Kuantumjournals
THE INTERNATIONAL RESEARCH COMMUNITY

Kuantum Journal Of Integrative Health And Medicine

Article Information

Received: July 08, 2024
Accepted: July 17, 2024
Published: July 20, 2024

Citation: Rakshith, et al. (2024) Gaurakshak: Disease Detection System in Cow using Optimized CNN Model. ku J of Inte Health and Med.1(1): 30-37.

Research Article

Gaurakshak: Disease Detection System in Cow using Optimized CNN Model

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1.Abstract

Agriculture and animal husbandry play an important role in the way of life around the world, highlighting the importance of timely diagnosis and treatment. Development of disease detection system in cows using deep learning represents a significant milestone in veterinary medicine and livestock management. By leveraging advanced deep learning algorithms, this system has demonstrated remarkable capabilities in accurately identifying and classifying diseases in cows based on visual symptoms extracted from images. As the existing systems have shown promising results, there are several avenues for future enhancements that can further elevate its effectiveness and impact. Firstly, expanding the dataset to include wider range of diseases prevalent in cows can enhance the system's ability to detect and classify broader spectrum of health issues. Additionally including multi modal data sources such as genetic, environmental and behavioral data can provide more comprehensive insights into animal health and improve disease prediction accuracy. Implementing real-time monitoring capabilities and alerts can enable immediate detection of disease outbreaks, facilitating proactive intervention by farmers and veterinarians. Continuous model training using incoming data can ensure that the system remains adaptive to evolving disease patterns. Early detection is crucial for all living beings, the urgency in animal health surpasses even that of human welfare. Convolutional neural networks (CNNs) are known for their ability to extract important features from images and provide a promising approach to computer vision field. This paper presents a novel method based on CNN to predict cattle diseases by analyzing and classifying input images. Using a specially designed CNN, the system increases disease identification accuracy. In addition, after the disease is detected, the system can facilitate treatment by providing users with detailed information about nearby doctors and hospitals. With an accuracy rate of 83%, the system represents a step forward in veterinary medicine and disease prevention and detection.

2.Keywords:

Convolutional neural network, Deep learning, Mastitis, Cow pox, Veterinary, Disease

3.Introduction:

I Livestock farming is a $1.4 trillion global asset that supports the livelihoods of 600 million farming families worldwide. According to the United Nations Development Program, the world population will reach 9.5 billion in 2050 and the world's demand for animal products (such as milk and dairy products) will increase by 70%. In countries like India, where agriculture forms the backbone of the economy, animal husbandry plays an important role in food production and economic security. India has a large and diverse agricultural area and is one of the world's largest producers of milk, catering to a population demanding a wide range of dairy products. Livestock farming, which includes cow, is linked to rural life, providing health to millions of farmers and becoming the basis of field-building agriculture. The growth in India's dairy production has not only met domestic demand but also helped exports, strengthening the country's position in the global economy. However, the growth of animal husbandry brings with it problems, especially when it comes to ensuring the health and welfare of animals. Diseases such as mastitis and Lumphy Skin Disease can affect animal health, production and farming as a whole.

Early and accurate diagnosis of these diseases is important not only for protecting animal health, but also for maintaining the stability and performance of livestock. Traditional diagnostic methods use visual inspection and manual inspection, which are time-consuming, labor intensive, and prone to human error. This is where the combination of modern technologies such as deep learning and neural networks (CNN) is promising. Using the power of artificial intelligence and machine learning, farmers can have the best tools to diagnose diseases quickly and accurately.

The development of a CNN-based detection system for Mastitis and Lumpy Skin Disease (LSD) in dairy cows represents a step forward in the use of technology to solve the important problem in animal health and production, as demonstrated in this study. The importance of animal husbandry in the world, the predicted increasing demand for animal products, and the significant role of animal husbandry in countries such as India, together demonstrate the importance and significance of advances in disease diagnosis and management. By embracing innovation and harnessing the potential of deep learning, the livestock industry can pave the way for a more sustainable, productive, and resilient future, ensuring the well-being of animals, the livelihoods of farmers, and the supply of essential food products to a growing global population.

