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Smart Herd: IoT-Driven Insights into Cattle Activity

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***Abstract*— Keeping animals healthy and well cared for is crucial for cattle farms and for producing milk in a sustainable way. But on large farms, it's tough to keep an eye on every animal every day. Farm workers often don't have the time to closely monitor each animal, which makes it hard to spot health issues early.**
The objective is to analyze cattle activity using IoT to enhance livestock management practices and optimize farming operations. It continuously monitors the health status of cattle by collecting physiological parameters such as heart rate, rumination, body temperature, GPS. The data is collected from various sensors and the data is being uploaded to a Think Speak server or User Interface (UI). After applying AI ML model on the real-time dataset, it will generate patterns and gain insights and hence if there's an issue, it'll generate an alert message on the user interface side. This product provides farmers with a cost effective and efficient solution for monitoring the health of their cattle.

***Index Terms*— Animals, Cattle, IoT, Machine Learning, SVM, Real Time Data, Health Monitoring.**

I. INTRODUCTION

Ensuring the health and sustainability of cattle farms is crucial for agriculture, but monitoring the well-being of animals, especially on large farms, often faces challenges due to labor limitations. This study explores the use of Internet of Things (IoT) technology to transform cattle management by tracking key factors like heart rate, rumination, body temperature, and GPS location.

IoT sensors gather real-time data, which is then analyzed using AI and machine learning algorithms like SVM: Support Vector Machine to detect any anomalies. The goal is to quickly spot whether cattle is healthy or unhealthy, enabling farmers to intervene early and manage their herds more effectively, ultimately improving sustainability in agriculture.

This research presents an affordable way to monitor cattle health, offering farmers better surveillance, easier data management, and more informed decision-making. It highlights the game-changing potential of IoT in advancing sustainable livestock management.

The following are the main results that can be expected from this project:

- Animals are healthy or unhealthy. It will be found at an early stage.
- Reduction in animals, especially Cattle-deaths.
- More Accurate medical diagnosis from Animals Body.
- Farmers will give precautions for particular symptoms to animals at an early stage.

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II. MOTIVATION

The motivation behind developing this product for cattle is driven by the growing need to monitor and improve cattle health, which is crucial for maintaining farm productivity. Cattle health issues, particularly those indicated by abnormal activity patterns, can significantly affect the overall well-being of the herd. Early detection of such issues can prevent more severe health complications, ensuring better care and reducing potential losses. By integrating IoT technology and machine learning, this product aims to provide real-time insights into cattle behavior, enabling farmers and veterinarians to quickly identify and address health concerns. This approach not only enhances animal welfare but also optimizes farm management, contributing to more sustainable agricultural practices.

III. REVIEW OF LITERATURE

Khalid El Moutaouakil et al. [1] developed an IoT-based cattle monitoring system and dashboard that leverages sensor data for real-time tracking and livestock health analysis. Their system demonstrated improved cattle health monitoring, productivity, and smarter decision-making for farmers.

Jai Ganesh Rajendran et al. [2] introduced a Cattle Health Monitoring System using Wireless Sensor Networks (WSN). By collecting real-time health parameters through wireless sensors, their solution reduced the need for manual observation and promoted efficient animal health tracking.

K. Darvesh et al. [3] proposed an IoT-based Cow Health Monitoring System using data analytics to detect abnormal behavior and generate alerts. The system proved beneficial for timely notifications regarding cow health, daily activities, and early disease detection.

Jehangir Arshad et al. [4] presented a secure and intelligent IoT-based cattle monitoring system, focusing on daily data collection and smart analysis. Their solution provided real-time health reports to farmers, helping take preventive action and improving cattle well-being.

Melchizedek Alipio and Maria Lorena Villena [5] studied the use of wearable devices and biosensors in livestock monitoring. Their findings emphasized the accuracy and efficiency of biosensors in assessing various health parameters, offering a more precise approach to cattle health tracking.

