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Cattle Farm Management System Using Machine Learning and Image Processing

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Abstract*: Livestock production in Sri Lanka faces multi- faceted challenges in disease management, milk production optimization, dietary enhancement, and financial performance. This research paper encompasses four significant components aimed at revolutionizing the cattle farming industry. The first segment introduces an innovative image processing-based solution to accurately identify and manage cattle diseases. By analyzing photos of cattle, this system diagnoses ailments and offers tailored treatment recommendations, thereby curbing disease spread and improving overall herd health. The second segment addresses milk production challenges, focusing on predicting and managing milk yields. Through comprehensive data analysis and predictive modeling, the study aims to mitigate disparities between forecasted and actual harvests, providing practical strategies for farmers to enhance productivity. The third segment concentrates on optimizing cattle diets. By collecting and analyzing data on nutritional needs, growth rates, and environmental factors, machine learning models are developed to enhance feeding schedules, ensuring improved health, productivity, and reduced feed costs.Lastly, the fourth segment aims to optimize financial performance in cattle operations. Leveraging machine learning and data analysis, the study focuses on cost tracking, cost estimation, and revenue optimization. Continuous monitoring allows for the implementation of money-saving techniques to increase overall profitability. These research initiatives collectively provide valuable insights and practical strategies for Sri Lankan cattle farmers, ultimately fostering a sustainable and thriving livestock industry. The integration of advanced technology and data- driven approaches holds the promise of elevating productivity, disease management, and financial sustainability within the cattle farming sector.

Keywords*: livestock disease management, image processing solutions, milk production optimization, cattle diet enhancement, financial performance in livestock operations.

1. Introduction

Cattle farming holds an indispensable role in many nations, particularly in countries like Sri Lanka, significantly contributing to their agricultural industry and economic stability. In Sri Lanka, the dairy industry plays a pivotal role in elevating the country's GDP and providing employment opportunities, primarily in rural areas. However, despite its economic significance, the dairy sector faces myriad challenges, including low milk production, unprofitability, and the management of cattle diseases.

This research paper encompasses multiple components that target distinct challenges within Sri Lanka's dairy industry. Primarily, the focus is on leveraging machine learning techniques and data analysis to enhance decision-making regarding cost tracking, production cost estimation, and identifying cost- saving measures in dairy cattle operations. The overarching objective is to improve the financial performance of cattle operations, ultimately addressing the industry's challenges related to high production costs and profitability.

An integral aspect of the research involves the optimization of cattle diets using data-driven methodologies. Traditionally, dietary decisions have been based on subjective judgment and prior experience, often neglecting the individualized nutritional needs of cattle. To overcome these limitations, the study emphasizes the development of machine learning models that analyze various factors influencing nutritional demands, such as growth rates, milk production, and environmental elements. By optimizing cattle diets based on these models, the aim is to enhance cattle health, performance, and reduce feed costs. Additionally, the research addresses the critical issue of disease management in cattle. An innovative solution is pro- posed, involving an image processing-based system capable of accurately recognizing and diagnosing cattle diseases. By creating a comprehensive database of ailments and their symp- toms, coupled with an efficient image processing program, the system aims to provide early disease detection and offer optimal treatment recommendations. Subsequent objectives focus on user interface integration, recommendation systems, and stringent testing to ensure accuracy and privacy of data.

These comprehensive research endeavors collectively strive to revolutionize Sri Lanka's cattle farming industry. By amalgamating advanced technologies, machine learning techniques, and data-driven approaches, the study aims to mitigate challenges, improve productivity, enhance cattle health, and ensure the economic sustainability of the dairy sector in Sri Lanka.

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2. Literature Survey

Since dairy products are a rich source of vitamins and minerals necessary for preserving human health, they are widely consumed worldwide. Sri Lanka's share of global dairy output by developing nations has increased. One of Sri Lanka's most promising agricultural sub-sectors is cattle and livestock. Due to restrictions on the import of dairy goods, there has been an upsurge in the demand for high-quality milk products in Sri Lanka recently, Cattle farmers are strongly urged in such conditions to increase milk production. Farmers face numerous difficulties in increasing milk output, though. These include difficulties in determining the best breeds of cows for milk production, inability to recognize illnesses and conditions affecting farm animals that interfere with milk production, and difficulties in predicting milk production on a farm [1].

