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IS-USG: INTELLIGENCE SYSTEM ULTRASONOGRAPHY Machine Learning Implementation for Recognition of Pregnant Sheep in Gumukmas Multifarm Jember

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ABSTRACT: In 2023, the government's program related to food independence emphasizes the importance of meat independence, including goat meat. CV. Gumukmas Multi Farm Jember faces several challenges in managing pregnant sheep, such as early detection of pregnancy, preventing abortion, and managing sheep health history. Therefore, the Intelligence System Ultrasonography (IS-USG) system was developed to detect sheep pregnancy more accurately and integrate medical data with the help of machine learning. This system allows automatic monitoring of pregnancy conditions and fetal health, and recommends interventions such as probiotic feeding. IS-USG is implemented using a web and mobile-based client-server architecture, with Laravel and MySQL backends, and RESTful API integration for real-time data synchronization. Testing was conducted to evaluate the effectiveness of the system, and initial results showed that this system can improve sheep reproductive management, accelerate pregnancy detection, and minimize the risk of birth failure.

KEYWORDS: IS-USG, pregnancy detection, sheep, machine learning, ultrasound, medical records.

I. INTRODUCTION

One of the government's programs in 2023 is food independence, and one of its pillars is meat independence [1]. According to the Center for Agricultural Data and Information Systems in 2020, the need for goat meat in 2023 is estimated to reach 10,000 tons [2]. One of the small industries engaged in sheep farming is CV. Gumukumas Multi Farm in Jember. Based on the results of discussions with CV. Gumukumas Multi Farm, four main problems were found in the initial survey: a) The need for early detection of the condition of pregnant sheep aged 40 to 60 days so that pregnant sheep can be examined safely and maintenance costs are reduced because sales can be made earlier, b) There are cases of abortion in sheep due to abnormal births and deaths, so an early detection system using ultrasound is needed, c) Treatment recommendations must be made based on early detection carried out so that development runs normally with a balanced diet and probiotics, and d) The breeding results achieved to date have not been properly recorded and are not listed on the sheep certificate.

The development of the Intelligence Ultrasonography System (IS-USG) is an innovative step in detecting pregnancy in sheep, monitoring fetal development, and storing sheep health history in an integrated manner. This system is designed to increase sheep productivity and reduce fetal mortality through sophisticated and easy-to-implement methods, so that it can provide more precise results in monitoring livestock health.

Traditional ultrasound systems used for animals today are limited to examinations to visually diagnose a variety of health problems, such as tumors or infections [3]. Although useful, this technology does not provide comprehensive information about the pregnancy history and health condition of the ewe fetus. With the application of the IS-USG system, not only visual images are produced, but also complete information about the nutritional needs and health of pregnant ewe, which is very important to prevent birth failure.

Through the use of machine learning, this system can improve the accuracy of detecting sheep pregnancy [4]. The data communication protocol will be modified to allow analysis of images generated by ultrasound, to determine whether the pregnancy condition of the sheep is in the normal category or not. The data from the analysis will be recorded in the medical record system. If a problem is identified, intervention measures such as probiotic feeding will be implemented immediately. Thus, the quality of the sheep offspring can be maintained through proper pedigree recording, so that the risk of inbreeding can be minimized.

II. METHOD

In this activity, steps were applied to implement IS-USG at Mitra Gumukmas Multifarm as explained in the picture.1The following implementation methods:

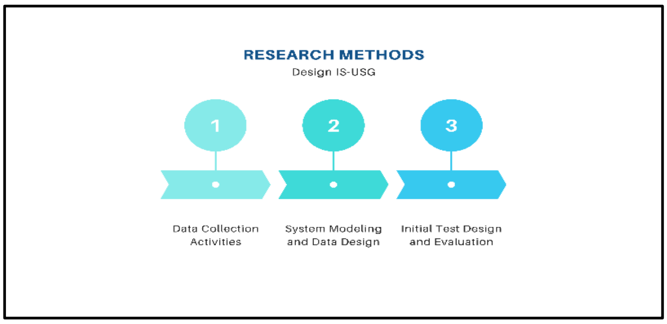


Fig. 1 Research Methods

A. Data Collection Activities

The initial stage of this research focused on collecting relevant data from partners as a basis for further development [5]. The data collected includes sheep productivity, which is then processed into a tabulation that can be used for further analysis. In this process, students are actively involved in helping to collect and process data, including presenting the results in the form of tables and graphic visualizations. This activity produces a sheep productivity tabulation document that will be the basis for the next research step.