Ashmitha G. et al. [6] proposed an IoT and AI-based sustainable livestock health monitoring system. Their system provided continuous health data and prompt alerts to farmers, thereby supporting proactive animal care and sustainable cattle management. Finally, a report from ResearchAndMarkets.com [7] discussed the global animal health monitoring software market, noting that inflation forecasts and deployment types (cloud vs. on-premises) influence adoption. It highlighted how software solutions are increasingly integrated into cattle, poultry, and other animal health monitoring systems.

The main purpose of this project is to monitor cattle health and analyze their physical activity using IoT and machine learning technologies to improve livestock management. The system aims to collect physiological parameters such as heart rate, rumination, body temperature, and GPS location using multiple sensors attached to the cattle. These data points are continuously transmitted to a centralized server, such as the ThinkSpeak platform, or to a custom-built User Interface (UI). Once the data is collected, various AI and ML models are applied to identify patterns in real-time and detect abnormalities in the cattle's behavior or health status. Upon identifying any such issue, the system automatically sends an alert to the user interface, enabling farmers to take timely action. The model offering the highest accuracy and most reliable predictions is selected for final deployment. This solution ensures efficient and cost-effective cattle health monitoring, particularly beneficial for large-scale farms where manual tracking of animal health is impractical. It involves collecting real-time physiological data from cattle using IoT-based sensors, followed by preprocessing, training, testing, evaluation, and deployment of the final model. The dataset is either generated from live sensor inputs or collected from open sources and research platforms. Various machine learning algorithms are then applied to analyze and predict the health status of the cattle. A typical data split of 80:20 is used, where 80% of the collected data is allocated for training the model and 20% for testing its performance. Once the model is trained and evaluated using performance metrics, the most accurate and reliable model is finalized for deployment. This final model is used for real-time detection of abnormalities in cattle behavior and health, generating instant alerts on the user interface to enable timely intervention and ensure the well-being of the livestock.

In every machine learning-based system, data collection forms the backbone of the project. For the proposed cattle health monitoring system, physiological parameters such as heart rate, rumination, body temperature, and GPS location are continuously collected through IoT-enabled sensors attached to the cattle. The gathered data is then transmitted to a cloud-based platform like the ThinkSpeak server for storage and analysis.

The general data flow of the proposed system is illustrated in the architecture diagram.

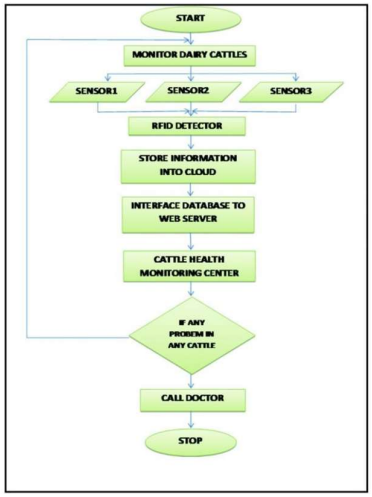

Fig. 1. Overview of the Workflow Diagram

Before applying any machine learning model, data preprocessing is performed to clean, normalize, and prepare the dataset for further analysis. This step is crucial to ensure the accuracy and reliability of the predictions, as real-time sensor data may contain noise or missing value