In order to increase the production development from this sector and reduce reliance on imports, initiatives on animal husbandry revival are urgently required. This essay aims to outline the work done in establishing a mobile intelligent system for diagnosing cattle ailments and providing first aid action suggestions. Fuzzy neural networks are used in the development of the system's main intelligent engine. Given the widespread use of smartphones, the user interface was created as a mobile application running on the Android OS. System evaluation using a real-world cattle diagnosis medical data set and expert verification revealed that the systems were capable of making accurate diagnoses with a 100% validity rate and an average accuracy of 96.37%. According to the experimental findings, frame-based knowledge representation outperformed rule-based knowledge representation [2].

Since they only provide sporadic data and necessitate a significant time and money commitment from veterinarians, current clinical techniques for live-stock health monitoring are insufficient. The livestock business may gain a lot from a sophisticated system that can continuously evaluate the health of individual animals, gather these data, and transmit the findings to owners and regional authorities. A system like this would not only enhance the health of each individual animal but would also aid in spotting and stopping contagious diseases, whether they were brought on by biological invasions or natural causes. In this work, the outcomes of a prototype telemonitoring system that uses wearable technology to continuously record animal health data are presented. Presented are the system requirements, hardware specifications, software requirements, and representative physiological measurements [3].

One of the main dangers for the spread of foot-and- mouth disease (FMD) is cattle transportation. The description of this intricate transportation network could be useful for surveillance and management duties. For FMD epidemiology in particular, network centrality may offer pertinent data. For the network of cattle transportation, a number of centrality measures can be calculated, and each one may offer insightful data on the dynamics of animal movement. Because it might not provide enough information to prioritize crucial nodes in the transportation network related to FMD propagation, taking into account just one centrality measure is of limited use. This study takes into account the network of cattle movement when identifying FMD's so called super-spreaders. The nodes known as super-spreaders have the ability to maximize their influence across the whole network. Multiple centrality measures that were computed on each node, such as degree and betweenness centrality, among others, were aggregated to identify these nodes. This method allows for the construction of a ranking of nodes with a high susceptibility to FMD propagation. Our findings demonstrate the need to identify super-spreaders nodes in the cattle transportation network in order to identify highly vulnerable regions while researching FMD spread [4]. Using the CBR and NNS approaches, one can quickly identify the diseases that affect cattle by comparing the similarities between newly discovered instances and those already recorded in the knowledge base. With 160 training data and 80 test data, this web-based application's diagnosis results had an accuracy of 85.83%. The CBR method and the NNS system have performed effectively in the diagnosis of Madura cattle illness, as evidenced by the high accuracy. To achieve more precise results, this algorithm must incorporate more symptom reasoning data and give each symptom more weight when diagnosing cattle diseases. Additionally, in order to lower the error rate, we require a technique for assessing the solution from the prior case. The proportion of calculation results received for testing the ginger plant diagnostic system was 77.68% and was rated as good based on the responses obtained from 21 respondents [5].

The cattle sector has seen significant growth in recent years, and lameness is a common health problem that affects both animal comfort and livestock productivity. Lameness has an impact on yield and profit in addition to animal welfare. Additionally, lameness is seen as a significant health and financial concern in contemporary cattle farming due to its high prevalence on farms. As a result, it is crucial to identify lameness early on and to do so accurately and promptly. The livestock business has recently adopted artificial intelligence and deep learning methods for lameness identification. In this study, we implemented a cow region detection system using the instance segmentation approach of Mask R-CNN [6].

The research undertook a comprehensive examination of current agricultural disease detection and diagnosis studies that employ Deep Learning (DL) techniques with multiple algorithms. According to the analysis, DL algorithms demonstrate a high degree of accuracy in diagnosing leaf diseases when there is an ample amount of data available for training. The study delved into various aspects, including the importance of amassing extensive datasets, the preprocessing tasks involved, the utilization of data augmentation techniques, and the evaluation of overall performance through performance metrics. While a number of DL methods showcased commendable detection results in specific datasets, they did not consistently perform well on larger datasets, indicating a lack of universal adaptability. Consequently, there is a need for customization to enhance the accuracy of DL models for different disease samples. Notably, most of the studies evaluated the effectiveness of DL models using the Plant Village dataset, which contains a substantial volume of images depicting various plants and their associated disorders. However, it is worth noting that this dataset was artificially generated in a controlled environment. Therefore, there is a pressing need for a substantial dataset comprising real-world scenarios of plant diseases [7].

