried out by installing loadcell or heavy sensors on the cage floor. This sensor has a sensitivity that has been tested both on a laboratory scale and on a field scale. Monitoring of the weight progress of goat cattle that are dormal is done by installing loadcell or heavy sensors on the cage floor. This sensor has a sensitivity that has been tested both on a laboratory scale and on a field scale. As for the design of the heavy range of sensors, it can be seen in Figure 3.

1. Modul HX711: Amplifier modules commonly used in digital scales to convert analog to digital signals on batteries. It has a very precise 24 ADC input and is designed for a variety of bridge-type sensors.

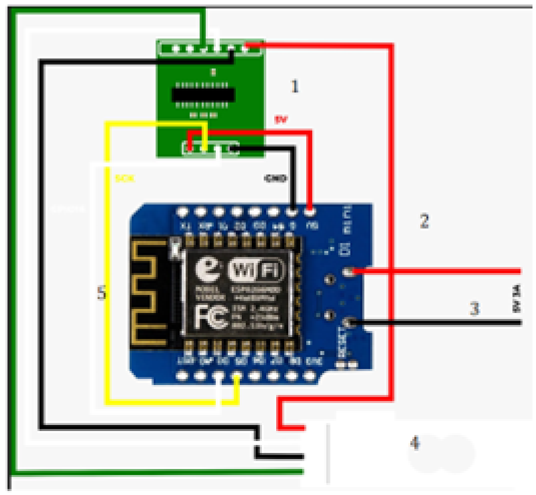



Figure 3: Loadcell network.

2. Microcontroller Wemos d1: The Wi-Fi-based development board module of the ESP8266 stack can be programmed with the Arduino IDE. Although this board looks like the Arduino Uno, it's much better than the Wemos D1.

3. Adaptor 5v 3a: A reliable power supply device that provides a stable and secure DC power supply with 5V voltage and 3A current. The adapter is designed with a compatible 5.5mm connector so it is easy to connect to a variety of electronic devices that require DC power.

4. Sensor loadcell: It is a load cell sensor that is normally included in a digital weighing system and can be used in a goat's cage to weigh the weight of the goat.

## 2.4 Temperature Sensor with MLX90614

Monitoring the development and health of goats through Android requires a device capable of transmitting data related to the health of the goats. Simply put, cattle's health can be measured by body temperature [22]. According to research, the normal healthy temperatures of goats are between 36°C to 38°C depending on environmental weather, animal type, and so on [23]. The use of the MLX90614 sensor is to measure body temperature. The way this sensor works uses an infrared sensor of the type that can be seen in Figure 4.

The MLX90614 temperature sensor uses infrared radiation emitted by an object to measure temperature. The device has the capability to sense electromagnetic waves in the range of seven hundred nm to fourteen thousand nm and has the ability to measure body temperature accurately at a distance of 5 centimeters. The temperature range measured by the MLX90614 sensor is between 70°C and 380°C [24]. Using this temperature sensor to measure and Transmission of current temperature data to anticipate stress in animals whose temperatures may change suddenly.

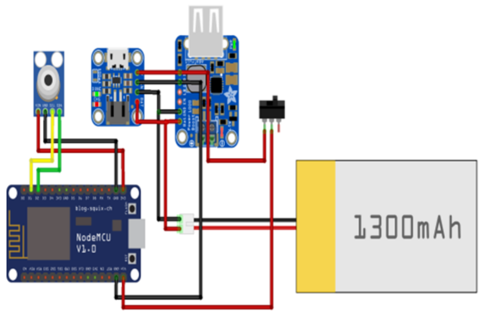



Figure 4: Weight sensor network.

A range of temperature sensors can be implemented by connecting a computer to a sensor to control temperature changes in an object [25]. On this sensor line, there are four pins: Vin, GND, SCL, and SDA. Vin pins are connected with 5V pins on Arduino, GND pins with GND on Arduino, scl pins connecting to A5 on Arduino, and SDA pins connected to A4 pins.

