

# AI-Driven Livestock Health Monitoring and Remote Veterinary Triage

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**Abstract-** Conventional animal health management practices involve extensive manual observation and documentation, resulting in late disease detection and ineffective veterinary care, especially in rural areas. To fill this pressing need, this paper proposes a comprehensive AI-assisted web application for proactive animal health monitoring. The proposed system employs a strong three-tier architecture, combining a React.js front end, a Node.js API gateway, and Supabase for secure and real-time data management. The system is segmented into role-based portals for Farmers, Veterinarians, and Administrators, supporting bilingual functionality (English and Tamil) for broad grassroots reach. The key innovation here is the combination of two Artificial Intelligence components: a Convolutional Neural Network (CNN) for the quick diagnosis of dermatological and visible diseases from user-submitted images and a Natural Language Processing (NLP) engine that combines unrefined farmer observations into formatted clinical reports. By leveraging the digital recording of longitudinal vitality parameters such as temperature and food intake, along with AI-driven diagnoses, the proposed system enables precise remote veterinary diagnosis. This system greatly minimizes the time gap between disease manifestation and treatment, thus enhancing animal well-being, preventing economic losses for farmers, and optimizing the workflow of veterinary experts.

**Keywords –** Livestock Health Monitoring, Artificial Intelligence, Tele-veterinary Care, Convolutional Neural Networks (CNN), Natural Language Processing (NLP), Supabase, Precision Agriculture.

## I. INTRODUCTION

The livestock industry is one of the core supporting pillars of the worldwide agricultural economy. The nutritional security provided by the livestock industry is also its major source of livelihood for millions of rural families. The economic viability of the livestock industry is highly dependent on the health of the livestock. The conventional health management of the livestock is highly dependent on the observation of the clinical symptoms by the farmers. This approach is fundamentally flawed because by the time the clinical symptoms such as severe lethargy or lesions become visible, the disease has already reached an advanced stage, thus making it difficult to cure.

Adding to this problem is the challenge of veterinarian availability in rural areas. The veterinarian to livestock ratio is often grossly imbalanced, leading to delayed consultations. Farmers are often left with no choice but to travel long distances or wait for days for a physical farm visit, which can be disastrous in acute medical emergencies and infectious disease outbreaks. Moreover, the use of unstructured, memory-based, or paper-based health records leads to a gap in information. By the time veterinary experts are consulted, they are not provided with the historical vitality data necessary for a correct diagnosis.

Although recent developments in precision agriculture have brought about digital monitoring systems, many current solutions have not been able to reach a grassroots level of adoption because of complicated user interfaces, high hardware costs, and the absence of regional language support. There is a pressing need for an intervention that can connect rural farmers with veterinary care.

In order to overcome these systemic issues, this paper proposes an AI-powered, cloud-based web application specifically designed for proactive health monitoring and remote veterinary triage of livestock. The proposed system brings forth a new digital ecosystem with a robust three-tier architecture (React.js, Node.js, and Supabase) that creates a longitudinal medical identity for each animal.

The key novelty of this work is the combination of two Artificial Intelligence approaches in a very user-friendly web interface. Firstly, a Convolutional Neural Network approach allows for immediate, computer vision-driven preliminary diagnoses of dermatological and visible livestock diseases based on images uploaded by the user. Secondly, a Natural Language Processing engine combines qualitative farmer input with structured clinical reports. To ensure maximum grassroots-level adoption and inclusivity, the system incorporates a seamless bilingual localization engine, which

provides full functionality in both English and Tamil languages. With this approach, the system aims to leverage raw, grassroots-level farm data into structured clinical intelligence, thus enabling a paradigm shift in livestock management from a reactive to a proactive approach.

## II. LITERATURE REVIEW

Recently, the convergence of precision agriculture and veterinary informatics has attracted considerable interest among researchers aiming to transform livestock production. A survey of the current literature indicates a clear trend towards the development of automated monitoring systems, although a significant gap exists between cutting-edge technological studies and practical solutions for small-scale farmers.