A comprehensive review of the existing literature sheds light on numerous issues that strongly resonate with the challenges confronted by Sri Lankan dairy farmers. Within this body of research, the work of Smith et al. (2019) [8] notably underscores the profound significance of meticulous record-keeping in the context of cattle farming. They bring to the forefront the pivotal role that technology plays in the modernization of record-keeping processes, propelling agricultural management into the digital age.

Furthermore, the investigations conducted by Johnson and Patel (2020) accentuate the critical importance of data analysis tools in the realm of predicting milk production patterns and optimizing the allocation of resources. [9] Their scholarly pursuits offer compelling evidence that the implementation of predictive modeling can usher in heightened efficiency within dairy operations, benefiting farmers through stream- lined decision-making processes.

In the context of addressing the vexing issue of inconsistent milk production, the research undertaken by Brown and Garcia (2018) delves deep into the intricate web of environmental factors that exert influence upon milk yields. [10] Their insightful findings underscore the value of comprehending and mitigating these multifaceted factors, thereby paving the way for more stable and predictable milk production practices. The implications of their work resonate strongly with the quest for improved dairy farming management in Sri Lanka, offering valuable insights into strategies for mitigating production fluctuations.

The design of a system for the automated dosing of cattle feed using mechatronic devices is presented in this study. Every procedure that needs to be controlled, including the belt drive, the weighing of the packages, which are divided into three weight categories (1/2 kg, 1 kg, and 2 kg), and the distribution, uses sensors and a force provided by a pivoting arm. Additionally, by using the current weight at the time of weighing on the scale as a variable, the addition of PLC optimized the process of identifying the weight of the cows and allocating their ratio. Additionally, the mechatronic system will lessen feed investment losses, increase feed distribution efficiency, and enhance cow quality of life [11].

The tests conducted show that the acoustic approaches offered have good performance rates. Additionally, they offer in-depth details (both short- and long-term) of the ruminant's foraging behavior. The proposed approaches can be executed in real time by a straightforward embedded device due to their cheap computational cost. When compared to a commercial system, the activity recognition method performed better in some instances. Future studies should address the problem of robustly recognizing rumination and grazing activities. The embedded system that was constructed exhibited adequate communication, processing, and autonomy traits [12].

Cattle can be fed most effectively by grazing across grasslands. Cattle that have been scatted can be bred. The well-known poem" the blue sky, the boundless grassland, while wind blows, grass, cattle and sheep can be found" can be found in many different contexts. But because natural grasslands have been destroyed, it is impossible to produce enough milk [13].

Weighing the cattle is a challenge for many cow breeders. The huge and massive body of the cow and the absence of weights on traditional farms and livestock markets are to blame for this. With the use of this research, farmers will be able to weigh their cattle and automatically feed them according to the times of day (morning, day, and night). The technology uses a keypad as an input device, a load cell sensor for heavy weighing, the HX711 module as an ADC, the RTC DS3231 for scheduling time readings, the servo motor to spin and push the weighed feed, the Arduino as a control center, and an LCD as a tool for information viewing. The outcomes demonstrated the system's potential for success. All of the components can operate as intended. Cows may be weighed heavily using load cells with a 91.90% success rate. The success rate for distributing feed on the schedule for feeding cows is 93.62%, and the RTC DS3231 can read the time to schedule distribution of feed according to the desired time [14].

A large-scale feed distribution for cattle is the purpose of a cow feed mixer. Precise amounts of specific smaller dry and liquid materials must be added to the total mixture. Currently, these nutrients must be manually calculated, measured, and added to the primary mix from the top of the mixer. The user estimates and manually controls the mixer's overall feed output while it is in motion. This implies that either there may not be enough feed at the end of the run or there may be a shortage. The purpose of a cow feed mixer is to evenly distribute feed to animals on a big scale. It is necessary to add specific tiny dry and liquid materials to the mixture in exact amounts. The user must currently manually calculate, measure, and include these nutrients into the main mix using the mixer's top. While the mixer is moving, the user estimates and manually controls the total feed output. This means that either there will be extra feed at the conclusion of the run or there will be insufficient feed [15].

The Food and Agriculture Organization (FAO) reports that the dairy industry contributes 17% of the entire livestock sector's GDP, which is a significant portion of Sri Lanka's agricultural economy [16]. However, the industry faces tough obstacles such as varying milk prices, restricted access to feed and water sources, and expensive production costs. These difficulties reduce dairy farmers' profitability and limit the sector's potential for growth.