The user of the MLX90614 infrared sensor was also used in research to design a liquid temperature control and monitoring system monitoring system to handle problems related to the effect of changing temperatures on a liquid or solvent [26]. The MLX 90614 sensor can monitor liquid temperature and provide information on the LCD to find out the current temperature data. When the liquid material reaches the reference temperature then a sound alarm will ring as an automatic warning. The heater is controlled via a relay, so it can turn off automatically if the user forgets to turn it off within a certain time [27].

In the steel plate surveillance research, the MLX90614 sensor was used for temperature measurement [26]. The MLX 90614 sensors were also used to detect the field plate temperature through radiation exposure of the object under test. Additionally, the MLX90614 sensor has been employed to monitor the temperature of the lubricant oil with the object of the diesel engine. This is done to keep the engine's salt temperature stable, the instability of the oil temperature will cause the oil quality to decline rapidly or become too fuzzy. The average temperature difference resulting from the temperature test between the MLX90614 sensor and the thermostat after the comparison was 0.17°C [25].

## 2.5 Normal Weight and Normal Temperature for Goats

There are many species of goats, thus the researchers use them as research objects. A clean and comfortable environment is one of the factors that affects goat productivity. The goats grow normally and healthy in areas with temperatures between 18°C to 30°C [28]. Similarly, the humidity level has an influence on good goat growth, ranging from 60% to 80% [29]. The physiological responses and productivity of goats are also affected by environmental temperature conditions such as too high heat and high humidity. Goats that are kept in cages with comfortable ambient temperatures grow faster and are not stressed.

The effect of stress is abnormal cattle growth [30]. The body temperature of a goat that is categorized as harmful if it is 36°C or higher. A stable heart rate, breathing frequency, and body temperature are measurements of animal behavioral expression related to its physiological variables. Measuring the response of cattle to environmental climate influences can be done using rectal temperature. The measurement of the body temperature of the cattle is done by lacing a few seconds of the thermometer in the inner rectum of the goat cattle. In normal physical conditions, the average rectal temperature of the goat is 39°C. The Goat's productivity is frequently impacted by both genetic and environmental variables [31].

# 3 Results

The construction and design of a reliable breeding house has carried out several stages and test.

## 3.1 Research Stage

The research is aimed at designing an IoT-based goat cage concept for goat development in real time with the use of IOT-based monitoring cameras and temperature sensor parameters, as well as online and Android applications. Figure 5 displays the study's stage. Figure 5 displays the study's stage.


Figure 5: The research stage.

The stages of research implementation are shown in Figure 5 which includes Field Data Survey, Software and Hardware Design, Field Testing, Implementation, and Results.

(a) Field surveys and data gathering of cattle in the field are surveys of data related to cattle covering the identity, character, healthy or normal condition of the cattle, and healthy cattle environment data covering cage models and environmental conditions that are comfortable for normal cattle growth. These data are then used to design an IoT-based cattle monitoring model. Furthermore, a need analysis is carried out, namely, to analyze the survey results data following the needs of the user-related information needed to monitor cattle accurately.

(b) Hardware and software design that includes cage design, monitoring device installation layout on cage in this case, camera installation, internet access point, Goat neck-mounted temperature sensor device with an Android application interface that's simple enough and easy to operate for farmers with no IT experience to use.

(c) Field testing involves the integration of sensors, cameras, and other input/output devices used in Internet of Things applications. Integrating the entire software and hardware and ensuring the connectivity of both.

(d) Implementation and evaluation. Installation of the hardware at the location of the object and training use of the E_MOBI application.

## 3.2 Monitoring Model

The design and monitoring model based on Online Live Realtime, or O-L-R is in Figure 6a and Figure 6b. Description of Figure 6 which is the monitoring of goat livestock development based on IoT as follows:

1. The standard IoT goat cage model has been designed to adapt to the concept of IoT and Cattle Identity. The cage design is tailored to the goat type and the layout of the IoT device installation: WiFi Access Point, solar cell Panel as a power source, heavy sensor, temperature sensor, monitoring camera, and solar cell resource.