4. Related Work

Animal care is one of the issues of increasing concern today, especially due to the growing population and the increasing demand for dairy products. In addition, regular maintenance of cattle health is important to extend the life of cattle and maintain animal quality. Many diseases can be transmitted from animals to humans, requiring early prediction of health and disease in cattle. In [1] the authors discusses about capabilities of related tools in providing acceptable solutions, and their limitations in predicting health conditions of cattle. A rapid livestock monitoring system based on the Internet of Things (IoT) also has been developed by authors. The proposed system will include a board of various sensors for recording various physical parameters, including temperature, heart rate, and temperature and humidity perception, and for image analysis to determine camera behavior. The measured data will be sent to the server using Wi-Fi/GSM technology, where machine learning (ML) models will be used to analyze the data to detect sick animals and predict the health status of cattle, thus providing early and timely treatment. For data visualization, a web portal and mobile application will be developed providing dashboards to review and view comprehensive data.

Livestock are often located in remote areas and diagnostic conditions are poor. In general, diagnosing animal diseases quickly and accurately is difficult to complete due to skill and experience. However, the farm can use the Animal Disease Diagnostic Expert System (ADDES) to accurately diagnose these diseases to ensure improved animal quality. Authors [2] tries to improve the accuracy of diagnosis and reduce loss by proposing a method using convolutional neural network (CNN). The goal is to develop effective strategies for this diagnostic problem by improving existing methods. The model does everything to produce accurate results by dynamically segmenting and extracting features from disease images. Evaluated the algorithms through experiments, and from the perspective of codes and diagrams, people can identify diseases and their causes in detail and treat them better.

Bovine respiratory disease (BRD) is a major cost to the dairy industry. The annual cost of BRD in the United States is approximately $640 million. Respiratory diseases caused the death of 21.3% of cows and 50.4% of weaned heifers. In addition, surviving infants may have many long term disadvantages, such as poor growth, childbearing, milk production and longevity, and may voluntarily infect other calves, causing transmission in the pen after weaning. BRD brings huge problems and financial losses to the dairy industry. In [3] authors addresses this challenge by developing a CNN model that detects BRD in cows and alerts farmers. IoT cattle NecKlace solution model has been developed by authors and its implementation and experimental results were observed.

With the advancement of technology, the future of all activities, including dairy farming, includes widely connected equipment. The Internet of Things (IoT), fog computing, cloud computing and data analytics together present a great opportunity to improve efficiency in the dairy industry. Authors [4] proposed a cloud computing enabled application system for animal behavior analysis and health monitoring in dairy farming scenarios. Data from sensors is sent to the cloud-based platform for data sharing and analysis, including operational decision making. The solution is designed to help farmers monitor the health of their animals and detect potential diseases early by analyzing behavior to generate early warning messages to monitor animal health, thus helping farmers increase milk production and productivity. The system plans to serve as standard, prevent vendor lock-in, and may continue to add new functionality, such as detecting issues such as calving, fever, and lameness.

Disease is what reduces cow's ability to produce milk. A normal cow can produce 12 to 15 liters of milk per day, while a sick cow can produce only 5 to 10 liters of milk per day. Early detection and management of infected cattle is difficult because the cow's condition is not constantly monitored and breeder's knowledge of the disease is limited. Authors [5] established cattle health management system which deals with health monitoring to diagnosis and treatment of diseased cattle. The system monitors the cow's body temperature and heart rate data from sensors and then provides results on the cow's health status (normal or abnormal). The system examines the cattle symptom information system entered by the breeder and then provides a prediction of disease diagnosis, treatment and prevention. Tests show that the monitoring system can monitor the health of dairy cows based on body temperature and heart rate with an error of 0.6 degrees Celsius and 3.5 times per minute. Tests of this detection system have shown that the detection system can detect diseases in dairy cattle with 90% accuracy based on physical symptoms.