Utilizing data and technology to improve dairy farm management and boost profitability has been the focus of recent research. An investigation by Bandara et al. [17] it was looked at whether machine learning algorithms could be used to forecast milk yield and boost Sri Lankan dairy farming productivity. To create a prediction model, the authors gathered information on a variety of elements, such as the cow's age, breed, and weight as well as the quantity of feed and water offered. The outcomes demonstrated that the machine learning method beat conventional regression models, offering precise predictions of milk yield and pointing to the possibility of increased profitability through enhanced feeding and management techniques of recent research.

Another study by Lambrino et al. [18] explored the potential for enhancing the effectiveness and profitability of dairy production using a decision support system (DSS). To give farmers timely advice on feeding and management techniques, the DSS used information on milk production, feed costs, and labor expenses. According to the authors, using the DSS boosted milk yield significantly, decreased production expenses, and increased profitability for dairy farmers.

In the same way, research by Zakeri et al. [19] Early detection of events in milk collection planning is crucial for optimizing the dairy supply chain and ensuring efficient operations. Research in this area highlights the significance of real-time data acquisition and event detection systems. These systems utilize various technologies, including sensors, IoT devices, and data analytics, to monitor critical parameters such as milk quantity, quality, and transportation conditions. Early event detection allows dairy managers to respond promptly to issues like equipment failures, milk spoilage, or transportation delays, thereby minimizing disruptions and ensuring the timely collection and delivery of milk.

3. Methodology

This system helps the cattle farmers to marinating their cattle farms. Following Fig. 1 shows the system overview of the whole system.

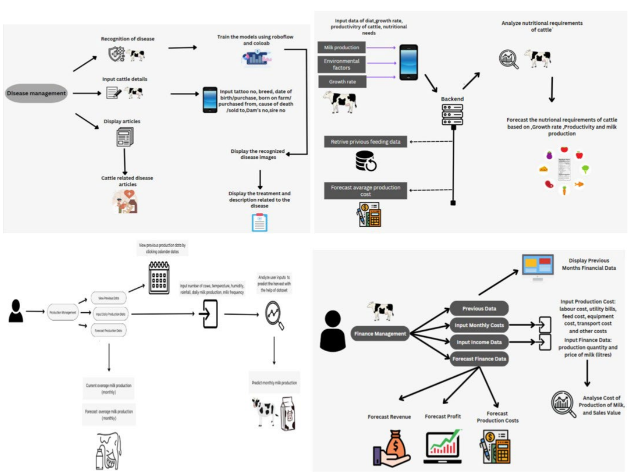

Fig. 1. System overview diagram

A. Create an Disease Recognition to Identify Cattle Diseases

Nowadays most of the people in our country and the world using smart phones. So, using a mobile application is a simple. But the application should be a user friendly one. Creativity and smart of an application valued the customer usability. Through this application we are trying to implement a disease recognition to identify diseases using images that user given as inputs. Then disease recognition identifying the illness and then give best possible guidance to minimize the spread of the disease.

Datasets annotate using Roboflow the accuracy of datasets are 59.3% and 67.6% respectively. In our research, we leverage the powerful capabilities of Google Colab to train our disease recognition model. Google Colab, short for Google Collaboratory, provides a cloud-based environment that is particularly well-suited for machine learning and deep learning tasks. With access to high-performance GPUs and TPUs, Colab allows us to efficiently train complex neural networks and process large datasets without the need for expensive hardware investments. Moreover, Colab integrates seamlessly with popular machine learning libraries like TensorFlow and PyTorch, enabling us to implement, experiment, and fine-tune our disease recognition algorithms with ease. This collaborative, cloud-based platform not only streamlines the training process but also facilitates knowledge sharing and collaboration among research team members, making it an invaluable tool in our pursuit of advancing disease recognition technology for the benefit of both the agricultural and medical fields.

In the implementation of the disease recognition there is 3 steps, first one is, identify disease:

- User can input image using mobile device or have option to check using live camera.
- System will identify the disease using image processing. It can display using Fig. 2.
- Using yolo v8 for training the model.