2. The software and hardware on E-MOBI include:

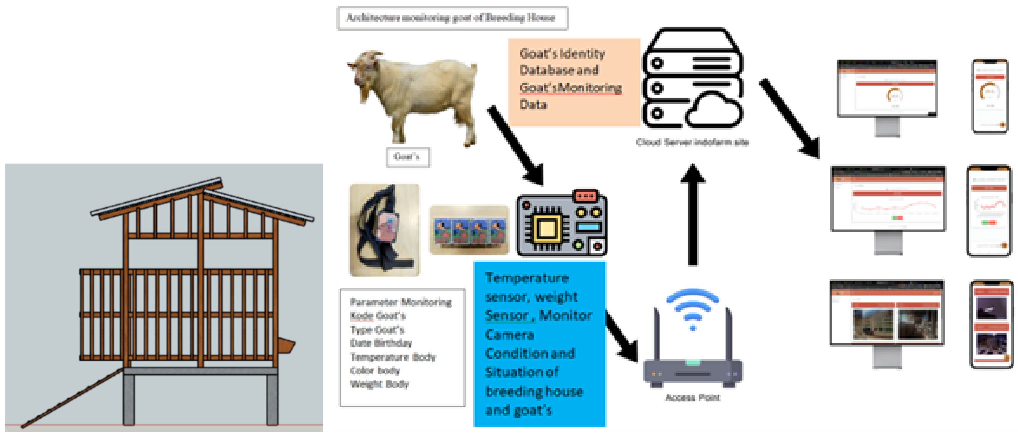
    (a) Android gadgets already installed E-MOBI application can be used to monitor goat cattle mining.

    (b) Monitoring is carried out through the transmission of data from the sensor attached to the object. The objects being monitored are goat cages and goat livestock physics. The sensors used are body temperature sensors, body weight sensors, and cameras monitoring the real physiological condition of cattle as well as cameras that monitor the environmental condition of the cage. All sensor devices are accessible in real-time via android.

    (c) An Android app that can be installed on a gadget so it can be accessed anytime and anywhere. This application has information that can be used to monitor the progress of cattle. The information provided on the cattle includes cattle identity, body temperature, weight, environmental conditions of the cage, and animal physiological conditions that are accessible in real-time.

Utilizing an Internet of Things (IoT)-based system, efficient and effective monitoring is possible. Information system monitoring by tracking the physical state of cattle and their animals in real-time, the development of livestock based on the Internet of Things is made possible. Notifications for room surveillance are included in the cage monitoring system to keep an eye on any activity that takes place in the space. Notifications are confirmed by email and web as a notification medium to perform desired data controls. It's an internet-based control system that can send image data automatically. The HC-SR501 PIR sensor is a device for detecting infrared radiation from an object. Raspberry Pi is used for the main controller. Universal Serial Bus as a capturing of the real condition of cattle and cages. All data is stored in (HDC) History Database Cloud and recorded every 30 minutes.

Monitoring of goat livestock is realized by monitoring the cage condition, body temperature, motion agility, and the goat's physique actual condition. All this data is transmitted with a sensor and IoT network. Measuring the temperature of the MLX-90614 sensor in the goat and the cages is working to save the temperatures of the cattle. Other monitoring




(a) (b)

Figure 6: (a) Breeding house of design, (b) IoT-based goats development monitoring model.

devices are cameras that are connected to the WiFi signal as connectors for the transfer of monitoring data on the server. The data from the sent sensor is analyzed and processed by the system to generate accurate and real-time goat development information [13].