Mastitis is a disease that occurs in milk-producing bacteria, especially in dairy products, and can be fatal. The disease, usually caused by bacteria, causes significant changes in the physical and chemical structure of milk. Since the lifespan of animals is shorter than humans, early diagnosis and treatment is important. Data mining methods are frequently used in early disease. Data search is divided into several branches. Distribution is one of these branches. In [6] authors analyzed the performance of classification algorithms such as J48, random forest, support vector machine, k-nearest neighbor and naive bayes classifier. Algorithms were applied to mastitis data obtained from a total of 100 animals and their performances were presented. The results show that the J48 algorithm has the best performance with 98% accuracy.

Foot-and-mouth disease (FMD) affects all cloven hoofed animals and is one of the most common diseases. This is a global epidemic with regional and global impacts; hence it has international jurisdiction. However, the only control method is culling. Therefore, once FMD occurs, it causes suffering. In order to control this disease effectively and efficiently, it is very important to plan ahead and obtain the prior approval of the government and local people. Author [7] presented a risk sharing method using a stochastic model to support home improvement. This approach has the potential to be adapted to other situations, natural disaster management and other events, as there are many situations in which agreement can be reached between stakeholders and policy implementers before an event occurs.

LSD is a skin virus. Bacterial diseases in cattle in Asia and Africa have been found to be responsible for skin disease, sheeppox, and goatpox, respectively. High fever, symptoms of the disease, often cause fatigue, decreased milk production, delay in growth and development, infertility, miscarriage and sometimes death. This disease has a major economic impact because it often causes chronic skin diseases in animals and affects the integrity of their housing. Authors [8] evaluated the performance of LRC, DTC, RFC, XGBC, SVC.

Veterinary care is an important part of animal care. The purpose of the veterinarian or doctor is to deal with the general health and treatment of animals. Veterinarians are responsible for the care and health promotion of animals at every stage of the animal's life. Access to veterinary services is difficult in remote and inaccessible parts of India. Farmers or livestock owners have to go far from their villages when they need treatment for their animals. This situation negatively affected the raising of omar animals in rural areas, mostly in remote areas. To solve this problem authors [9] developed a website that connected veterinarians and pet owners. Livestock represent valuable products in the food industry, such as dairy products, and are also an important business for their owners. The production of dairy products and other food products has faced problems due to low production due to the use of bad bacteria and viruses. In this case, animals also die, causing great financial losses for animal owners and the country. These problems need to be addressed before the situation gets out of control, and this can only be done by providing veterinary services to all parts of the country, even online from standards, or by providing veterinary services to people in rural areas. Livestock production in agriculture is an important source of food in India, providing financial support to many farmers and contributing to the Indian economy.

In some emergency situations, veterinarians or animal hospital staff cannot treat the animal immediately because they cannot monitor the animal 24/7 after surgery or during the recovery period. This problem is the main cause of death of these animals. Hence the authors [10] came up with the idea of developing a health monitoring device that could monitor the heart rate and body temperature of sick animals in the animal hospital. This work focuses on heart rate and body temperature. If the heart rate and body temperature are abnormal, this will alert the veterinarian or animal hospital staff that the animal is in danger and needs appropriate treatment. The system can monitor sick animals by recording and analyzing their health information when the animal has an abnormal heartbeat or body temperature, and can be treated as soon as possible.

In recent years, the search and management of animals has a high value and has attracted attention in the field of smart agriculture. It is important to investigate and make decisions from the data collected to facilitate rapid diagnosis and early treatment of infectious diseases in animals. In [11] authors presented an IoT-based livestock management system to simulate the spread of mastitis in cows. To monitor the social behavior of grazing cows, portable GPS devices were used to track the cow's movements and contacts. Based on this information, they create a grid by treating cows as vertices, their contacts as edges, assigning contact between cows as edge weights, and determine the high edge grid based on contact spatiotemporal data and heavy cattle behavior.