Second one is, solution for the diseases:

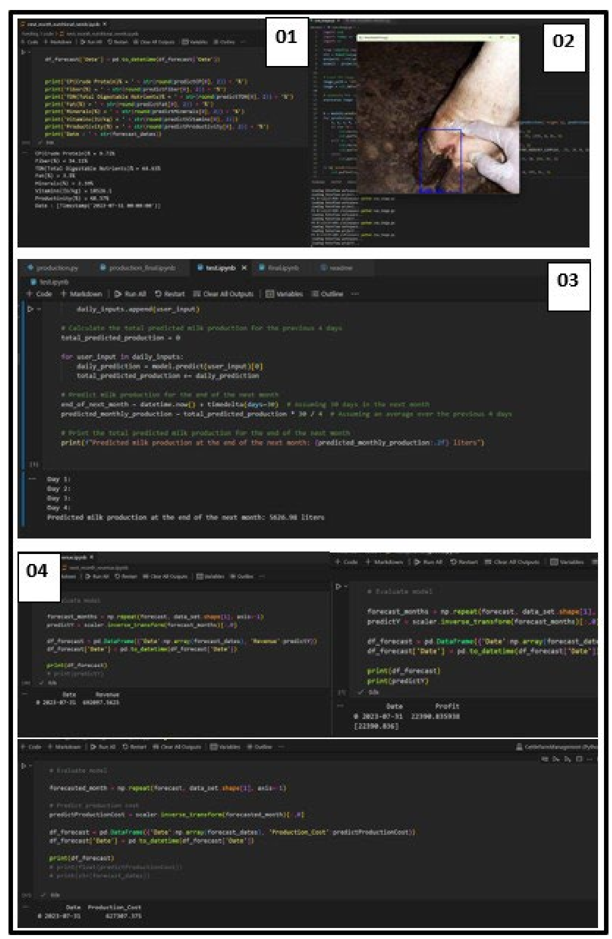

Fig. 2. Disease identifying using image processing

- System will show the result for the disease like name, disease description, solution and recommendations.
- User can get to the read the disease article click on read more button it will redirect to the farm guide part.

Third one is, save disease data:

- System will provide the questions for the user
- Cattle index
- Cattle breed

If user verify the system disease, if right so system will save the disease data use for forecast algorithms.

YOLO (You Only Look Once) is a deep learning-based object detection model that utilizes a specific mathematical equation to identify objects within images or video frames. YOLO's key innovation is its ability to perform both object localization and classification in a single forward pass through a neural network. The equation at the heart of YOLO is the one responsible for generating bounding boxes and class predictions. Let's delve into this equation with advanced details.

YOLO Equation: The core equation used in YOLO for object detection is as follows:

$$P(object) \cdot IOU \cdot P(classobject) = P(class) \cdot P(objectclass) \cdot P(classobject) \quad (1)$$

- P(object): This term represents the probability that an object exists in a given grid cell. YOLO divides the image into a grid of cells and predicts whether an object's center falls within a particular cell.
- IOU: IOU (Intersection over Union) measures the overlap between the predicted bounding box and the ground truth bounding box. It quantifies how well the predicted box aligns with the actual object.
- P(classobject): This is the conditional probability that a particular class is present given that an object is detected. YOLO can classify objects into various predefined classes, and this term represents the confidence score for each class.
- P(class): This is the prior probability of a particular class, irrespective of whether an object is present or not. It provides the overall likelihood of encountering each class in the dataset.
- P(objectclass): This term is responsible for estimating the probability that an object exists given that a particular class is detected. It combines both objectness and class prediction.

Explanation:

In essence, YOLO processes an image by dividing it into a grid and making predictions within each grid cell. For each grid cell, the model predicts bounding boxes and associated class probabilities. The equation above quantifies the confidence of the model's predictions.

• P(object) assesses whether there is an object within a grid cell.

• IOU measures how accurately the predicted bounding box aligns with the actual object.

• P(classobject) gives the class confidence for the detected object.

• P(class) provides the general class probabilities.

• P(objectclass) combines objectness and class prediction.

YOLO's training objective is to optimize this equation to make accurate predictions for both object presence and class labels.

It uses techniques like backpropagation and gradient descent to iteratively improve its predictions during training.

This equation, along with a deep convolutional neural network, enables YOLO to achieve remarkable accuracy in real-time object detection, making it a powerful tool in computer vision applications. The model training outputs are displaying in fig. 2 part 02.

In fig. 3 displaying the model training output for Bovine Viral Diarrhea disease and fig 4 displaying the model training output for Foot Rot disease.