B. System Modeling and Data Design

At this stage, the research focuses on creating an integrated system design that will be a guideline in developing the IS-USG engineering device. This design includes the preparation of a system circuit, the creation of UML, wireframes, and database diagrams that will be used in software implementation. Students participate in helping to prepare this design model by contributing to various technical aspects. The final result of this activity is a system modeling document that will be the basis for the next implementation process.

The following is a Machine Learning modeling design for an ultrasound system

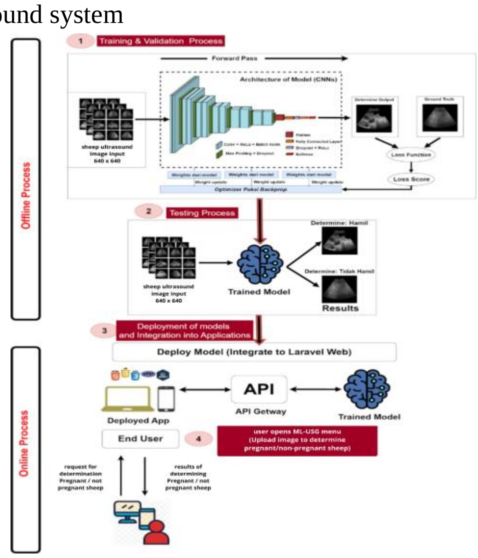


Fig. 2 End to End AI IS-USG

This figure shows the workflow of a sheep pregnancy detection system using the Convolutional Neural Networks (CNNs) model. In Process 1, the model is trained using the sheep ultrasound (USG) image dataset [6]. This data is used to train and validate the model, resulting in a pre-trained model [7]. Process 2 involves testing the pre-trained model with real data to test its accuracy in determining pregnancy status [8]. Although this step is optional, it is important to ensure that the model performs well on data outside the training dataset, depending on the data splitting scheme used [9].

After testing, in Process 3, the trained model is deployed to a Laravel-based backend application. The model is directly integrated into the system for use in real-world scenarios. In Process 4, farmers or end-users can access the ML-USG feature through a web or mobile interface. Users simply upload a sheep ultrasound image, and the model processes it to determine the pregnancy status of the sheep, providing fast and accurate results. Convolutional Neural Network (CNN) is a type of artificial neural network specifically designed for processing grid data tasks such as images, and is particularly effective for pattern and object recognition in images [10].

C. Initial Test Design and Evaluation

This stage focuses on the design of the device testing method, which aims to ensure the function and effectiveness of the IS-USG system. The test is designed theoretically with a focus on evaluating the expected results, including device testing, sheep medical record data analysis, and probiotic treatment. The expected output is a data collection plan and initial evaluation based on the designed test design. This test method design document will be a reference in the implementation and evaluation stages of the system in the future.

III.RESULTS

Based on the research that has been carried out, the following results were obtained:.

A. Data Collection Activities

The data obtained in this stage focuses on sheep identification, including basic information such as identification number, age, sex, and initial health status. This identity data is important for building the data framework needed in the information management system and medical records to be developed. Although limited, this information is the initial basis for compiling a system model that can accommodate the addition of more detailed data in the future.

B. System and Data Modeling Design

The IS-USG system modeling is still designed with the integration of sheep identity data as a main component in mind. The system design is capable of handling identity data with the flexibility to be further developed when health data or medical records are added [11]. The resulting UML diagrams and wireframes provide an overview of how the identity data flow will be managed in the system, ensuring good connectivity between the various components to be implemented.

1. *System Architecture:*

This system uses a client-server architecture, where users (veterinarians and farmers) can interact through a web interface or a mobile application. On the frontend side, for the web, the system is built using HTML, CSS (Tailwind CSS), and JavaScript which produces a responsive and intuitive interface. Meanwhile, for the mobile application, the Flutter framework is used to ensure a consistent user experience across devices. On the backend, for both web and mobile, the Laravel framework is used to handle business logic, user authentication, and data storage. This system also utilizes MySQL as a database to store medical records, IS-USG examination results, and sheep profiles [12]. All interactions between the frontend and backend are facilitated through RESTful APIs, ensuring real-time and efficient data synchronization between the user interface and the central server, including integration with IS-USG devices