A multivariate model of disease transmission that takes into account direct contact with infected cattle and indirect contact through environmental contamination to predict the incidence of mastitis has also been proposed. The model can answer two questions in the detection and control of animal diseases: Firstly, which cows should be examined first to determine whether there is a diseased cow in the field? Secondly, how to classify cows for further analysis? Theoretical and simulation-based analysis of an experimental field (17 cow and more than 70 hours of data) demonstrates the effectiveness of the proposed method. Additionally, assessing somatic cell count (SCC) mastitis checks whether predictions are correct in the real situation.

In contrast to the widespread use of computer-aided diagnosis of human diseases, the limited availability of veterinary imaging has prevented its application in animals. Additionally, in situations where clinical information is frequently captured in the clinic, such as optical tomography and fundus imaging, digital camera or smartphone imaging may be useful for pet owners. The study [12] focused on providing comprehensiveness throughout the screening process in order to accurately identify disease using images obtained from pet owners, although in most cases the images shown were taken using specialized equipment in the hospital. Considering these challenges and the important role of computerized diagnosis in veterinary science, this study was designed to develop a deep learning method for uniform classification of images of ocular diseases in animals. The data used in this study consists of images obtained from slit lights and digital cameras of various canine and feline eye diseases. The scheme includes two layers of labels for various learning tasks and one layer of gradient inversion based on the same graphics. Accuracy of 84.7% and 65.4% was achieved on all dog and cat data, respectively. Specifically, in the camera area, dogs and felines achieved 86.2% and 73.2% accuracy, respectively.

IoT is designed to connect people, processes, information and objects; it changes the way we look at and interact with everything. The combination of information and communications technology (ICT) with data analysis techniques has the potential to transform some of the oldest industries in the world, including dairy farming. It provides a great opportunity for vertical businesses such as the dairy industry to improve products by gaining better information to improve farming, thus increasing their profitability benefits and returns. Dairy farming has all the limitations of a modern business. They can produce stable, manageable cattle, expensive farming and many other agricultural activities. In the technology driven age, farmers are looking for help from smart solutions to be efficient and help manage their farms. Authors [13] proposed an end-to-end IoT application system with weather forecast and weather services that can analyze data generated by devices used on cattle feet to predict strange behavior of animals related to diseases such as lameness. The solution helps farmers with animal care by using behavioral indicators to provide early warning of animal health. This helps increase productivity and milk production through early detection of potential diseases. The program specifically aims to detect lameness in cattle at an early stage, before the farmer or veterinarian notices any signs of lameness in the cattle. The results of three experiments conducted on a world-class smart farm with 150 cows in Ireland show that the design can provide warning messages up to 3 days before the inspection.

Monitoring animal health is an important research area in smart agriculture. The health of cows is important for continuous increase in milk production. Unfortunately, on large farms, daily monitoring of the health of each cow is a difficult and time-consuming task. Authors [14] developed Live Care, an IoT-based framework for monitoring the health of cows on large-scale farms. This monitors changes in the cow's behavior every day. This work also introduces the Cattle Disease Distribution (CDP) algorithm, an unsupervised multi-class system that forms the core of the Live Care framework. The CDP algorithm can predict various cattle diseases by analyzing changes in cattle behavior. Some of the cattle diseases, their measurable symptoms and the various sensors used to record them were also discussed. The performance of the CDP algorithm with other machine learning algorithms was evaluated.