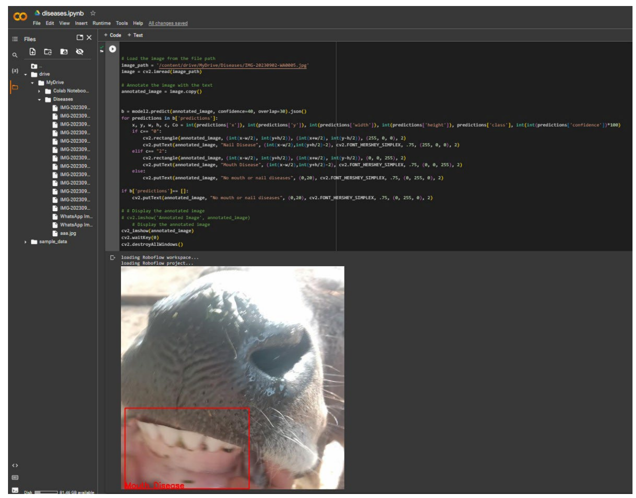

Fig. 3. Bovine viral diarrhea disease

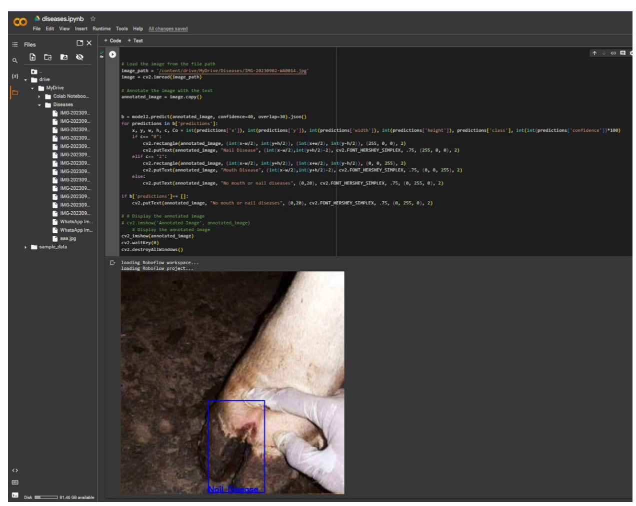

Fig. 4. Foot rot disease

B. *Identify, Analyze and Forecast the Harvest and Production of a Cattle Farm*

Through this application we are trying to Identify and analyze the factors that affect the harvest and productivity in a cattle farm, calculate the actual harvest and compare it with the analyzed data, develop predictive models that can forecast future harvests and productivity, identify the reasons for any discrepancies between the actual harvest and the predicted harvest, and develop strategies to address them.

The implementation of this multifaceted data collection and forecasting function for cattle farming involved a carefully orchestrated blend of technologies and design considerations. Leveraging Google API within Google Colab and Python allowed for the seamless acquisition of environmental data, including daily average temperature, humidity, and rainfall, enhancing data accuracy. The user interface prioritized user-friendliness, acknowledging the potential challenges of daily data input, ensuring a streamlined and efficient process for farmers. Importantly, the system accommodated users by enabling them to review previously added data while maintaining data integrity by disallowing updates. MongoDB served as a robust database to store and manage the collected data, offering scalability and reliability. The generation of monthly forecasts, represented through a line chart featuring both historical production points and the forecasted value, empowered farmers with valuable insights. Additionally, the integration of "read more" links to a farm guide on production articles under- scored the system's commitment to providing comprehensive resources for cattle farmers, making it a well-rounded and practical solution for the industry. The model training outputs are displaying in fig. 2 part 03.

C. Identify, Analyze and Forecast the Feeding of a Cattle Farm

Implementing the Cattle Feeding function involves a multifaceted approach, combining various technologies and development processes to create a comprehensive solution for cattle farmers. Here's a breakdown of the key steps in the implementation process:

- In the initial phase, the focus is on collecting essential data from the farmer. This begins with the creation of a user-friendly User Interface (UI) for the mobile app, which is built using Android Studio. The UI includes input fields and forms designed to capture crucial information such as the type of food, feed composition, growth rate, productivity, monthly feeding costs, health data, and environmental factors. These input fields may include dropdown menus, text fields, and checkboxes to facilitate data entry and ensure data accuracy.
- Once the data is collected, the system employs machine learning techniques, potentially utilizing Google Colab for model training. Machine learning models, such as regression or neural networks, are trained to forecast nutritional needs based on the collected data. The results generated include predictions of nutritional requirements, suggested feeding diets with precise quantities, feeding schedules, and graphical representations of nutritional needs over time through charts and graphs, allowing farmers to visualize trends and make informed decisions. Additionally, a cost analysis algorithm is implemented to calculate feeding costs and offer cost-saving recommendations, such as optimizing feed compositions or sourcing options.
- The system includes "Read More" links within the mobile app, strategically placed to direct users to relevant farm guide articles related to cattle feeding. These links serve as valuable resources, providing additional knowledge and guidance to farmers, thus enhancing their understanding of best practices in cattle feeding.
- Efficient data storage is essential for future analysis and forecasting. MongoDB is used as the database to store user inputs and feeding data. A well-structured database schema is implemented to organize and store data efficiently. Data is saved on a per-cattle or per-calf basis, allowing for historical tracking and analysis. To ensure data security and user privacy, the system incorporates robust authentication and authorization mechanisms.
- The mobile app is seamlessly integrated with a back-end system, which could involve creating an API or backend service. This backend facilitates communication between the mobile app and the MongoDB database. It handles critical functions such as data processing, result generation, and data storage, ensuring the app's smooth operation.
- To guarantee the app's reliability and accuracy, comprehensive testing is conducted. This involves identifying and resolving any bugs or issues that may arise during usage. Rigorous testing also assesses the accuracy of the machine learning model's predictions and evaluates the functionality of the cost analysis and data storage components. User feedback is actively sought, enabling the incorporation of user suggestions and necessary adjustments to enhance the app's usability and effectiveness.
- Upon successful development and testing, the app is deployed on Android devices through platforms like the Google Play Store. Ongoing maintenance is crucial to ensure the app remains compatible with new Android versions and continues to meet the evolving needs of farmers. The machine learning model must also be peri- odically updated with the latest data and research in cattle feeding to maintain accuracy and relevance.

By following these well-defined implementation steps and leveraging technologies like Google Colab, MongoDB, Android Studio, and best practices in mobile app development, the Cattle Feeding function becomes a valuable tool for farmers, promoting optimized feeding practices, cattle health, and cost-efficiency in cattle farming operations. The model training outputs are displaying in fig 2 part 01.

D. Identify, Analyze and Forecast the Finance of a Cattle Farm

The optimization of financial performance within a cattle operation through the strategic integration of machine learning (ML) techniques. The system's design encompasses a multi-faceted approach to enhance financial decision-making by leveraging comprehensive data analysis. The system's operation revolves around a sequence of sub-objectives aimed at collecting, organizing, and processing data for informed decision-making. Initially, the system focuses on the collection and organization of pertinent data related to cattle operations. This includes crucial factors such as herd size, feed costs, labor expenditures, and production outputs, ensuring these data sets are structured for effective analysis and interpretation. Subsequently, the system prioritizes the identification of key performance indicators (KPIs) essential in evaluating the financial health of the cattle operation. These KPIs, such as cost per head and feed cost per pound of gain, serve as pivotal benchmarks for financial assessment. Following this, the system employs ML models to predict future financial outcomes based on historical data, offering insights into potential areas for cost reduction and revenue growth. Once identified, the system suggests and implements cost-saving strategies, which might involve altering herd management practices, optimizing feed formulations, or adjusting labor allocation. The system continually monitors and evaluates financial performance, regularly analyzing data and KPIs, enabling dynamic adjustments to ensure the cattle operation meets its financial objectives. This comprehensive system acts as a powerful tool, streamlining data-driven decision-making to maximize financial efficiency within cattle operations. The model training outputs are displaying in fig. 2 part 04.