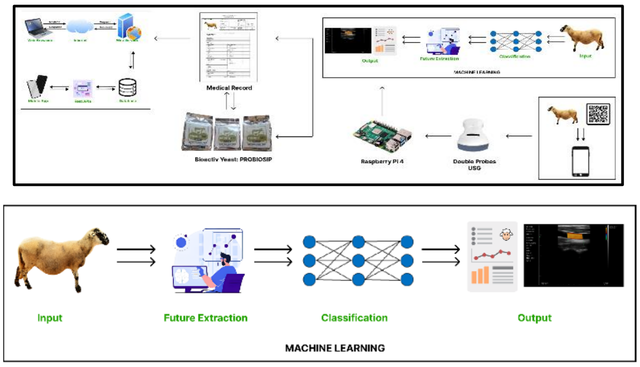


Fig. 3 IS-USG Machine Learning Flow

On the Machine Learning side of IS-USG, using Convolutional Neural Networks (CNN) which works through several interconnected stages to process and analyze image data. First, the image is fed into the CNN through a convolution layer, where special filters are used to detect important features such as edges, textures, and patterns from the image [13]. This process allows the network to extract relevant information from the image automatically.

After that, the data that has been extracted through the convolution layer will be processed by the pooling layer. This layer serves to reduce the dimension of the data while maintaining the most important features, thereby reducing the amount of information that needs to be calculated without losing the quality of the prediction [14]. Next, the compressed data is passed to the fully connected layer, which connects all previous neurons to make a final decision based on the extracted features, such as classifying whether an image shows a pregnant sheep or not [15].

In the final stage, after the data is processed by the fully connected layer, activation functions such as ReLU are used to introduce non-linearity, allowing the model to recognize more complex patterns. Then, the final result of the prediction will be processed and output as a classification, providing a conclusion based on the model training [16].

2. *Workflow Scenario:*

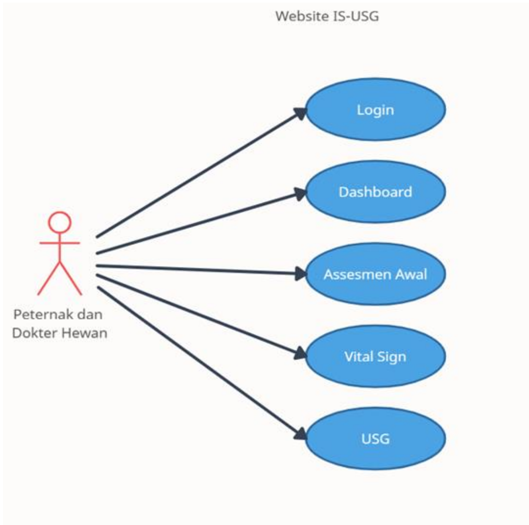


Fig. 4 Use Case Diagram

The IS-USG system modeling is still designed with the integration of sheep identity data as the main component in mind. The system design can handle identity data with the flexibility to be further developed when health data or medical records are added. The UML diagrams and wireframes produced provide an overview of how the identity data flow will be managed in the system, ensuring good connectivity between the various components to be implemented [17].

3. *Workflow:*

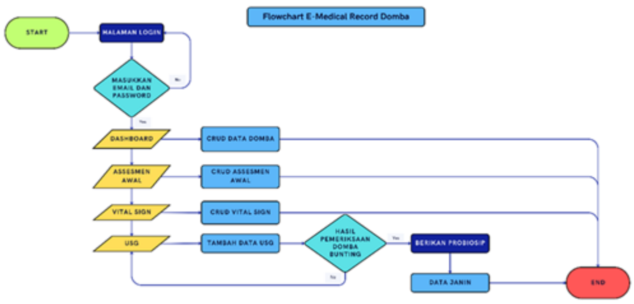


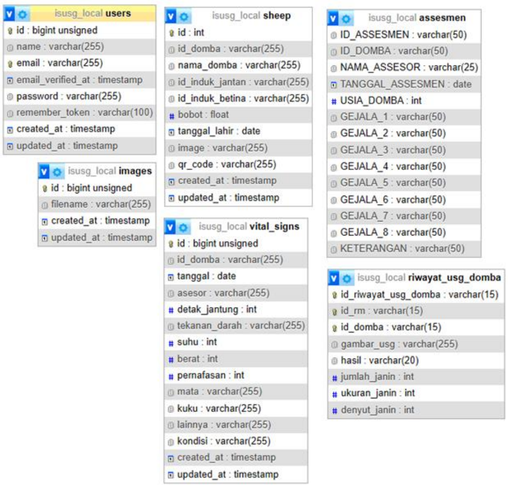
Fig. 5 Flowchart

The flowchart for the Sheep Medical Record Website and Mobile system follows an efficient flow, starting from login, where the user enters a predetermined account. After the account is validated, the user successfully logs in and is directed to the main dashboard. Within the dashboard, users can access various features such as CRUD sheep data, initial assessment, vital signs, and ultrasound examinations. Each feature gives users the ability to input, display, update, or delete related data, and provides confirmation notifications after each operation. After the user has finished accessing one of the features, the user can return to the dashboard to select other features or complete the session user.