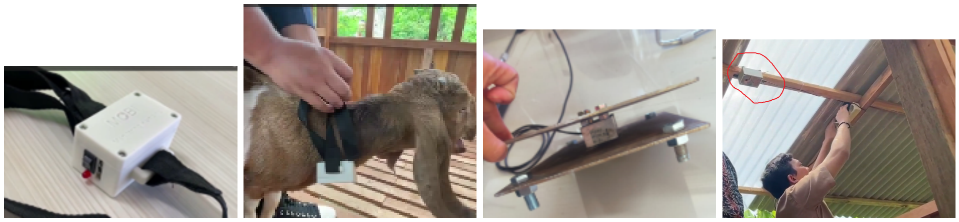
# 4 Discussion

The discussion of the results of this research includes breeding house and Monitoring Application based on IoT.

## 4.1 Breeding House of Goat Based On IoT

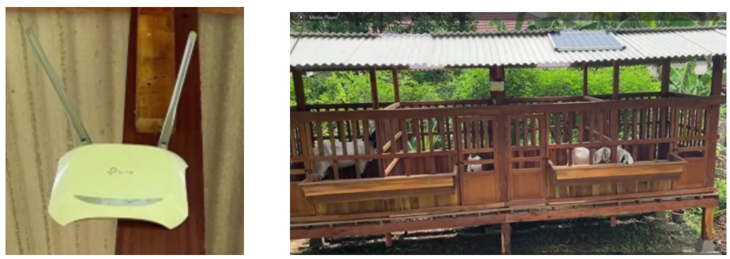
The study tested the performance of the software and hardware as well as the integration of the IoT system. Testing included testing of the weight sensor performance, performance of a goat's body temperature sensor, camera performance monitoring of the physical condition of the object, and performance of an IoT application in its entirety. The cage and goat objects used are 8 cages and 8 goats. Before the implementation of hardware and software tools on the field first test the accuracy of the equipment performance including the smooth access of data transmission from the object to the IoT application accessed through the Android gadget. Some of the equipment installed in the goat cage can be seen in Figure 7.

The real time goat development monitoring hardware installed in the cow pen and body is shown in Figure 7. Flat-flooding equipment smooth internet access and solar cell power on the goat cage can be seen in Figure 8. The equipment must be securely installed in the cage, as shown in Figure 8 so that the monitoring can be carried out with the lancer. It requires a precise and accurate tool placement layout. To transmit clear image data, the surveillance camera must be placed correctly and not obstructed by other objects.



(a) (b) (c) (d)

Figure 7: (a)Temperature sensor, (b)Installation of sensors, (c)Box loadcell, (d)Camera real-time.



(a) (b)

Figure 8: (a)Access point of wifi, (b)Panel solarcell as resource battery.

## 4.2 IoT-based monitoring applications

Real-time monitoring using an Android app based on the Internet of Things (IoT). The app has several pages that make it easy for users to get information on the evolution of goat livestock.

(a) Registration Page The IoT device (in this case ESP8266 Node MCU) is used to send images of the situation of the cage and goat cattle to the cloud server. It also sends data on the body temperature and weight of goats to the Cloud server. Every 30 minutes, all the information will be stored or documented in the database to store it as a history. To access all the data sent to the server, the Android device must enter the username and password to keep the system and data secure. Figure 9 shows the data filling page of the registered user account. If you have not yet registered, you must register first.

(b) Sheep's weight monitoring page The next page on this app is an interface that displays weight information for each goat. Goat weight information is transmitted in real-time from the loadcell sensor. This sensor is placed on each cage, so it can transmit each goat's weight information one at a time. This interface can be seen in Figure 10. In Figure 10 is an interface to monitor the weight development of each goat. This is to monitor the normal growth of goat cattle with the increase in age and normal weight of healthy goats. All data is recorded at a periodic time that can be adjusted according to the needs of the farmer.

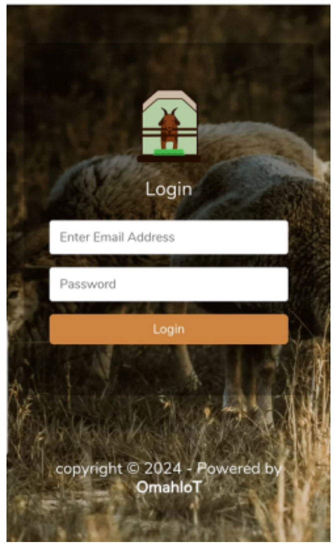



Figure 9: Registration page of design.