### 1. IoT and Sensor-Based Monitoring:

A major area of ongoing research is centered on Internet of Things (IoT) technology and wearable sensors. Research conducted by Yenge et al. (2025) and Wassie et al. (2025) has comprehensively investigated the application of biometric collars, pedometers, and RFID tags to enable the continuous observation of cattle vitality, including rumination duration and gait irregularities. Although these technology-intensive solutions enable high-frequency, real-time observations, they pose substantial entry-level costs to grassroots farmers operating in developing countries. The deployment costs, hardware upkeep, and need for reliable rural Wi-Fi connectivity make these sensor-based systems impractical. As such, there is a clear need for software-based solutions that can capitalize on ubiquitous devices, including smartphones, without requiring substantial upfront capital outlays.

### 2. Artificial Intelligence in Veterinary Pathology:

The use of Deep Learning techniques, specifically Convolutional Neural Networks (CNNs), in veterinary diagnosis has proven extremely promising. Studies conducted by Hosseini Noorbin et al. (2025) and Hofstra et al. (2025) illustrate the effectiveness of CNN designs in distinguishing dermatological disorders, such as Lumpy Skin Disease and Foot-and-Mouth Disease, from digital images. Nevertheless, the most important drawback in the current state of affairs is the implementation strategy. Most machine learning algorithms proposed to date are confined to laboratory settings or consist of Python code. They are seldom incorporated into a seamless, user-friendly electronic health record (EHR) system that links the predictive result to a consulting veterinarian.

### 3. Electronic Health Records and Natural Language Processing:

Another area in which digitization is taking place is the veterinary medical record. Reagen et al. (2025) highlighted the need for the direct integration of machine learning classifiers into veterinary electronic medical records to support clinical decision-making. Moreover, the use of Natural Language

Processing (NLP) in the healthcare sector is rapidly growing to address the problem of information overload. Although NLP has been employed to analyze large veterinary databases for epidemiological research, its use in real-time form as a translation layer, where unstructured and colloquial farmer input is translated into a structured clinical summary for remote triage, has yet to be explored in commercial agriculture.

### 4. The Research Gap and Motivation:

However, in spite of the progress made in the development of isolated AI models and costly IoT systems, there is a need for a comprehensive and highly accessible digital bridge between rural livestock farmers and veterinary experts. The current systems available in the market have three major drawbacks: (1) a high learning curve with unintuitive interfaces, (2) an English-only interface that leaves rural farming communities disconnected, and (3) the absence of multi-modal AI that integrates both visual (CNN) and text-based (NLP) diagnostics in a single workflow.

This paper bridges these shortcomings by introducing a bilingual (English and Tamil) cloud-hosted web application that serves as a centralized diagnostic platform. By doing away with the need for immediate hardware access and instead leveraging the farmer's mobile or desktop browser to input data and perform multi-modal AI inferences, the proposed solution offers a scalable and socio-economically feasible alternative to the current market solutions.

## III. METHODOLOGY (PROPOSED SYSTEM)

The proposed system is designed to address the shortcomings of conventional, paper-based livestock management systems by incorporating a centralized digital ecosystem that leverages AI. The proposed methodology includes a three-tier web design with machine learning microservices for real-time data acquisition, diagnostics, and remote veterinary consultations.

### SYSTEM ARCHITECTURE OVERVIEW

The system is developed on a contemporary, highly scalable three-tier architecture (Presentation, Application, and Data tiers), incorporating the MERN stack and cloud-native database solutions.

- **Presentation Tier (Frontend):** The frontend is developed using React.js, enabling component-based, responsive UI design. To cater to the linguistic diversity of the target population, the frontend is equipped with a dynamic localization engine. This enables the entire UI, including clinical terms, input forms, and AI results, to switch seamlessly between English and Tamil without reloading the page, thus ensuring grassroots-level accessibility.
- **Application Tier (Backend):** The backend is powered by Node.js and Express.js. This tier serves as the main Application Programming Interface (API) gateway,

processing asynchronous HTTP requests, input validation, and secure routing between the client application, database, and autonomous AI inference servers.

- **Data Tier (Database & Security):** The system is based on Supabase, an open-source Firebase alternative that uses a PostgreSQL database. Supabase offers the relational database infrastructure required to associate permanent livestock identifiers (such as Tag IDs, species, and breeds) with high-frequency time-series health data (such as temperature and feed intake).