4. Result and Discussion

A. Create a Disease Recognition to Identify Cattle Diseases

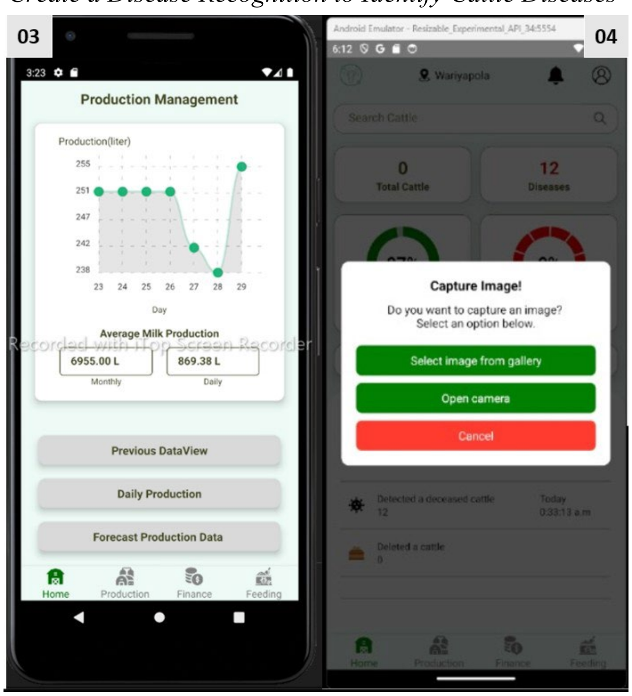

Fig. 5. Main four functions implemented on the App

Disease management component consists with disease recognition, input cattle details and displaying cattle disease related articles. In the disease recognition, Roboflow use for data preprocessing and Google Colab for model training. The model training in Google Colab, YOLO equation uses for object detection, and OpenCV use for image processing. For all the components of the research we need each cattle detail, for that we were create cattle details input form, from that users can keep records of their cattle's. When considering disease management, the knowledge of cattle related diseases is important, because of that we are maintaining cattle disease articles. The articles are based on research findings. Using the trained model users clearly identify the BVD disease and the foot rot disease. In Fig. 5, part 04 displaying the disease recognition function.

B. Identify, Analyze and Forecast the Harvest and Production of a Cattle Farm

Underscores the significance of the data collection and forecasting function designed for cattle farming. Gathering an array of critical data, including cattle information, environmental factors, milking practices, feed and nutrition, and historical milk production, provides a holistic understanding of farm operations. The integration of the Google API for environmental data retrieval greatly improves data accuracy and efficiency. Acknowledging the potential challenges associated with daily data collection, the user interface prioritizes user-friendliness, encouraging consistent and precise data entry.

The ability for users to review previously entered data, albeit without the option to modify it, ensures data integrity. Utilizing Google Colab and Python with MongoDB as the database solution, the system showcases robust implementation, scalability, and reliability. The generation of monthly forecasts, presented via a line chart displaying both historical production data and the forecasted point, equips farmers with actionable insights. Furthermore, the integration of "read more" links connecting users to a comprehensive farm guide on production articles enhances the system's value as a practical and educational resource for the cattle farming community. In Fig. 5 part 03 displaying the production management function.

C. Identify, Analyze and Forecast the Feeding of a Cattle Farm

In the discourse of cattle farm management, the feeding function assumes a pivotal role in orchestrating the welfare, health, and productivity of livestock while maintaining a balance between efficacy and cost-efficiency. Within this context, the system functions as a robust tool, equipped with an array of capabilities including data collection, result generation, and data storage, catering to the needs of modern farmers. The system's strength lies in its ability to collect comprehensive data, essential for informed decision-making. It compiles a spectrum of information from farmers, covering critical aspects such as the type and composition of food, individual growth rates, productivity metrics, monthly feeding costs, health records, and the influence of environmental factors on nutritional requirements. Leveraging this collected data, the system then generates detailed and tailored results. These outcomes encompass calculated nutritional needs customized for each animal, precise feeding diets with specified quantities, structured feeding schedules, visual representations of nutritional trends through line charts, cost analyses proposing avenues for cost reduction, and additional resource links to farm guide articles, augmenting the farmers' knowledge base. This comprehensive suite of data-driven results serves as an invaluable guide, empowering farmers to make optimized and well-informed decisions regarding cattle feeding practices. In Fig. 6 part 02 displaying the feeding management function.

Fig. 6. Main four functions implemented on the App

D. Identify, Analyze and Forecast the Finance Management of a Cattle Farm

In Fig. 6 part 01 displaying the finance management function. In finance management, can view the previous finance data, can enter monthly cost and income and also can forecast the finance data.

5. Conclusion

In order to increase the precision of disease identification, provide better treatment and management options, and advance animal welfare, it is generally advised to keep up research and development in this area. The creation of such a software system can aid cattle producers in determining the elements that influence production and harvest, creating efficient plans to deal with inconsistencies, and enhancing the overall efficiency of the farm.

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