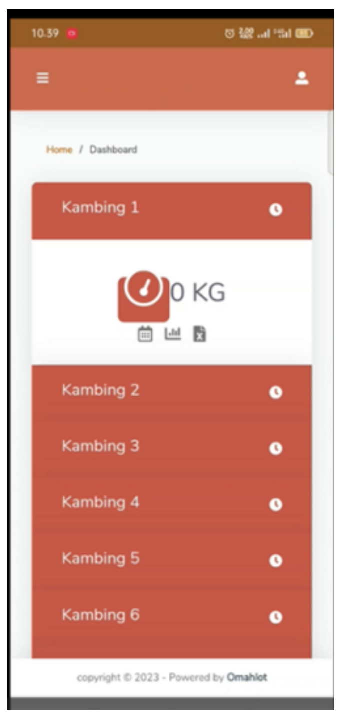



Figure 10: Heavy information interface goat Cattle.

(c) Goat's Body Temperature Information Page The goat's body temperature information page is shown in Figure 11. The body temperature of the goat is presented in the form of graphs as well as visualizations of the increase in body temperature so that it is more informative. In addition, you can see the situation and real-time conditions of the cage and the cattle that are in it.

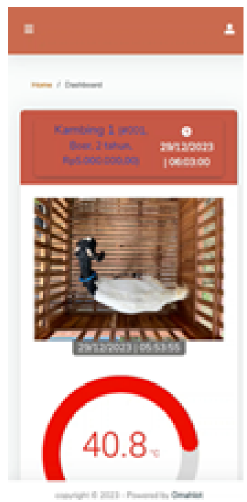



Figure 11: Goat's body temperature information page.

(d) Goat's Cattle Identity Page Data monitoring in the goat farm houses can be done by selecting the required dates. The app also provides information about the goat's identity as well as the sale price. The view of both interfaces can be seen in Figure 12. In Figure 12a shows the selection interface of the date to which the data will be accessed, whereas Figure 12b is the identity information of the goat cattle including the type of goat, age, and sale price. Users can access information on the selected date. By default, the application will display information on the today date.

## 4.3 Tool Test Results

Before the monitoring equipment is deployed in the field, it is tested first in the relevant environment. Tests are carried out in cages and goat livestock. Tests include hardware testing and software testing of IoT-based goat development monitoring applications. The monitoring system consists of three parts: (1) the IoT module is a weight sensor, body temperature sensor, physical state monitoring camera and solar cell as a power resource designed to be put on goats, (2) the access point is a device connected to the Internet and (3) the goat monitoring data storage media is Cloud Server.

(a) Goat Weight Sensor Test

Table 1 displays the findings from heavy sensor testing conducted on four goats. Table 1 shows that taking data of goat weight through the weight sensor results stable demonstrated from the size of a relatively equal goat's weight figure.


(a) (b)

Figure 12: View goat monitoring results using cameras.

Table 1: Heavy sensor performance test results on goat objects

| Number | Time | Goat 1 | Goat 2 | Goat 3 | Goat 4 | Goat 5 | Notified Server |
|---|---|---|---|---|---|---|---|
| 1 | 10.20.15 | 48,95 kg | 49,53 kg | 47,62 kg | 38,87 kg | 52,64 kg | sent |
| 2 | 10.50.15 | 48,94 kg | 49,52 kg | 47,61 kg | 38,88 kg | 52,65 kg | Sent |
| 3 | 11.20.15 | 48,95 kg | 49,54 kg | 47,63 kg | 38,88 kg | 52,64 kg | sent |
| 4 | 11.50.15 | 48,96 kg | 49,53 kg | 47,62 kg | 38,88 kg | 52,65 kg | sent |
| 5 | 12.20.15 | 48,95 kg | 49,52 kg | 47,62 kg | 38,87 kg | 52,65 kg | sent |