4. *System Requirement:*

The system requirements for the Domba Medical Record Website and Mobile include a server with a multi-core processor, minimum 8GB RAM, and 500GB SSD for data storage. The backend system uses the Laravel framework, with MySQL as the database for storing medical records and examination results. On the frontend side, the website is built using HTML and Tailwind CSS, while the mobile application uses Flutter. The web server used can be Apache or Nginx. Users can access the system through a modern browser for the website, as well as a mobile application with RESTful API integration that connects ultrasound data between the website and mobile efficiently.

5. *Database Design:*



The Sheep Medical Record Website database design is designed to support structured and efficient data management, with a focus on storing information related to users, sheep identities, and medical records. This system utilizes MySQL as the main database, which consists of several core tables to manage sheep data, medical records, initial assessments, vital signs, and ultrasound examination results. Each table is designed to be interrelated to allow for comprehensive data integration, supporting easy access and tracking of sheep health history in real-time. This design ensures flexibility and scalability in handling sheep medical data at various farm scales.[18].

6. *User Interface Design:*

a. *Login*

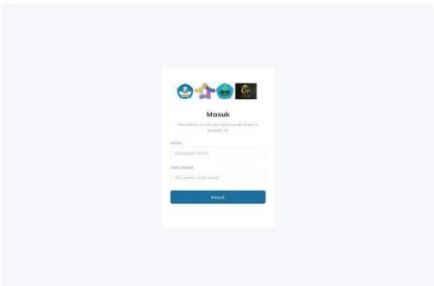


Fig. 7 Interface Design Website Login

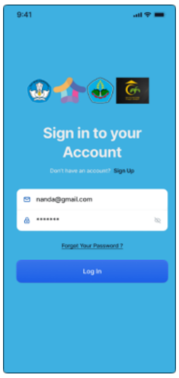


Fig. 8 Mobile Login Interface Design

Users (veterinarians or farmers) can log in to the system with a registered account. This feature ensures secure access only for authorized users, through an authentication process.[19].

b. *Dashboard*

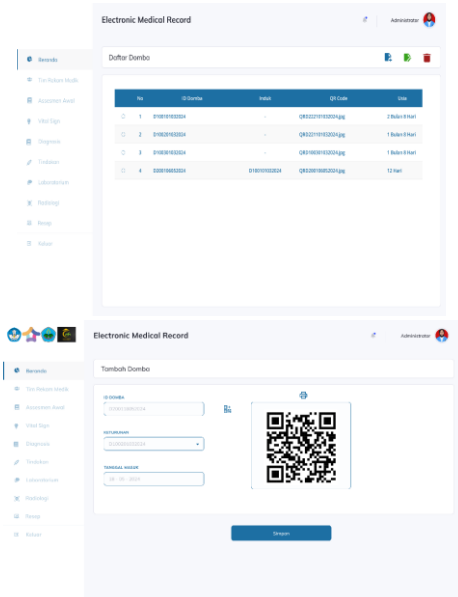


Fig. 9 Website Dashboard Interface Design

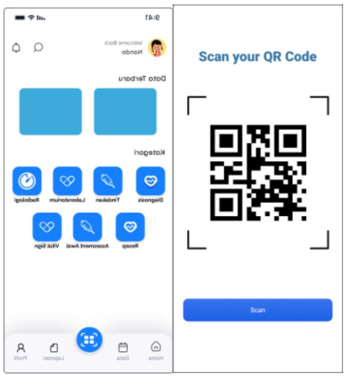


Fig. 10 Mobile Dashboard Interface Designs

The dashboard serves as a control center for users to manage all sheep data and their medical records. In the dashboard, users can access various important features such as Sheep Data CRUD, where users can add, display, update, and delete sheep data. Each registered sheep will be equipped with a unique QR Code, which makes it easy to identify and quickly access medical data through scanning[20].