Subclinical mastitis in cows affects the health, health, longevity and performance of cows, reducing productivity and profitability. Early prediction of subclinical mastitis may enable farmers to implement interventions to reduce its impact. Authors [15] investigated whether a predictive model developed using machine learning techniques could detect mastitis 7 days before its onset. The data used consists of records of 1,346,207 milk days (i.e. a day in which milk is collected both in the morning and evening) and covers 9 years of production from 2,389 cows on seven Irish farms surveyed. Mixed milk production and maximum milk quantity per cow milk composition (e.g. fat, lactose, protein) and somatic cell count (SCC) collected twice a day weekly. Other characteristics defining parity, calving date, predictive infectivity of SCC, body weight, and history of subclinical mastitis are also present. The results showed that the learning model gradient boosting machine predicted the onset of subclinical mastitis 7 days before the appearance of subclinical disease achieved a sensitivity of 69.45% and 95.64%, respectively. Reduce data collection frequency to reflect the frequency of the closed file. Simulation data collection formula composition and SCC to cover every 15, 30, 45 and 60 days. When milk composition and SCC were recorded every 60 days, the sensitivity and specific scores decreased with recording frequency to 66.93% and 80.43%, respectively. The results show that a model based on daily data collected from the dairy industry can achieve a strong predictive value for subclinical mastitis and a reduced frequency of SCC closure, regardless of milk quantity.

5. Methodology

Flowchart of the proposed system which focuses on detecting diseases like cowpox and mastitis is shown in

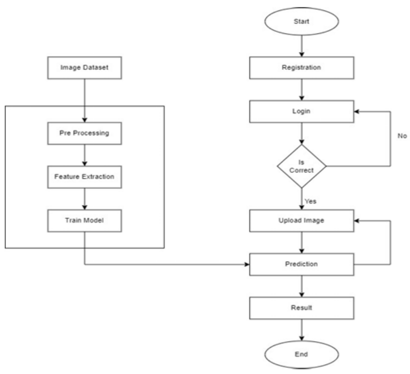


Figure 1: Proposed disease detection system.

The system involves the advanced capabilities of neural network (CNN) and is designed to support farmers by integrating agricultural technology into their business. By simplifying the process of identifying disease, it also provides good insights and helps decision-making on herd management. This new solution is an important tool in agriculture and production monitoring, ensuring farmers have the knowledge and technology to protect their cows from diseases such as cowpox and mastitis.

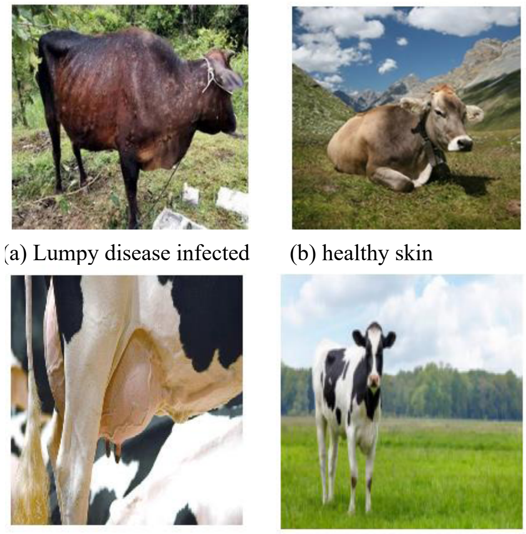
To initiate the cow disease detection application, the user can either capture a photo or can upload the image of a cow showing symptoms, which predicts the disease as cow pox, mastitis or healthy cow with the precautions and causes for the same. This can be done using the smartphones. The versatility of this capture system ensures that the Gaurakshak application can be used effectively on many farms, from small farms to large enterprises.

5.1. Dataset creation

Generating optimal data is an important step in training deep learning models for cow disease detection. The data was collected from Kaggle and includes images representing different stages and severity of mastitis and cowpox, as well as images of healthy cows for comparison.

5.2. Pre-processsing

Pre-process images to standardize their format and improve modeling. Techniques include converting the image to a uniform resolution, normalizing pixel values, and cropping to focus on regions of interest. Data evaluation can also be done by adjusting the distribution pattern of different organisms to solve the problem of category imbalance. Fig.2 illustrates the different categories of cow images used to train the model, distinguishing between healthy udders, mastitis-infected udders, healthy skin, and cowpox-infected skin.



(a) Lumpy disease infected (b) healthy skin

(c) Mastitis infected cow (d) Healthy cow

Figure 2: Cow images.