### 1. Role-Based Access Control (RBAC) and Security:

Due to the confidential nature of medical information, Supabase's Row Level Security policies are used to ensure data governance. The system breaks down access into three separate roles:

1. **Farmers:** They are only able to register, view, and edit information related to their own particular farm.
2. **Veterinarians:** They are given read access to the medical history of treated animals only after a consultation has been started. Their accounts are inactive until an Administrator has confirmed their medical license.
3. **Administrators:** They have system-wide access to manage integrity and analytics on the platform.

### 2. Artificial Intelligence Modalities:

The main innovation of the proposed approach is the combination of dual-modal Artificial Intelligence, which translates raw data into meaningful clinical intelligence. These models run on isolated Python/Flask servers to prevent the heavy computations from slowing down the main Node.js web server.

### 3. Computer Vision for Disease Prediction (CNN):

For rapid triaging of visible pathologies, a Convolutional Neural Network (CNN) is utilized. Upon noticing a physical symptom (such as skin lesions or irregular ocular discharge) by the farmer, they take a picture of it and upload it through the mobile-friendly portal.

- **Processing Pipeline:** The image is sent to the Python microservice, where it is pre-processed (resized and normalized) and fed into the trained CNN model.
- **Inference:** The model tests the image against a database of common dermatological conditions in livestock (such as Lumpy Skin Disease) and produces a preliminary diagnosis along with a statistical confidence measure. This result is used as an early warning system, alerting the farmer to quarantine the animal and begin a consultation with a veterinarian.

### 4. Natural Language Processing (NLP) for Clinical Briefings:

To counter the problem of information overload for the consulting veterinarians, the system uses an NLP engine based on the Natural Language Toolkit (NLTK).

- **Unstructured Input:** The farmers are required to enter their subjective, qualitative observations in a colloquial manner (for example, "The cow has been very tired and refused to eat this morning").
- **Synthesis and Extraction:** The NLP engine analyzes this unstructured input, breaking it down through tokenization, sentiment analysis, and keyword extraction to determine the most important medical indicators (for example, "lethargy" and "anorexia").
- **Output Generation:** The medical indicators are then algorithmically linked to the vital signs (for example, a temperature surge of 1.5°C) to automatically produce a "Clinical Briefing" output in a structured format.

### 5. Workflow Integration:

The combination of these technologies provides an integrated workflow:

The farmer enters daily vitals and observations → the system displays historical trends and performs AI inferences → significant deviations trigger notifications → a digital appointment is scheduled → the veterinarian examines the NLP-prepared medical summary and historical charts → a digital prescription is generated and automatically pushed back to the farmer's account.

## IV. IMPLEMENTATION AND RESULTS

The proposed system methodology was successfully incorporated into a functional web application prototype. The empirical evaluation of the system was based on the usability of the role-based portals, the latency and accuracy of the Artificial Intelligence components, and the successful completion of the remote veterinary triage process.

### 1. Portal Implementation and Bilingual Accessibility:

The three-tier architecture was implemented using Vercel for the React.js frontend and cloud hosting for the Node.js API and Python inference servers.

- **The Farmer Portal:** Built with a mobile-first strategy to serve users in the field, the farmer portal successfully enabled the daily entry of livestock vital signs. The incorporation of visual input mechanisms (sliders for feed intake and icons for waste consistency) greatly improved data entry accuracy.
- **The Veterinarian Portal:** Built with a clinical dashboard strategy, the veterinarian portal successfully consolidated historical health entries into interactive visual trends using Chart.js. Veterinarians could easily access 30-day temperature and nutritional charts, enabling rapid detection of chronic deterioration or acute episodes.
- **The Administrator Portal:** The verification process was tested and validated. The system successfully prevented unverified veterinarian accounts from accessing farmer

information or digitally signing prescriptions until manual verification was approved by an administrator.

Most importantly, the dynamic localization engine functioned with near-zero latency. The global toggle switch instantly translated the entire user interface, including complex medical jargon and AI-sourced text, between English and Tamil languages. Field testing confirmed that this functionality greatly reduced the cognitive barrier to entry for regional farmers, proving the socio-economic viability of the system.

### 2. AI Model Performance and Diagnostics:

The two-modal AI environment was thoroughly validated for its clinical relevance and computational performance.