c. *Initial Assessment*

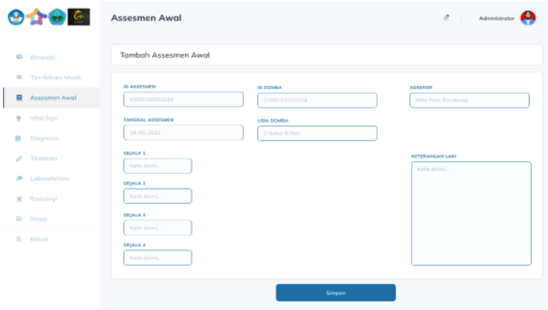


Fig. 11 Interface Design Initial Assessment Website

Fig. 12 Interface Design Initial Assessment Mobile

This feature allows users to input initial assessment data of sheep, which includes important information such as physical condition and health history. The initial assessment is used to provide an overview of the condition of the sheep before further action is taken. Once the initial assessment data is entered, the system will store it in a database and link it to the sheep profile identified through the QR Code, making it easy to track and quickly access related medical information.

d. *Vital Sign Checkup*

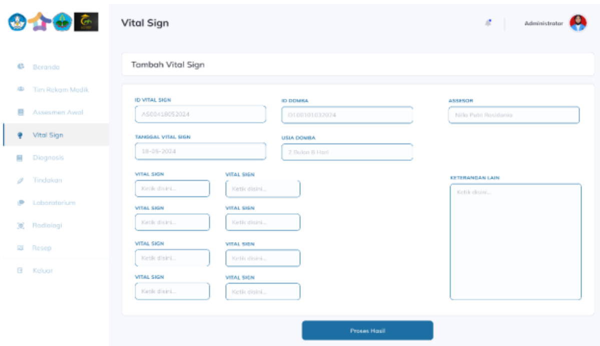


Fig. 13 Interface Design Vital Sign Websites

Fig. 14 Mobile Vital Sign Interface Designs

This feature allows users to record vital signs of sheep, such as body temperature, pulse rate, and respiratory rate. This vital sign data is important for monitoring the health condition of sheep in real-time. Every data entered will be stored in the database and directly connected to the sheep profile via QR Code, making it easier to monitor the health of sheep comprehensively and historically.[21].

e. *Pregnancy Detection*

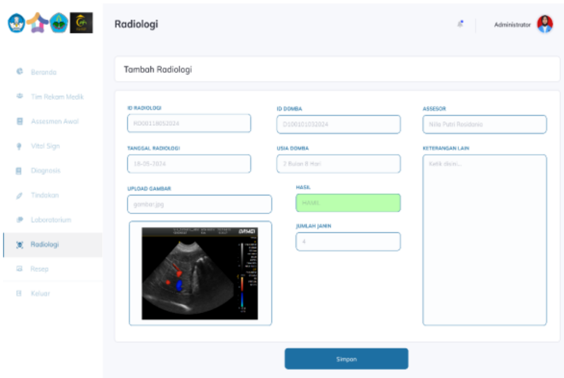


Fig. 15 USG Website Design Interfaces

Fig. 16 Mobile USG Interface Design

This feature allows users to record and save the results of sheep ultrasound (USG) examinations.[22]. If the ultrasound results show that the sheep is pregnant, the system will record the information and provide recommendations for administering PROBIOSIP as a vitamin to support the health of the sheep during pregnancy. This ultrasound data will be directly connected to the sheep profile via QR Code, making it easier for veterinarians and farmers to track the sheep's reproductive health history, as well as assisting in better management of pregnancy care.

7. Development Plan

The development plan for the Sheep Medical Record Website includes enhancing features and integrating AI-based sheep health analytics to predict health conditions. In addition, the plan includes creating a mobile application for easier and more flexible data access. Improving data security and optimizing server performance to handle a larger number of users is also a priority.

8. Initial Test Design and Evaluation

Initial testing focused on validating the management of sheep identity data through the IS-USG system. The testing method involved simulating the input and processing of identity data to ensure data accuracy and integrity. Initial evaluations showed that the system was able to handle identity data efficiently, with results as expected.

CONCLUSIONS

Identity data collection is an important part of the development of this system. The data obtained provides an initial insight into how the system can facilitate the efficient storage and management of animal information. Clarity of sheep identity helps to build a more structured system architecture, allowing researchers to track each individual in detail in the future.

The developed system design has shown flexible capabilities to receive and process data with precision. The UML diagrams and wireframes produced show data flow scenarios that are arranged to support further development. This system model is ready to be implemented in the field and tested on a wider scale with additional medical data and ultrasound test results.

The initial testing phase showed that the system can work with identity data effectively. Initial validation ensures that the system is reliable as a platform for animal data management. These results will be an important basis for the development of more sophisticated technology-based animal medical record devices in the next implementation phase.

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