5.3. Model creation

The deep convolutional neural network was chosen due to its remarkable performance in image classification tasks. This involves creating a deep learning model with the necessary processes, creating its design, and defining the connections between the processes. This phase involves selecting the appropriate optimization function, optimizing the hyperparameters, and initializing the weights of the model. The goal is to create a good architecture that can learn complex patterns from data, making it easier to classify the udder and skin of beef affected by mastitis and cowpox.

5.4. Training

The dataset was partitioned into training and validation sets to facilitate model training and evaluation. The training process utilized a sequential CNN model architecture tailored for cow disease detection, focusing on mastitis and cowpox. The training objective was to minimize classification errors and optimize the model's ability to accurately classify cow images into healthy and diseased categories.

5.5. Analyze and classify disease

Using CNN, the system performs a qualitative analysis of images by examining different patterns and features associated with various cow diseases. Through this analysis, the system can identify and classify the observed symptoms, provide a detailed diagnosis and detect specific diseases present, such as cowpox, mastitis and other diseases affecting cow feed.

5.6. Displays precautions and causes

After identifying the diseases, the application notifies the user by displaying the name of the detected virus, along with a detailed analysis of possible causes and a set of recommended precautions. This important document serves as a guide for farmers to take immediate and effective measures to reduce the effects of diseases on livestock, thereby controlling their health and productivity.

6. Results

The pie chart in Fig. 3 shows the dataset is divided into two parts: training and testing.

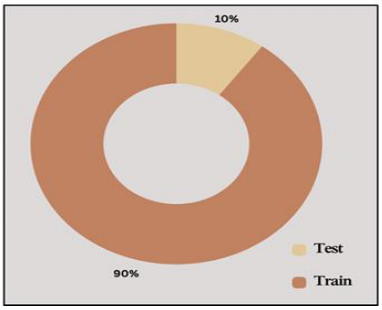


Figure 3: Data distribution.

This dataset is a collection of images related to mastitis and lumpy skin disease. These images are used to train a CNN model that is used by the application to detect diseases in cattle. The proposed CNN model obtained an accuracy of 83.47% after 20 epochs. The Figure 4 shows how the model performs over time during training and testing, showing actual progress over time.

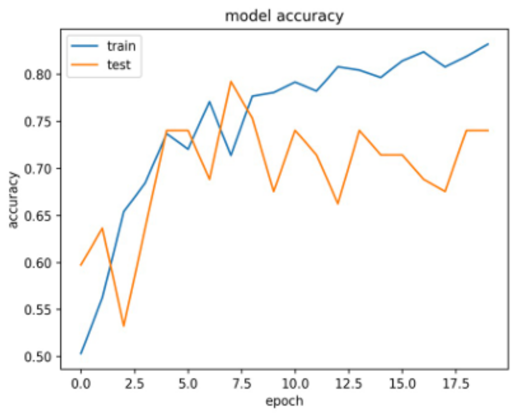


Figure 4: Accuracy graph.

The loss obtained by the proposed CNN model is shown in the Fig. 5. Loss decreases during the training and testing phase.

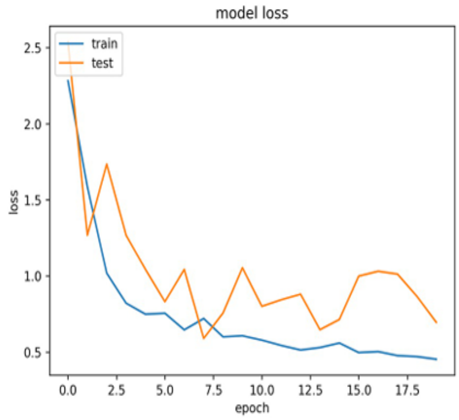


Figure 5: Loss graph.