(b) Goat Temperature Test

Measurement of the performance of a goat body temperature sensor device to test the reliability of the sensor to be installed in the breeding house or cage. The results of the temperature sensor testing on five goat livestock shown in Table 2. From the test data in Table 2, it is comparable that the temperatures of the five goats have increased with the increase in the temperature of the breeding house; the rise in temperatures is influenced by the natural conditions, i.e. the more day it is, the more the temperature increases because of the temperature in the tropics. Data from Table 1 indicates that the body temperature of the goat is still normal in the range of 36°C to 40°C, thus classified as healthy.

Table 2: Testing the performance of temperature sensors on a goat's body

| Number | Time | Goat 1 | Goat 2 | Goat 3 | Goat 4 | Goat 5 | Notified Server |
|---|---|---|---|---|---|---|---|
| 1 | 09.20.15 | 37.15 C | 37.20 C | 37.22 C | 37.25 C | 37.15 C | sent |
| 2 | 09.50.15 | 37.25 C | 37.20 C | 37.27 C | 37.26 C | 37.25 C | sent |
| 3 | 10.20.15 | 37.25 C | 37.25 C | 37.28 C | 37.35 C | 37.28 C | sent |
| 4 | 10.50.15 | 37.28 C | 37.27 C | 37.35 C | 37.37 C | 37.28 C | sent |
| 5 | 11.20.15 | 37.31 C | 37.27 C | 37.35 C | 37.37 C | 37.29 C | sent |

(c) Physical condition monitoring camera testing of cattle and goats

Testing the transmission of image data through cameras attached to the goat cage is shown in Table 3. In Table 3 it is indicated that the image data has been sent and recorded in the system database. As for the test results for data transfer access speed, you can see in Table 4. Data transmission from sensor to server from the test results in Table 4 is relatively fast. The data transmission speed from the Android-accessible monitoring gadget from server averages more than 5.10 seconds.

Table 3: Data transmission test results from surveillance cameras

| Number | Live | Link Image |
|---|---|---|
| 1 | Live1 | http://camrea.site1/input.php?sn=2021110010/ data:image10/ |
| 2 | Live2 | http://icamera.site2input.php?sn=2021110011/ data:image11/ |
| 3 | Live3 | http://camera.site3/input.php?sn=2021110012/ data:image12/ |
| 4 | Live4 | http://camera.site4/input.php?sn=2021110013/ data:image13/ |
| 5 | Live5 | http://camera.site5/input.php?sn=2021110014/ data:image14/ |

Table 4: Data transfer speed test results

| Number | Data Transmission Speed | Time Speed (second) |
|---|---|---|
| 1 | Test1 | 5.9 |
| 2 | Test2 | 5.05 |
| 3 | Test3 | 5.08 |
| 4 | Test4 | 5.24 |
| 5 | Test5 | 5.12 |
| | Time Average | 5.10 |

# 5 Conclusion

The result of this study is a breeding house model equipped with Internet of Things (IoT) based goat development monitoring. Goat development and the current condition of breeding houses can be monitored online-Live Real-time (OLR). Monitoring is designed using Internet of Things technology (IoT). Farmers may easily keep an eye on goats' physical and health development in real-time with this approach model. The development is physically monitored through cameras. Health progress is monitored using weight sensors and body goat temperature sensors. The cost of monitoring is becoming more efficient and effective as well as the quality of livestock is improved using this Android app. The access speed of the test results is less than 5 seconds, and the average speed of data delivery is 5.11 seconds.

The results of the research showed that the physical condition of the cage significantly influenced the development of the animal condition of goats. The history data on this application can be used to monitor the body weight of the goat according to normal development, that is, according to age and type. The temperature of a goat's body is influenced by the temperature of the cage.

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