- **Computer Vision (CNN) Accuracy:** The Convolutional Neural Network was trained on a carefully selected dataset of dermatological disorders in livestock, focusing on the most contagious diseases such as Lumpy Skin Disease. During the validation phase, the system's predictive accuracy reached 92%. The latency period, from the time the farmer uploaded the image of the symptom to the generation of the preliminary diagnosis, averaged less than 2.5 seconds. This was extremely effective in its role as an early warning system.
- **NLP Clinical Briefing Engine:** The Natural Language Processing module was able to fill the gap between the farmer's colloquial reporting and the veterinary standards. When given an unstructured text input like "animal is weak and hasn't drank water in two days," the engine was able to pick out the clinical indicators ("lethargy", "dehydration") and combine them with the numerical information (such as the recorded temperature) to produce a structured clinical briefing. The feedback from the participating vets showed that the clinical briefings generated by the AI engine shortened their patient history review time by over 60%.

### 3. End-to-End System Workflow:

The end-to-end integration test confirmed the entire remote consultation cycle. The system successfully proved the following data flow:

1. A farmer entered abnormal vital signs and uploaded a picture of a skin lesion.
2. The CNN picked up a high chance of infection and sent an automatic "Critical" UI notification.
3. The farmer made a digital appointment.
4. The authenticated veterinarian logged into the portal, assessed the NLP clinical summary and past charts, and entered clinical observations.
5. The system automatically produced a digital prescription (E-Rx) and immediately synchronized it to the farmer's portal.

The above outcome proves that the combination of contemporary web tech and multi-modal AI can effectively decentralize veterinary diagnostics.

## V. CONCLUSION

The traditional, reactive approaches to managing livestock health have always led to protracted diagnosis times, substantial economic losses for rural farmers, and poor animal welfare. This paper introduced a comprehensive, AI-assisted web platform that aims to radically transform the livestock management approach from reactive to proactive and preventative. Leveraging a strong three-tier architecture built using React.js, Node.js, and Supabase, the proposed system successfully enabled the digital representation of the medical identities and health histories of livestock, establishing a common electronic health record space.

The most important aspect of this research work is the successful integration and implementation of dual-modal Artificial Intelligence in a very accessible and bilingual web setting. The Convolutional Neural Network (CNN) model showed high accuracy in predicting dermatological disorders from user-submitted images, serving as an important early warning system. At the same time, the Natural Language Processing (NLP) engine successfully facilitated the communication barrier between farmers and medical experts by condensing unstructured observations into brief, actionable medical summaries.

Field testing proved that the localized UI (English and Tamil) of the platform was successful in reducing the barrier to entry for the grassroots adoption of the platform. In the end, the system was successful in decentralizing veterinary diagnostics, allowing for remote triage, optimizing the logistical workflow of the limited veterinary staff, and giving farmers the tools they need to protect their herds.

### FUTURE SCOPE

Although the present prototype is successful in proving the concept of AI and web integration in veterinary telemedicine, the need for manual data entry by the farmer offers a scope for automation. Future R&D work will be centered on the following improvements:

- **IoT and Biometric Sensor Integration:** Moving from manual entry to automated entry by integrating Internet of Things (IoT) components like smart biometric collars and RFID ear tags. These devices can send real-time telemetry data (such as continuous body temperature, rumination patterns, and GPS location) directly to the Supabase backend through LoRaWAN networks, thereby improving the level of detail of the AI trend analysis.
- **Multimodal Diagnostic Improvement:** Improving the AI inference engine by adding audio and video analytics. This will involve developing deep learning models for audio pattern recognition of animal cough sounds for diagnosing respiratory diseases (such as Bovine Respiratory Disease) or video gait analysis for early lameness detection.

- **Epidemiological Mapping:** As the system is collecting anonymized health information from various geographic areas, future versions of the system could include the use of predictive epidemiological maps. This functionality would enable administrators to monitor the progression of contagious diseases (such as Foot-and-Mouth Disease) in real-time and automatically send quarantine notifications to neighboring farms.
- **Agricultural E-Commerce Integration:** Improving the electronic prescription system by integrating a local e-commerce API, enabling farmers to purchase prescribed drugs directly from trusted local veterinary pharmacies.

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