The "Gaurakshak" app leverages CNN to revolutionize cow health management by quickly and accurately diagnosing diseases such as mastitis and lumpy skin disease. By identifying the disease, the need for manual examination and professional knowledge is reduced, timely treatment is provided and the spread of the disease in the herd is prevented. This innovation improves food security by ensuring a stable milk supply. Users can collect veterinary and hospital information to obtain additional help for diagnosis or treatment.

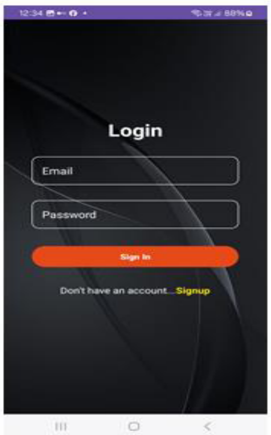


Figure 6: Login page.

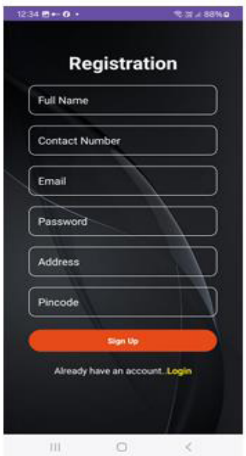


Figure 7: Registration page.

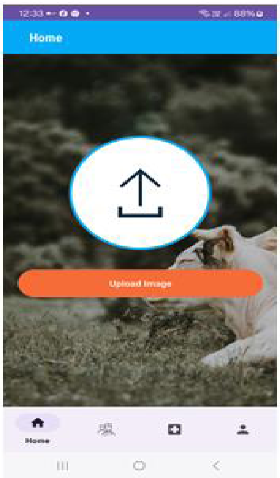


Figure 8: Upload image interface.

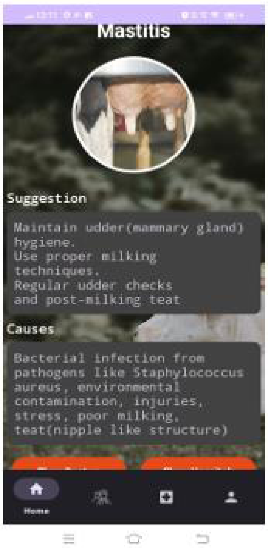


Figure 9: Mastitis disease detection.

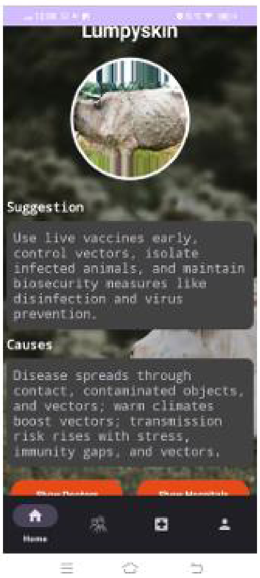


Figure 10a: Detection of lumphy.

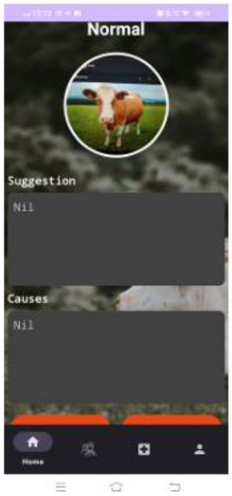


Figure 10b: Normal cow skin.

7. Conclusion

Gaurakshak: The disease detection app involved the concept of deep learning, introducing a massive technology that will revolutionize cattle disease management. This paper highlights the important role of careful data collection and prioritization to train our deep learning models. The importance of the right strategies for accurate disease detection is also highlighted. Deep learning is at the heart of our efforts to move beyond traditional diagnostic methods for conditions such as milk mastitis and lumpy skin disease. The innovation not only facilitated swift and reliable identification of these ailments but also offered valuable insights into preventive measures, showcasing the practical application of AI in veterinary care. In essence, "Gaurakshak" was a journey of discovery and progress, showcasing the transformative power of AI in livestock health management. It underscored the significance of technology in advancing animal welfare and food security, representing a significant step forward in our quest for sustainable livestock farming.

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