TABLE I. COMPARISON TABLE ON EXISTING MACHINE LEARNING TECHNIQUE

Sr. No	Authors	Year	Disease	Machine learning algorithm	Dataset input	Remarks	Conclusion
1	Khalid El Moutaouakil, Hamza Jdi, Brahim Jabir, Noureddine Falih	2023	IoT-based Cattle Monitoring Systems and Dashboards	IoT Technology	Cattle data collected via IoT sensors	IoT based monitoring enhances real-time tracking and analysis of livestock conditions	IoT solutions improve cattle health monitoring, productivity, and decision making
2	Jai Ganesh Rajendran, Manjunathan Alagarsamy, Vaishnavi Seva, Paramathi Mani Dinesh, Balamurugan Rajangam, and Kannadhasan Suriyan	2023	A system that uses wireless sensors to keep track of cattle health.	Wireless Sensor Network (WSN)	Health parameters collected via sensors	Wireless networks enable automated health monitoring and reduce manual dependency	WSN plays a crucial role in continuous health tracking and efficiency in animal husbandry
3	K. Darvesh, N. Khande, S. Avhad, and M. Khemchandani	2023	A smart system that uses IoT to monitor the health of cows.	IoT, Data Analytics	Cattle health and behavioral data	Provides early notifications to farmers regarding health status, behavioral shifts, and daily activity of cows	IoT-based systems enhance cow monitoring, allowing better health tracking and farm management
4	Jehangir Arshad, Talha Ahmad Siddiqui, M. Ismail Sheikh, M. Sadeed Waseem, M. Abu Bakar Nawaz, Elsayed Tag Eldin, and Ateeq Ur Rehman	2023	Installing an intelligent and secure system to keep track of cattle health.	IoT Data Collection	Daily cattle activity and health monitoring data	Enables real-time cattle health monitoring and provides daily updates to farmers	Improves cattle care by allowing timely precautionary measures

5	Melchizedek Alipio and Maria Lorena Villena	2023	Smart wearable devices and sensors used to monitor the cattle health.	Wearable Devices, Biosensors	Health parameters collected via biosensors	Assesses and categorizes wearable devices for cattle health monitoring	The use of biosensors enhances precision in cattle health tracking
6	Ashmitha G., K. M. Daniel, J. Saravanan, K. Ayyar, and K. S. Jaibhavani	2023	A sustainable system that uses smart technology to track and manage livestock health.	IoT, AI-based Data Analytics	Real-time cattle tracking and health data	Detects cattle, analyzes health condition and provides essential notifications to farmers	Sustainable monitoring systems improve cattle heath management and decision-making
7	ResearchAndMarkets.com	2023	Global Animal Heath Monitoring Software Market by Animal Types	Cloud-Based, On-Premises Deployment types	Animal (Cattle, Horse, Poultry)	Research focuses on the impact of high inflation forecasts on animal health monitoring markets	Market trends and deployment methods influence the adoption of animal health monitoring systems

IV. ALGORITHMS

A. Support Vector Machine (SVM)

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data for classification and regression analysis." Support vector used to classify models.

In this research, the Support Vector Machine (SVM) algorithm was employed to classify cattle activity patterns based on IoT sensor data. The IoT system continuously collected physiological and environmental parameters such as body temperature, heart rate, humidity, and accelerometer readings from wearable devices attached to the cattle. The SVM algorithm was then applied to this multidimensional dataset to distinguish between various activity states such as grazing, walking, resting, and abnormal movements. Mathematically, SVM aims to find an optimal hyperplane that maximizes the margin between different activity classes, which can be expressed as:

$\min_{w,b} \ \frac{1}{2}\|w\|^2 \quad \text{subject to} \quad y_i(w \cdot x_i + b) \geq 1$

where xi represents the input feature vector obtained from IoT sensors, yi denotes the class label of the activity, w is the weight vector, and b is the bias term. The SVM classifier effectively handles nonlinear relationships among sensor variables using kernel functions, thereby improving the accuracy of cattle activity recognition. This approach enables early detection of abnormal or unhealthy behavior, facilitating timely intervention and better livestock management.

Simulation Results and Statistical Validation

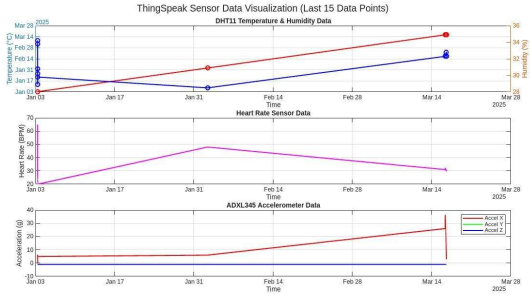

Fig. 2. Data Visualization of All Combined Sensor Outputs

This graph represents IoT-based cattle monitoring sensor data visualized from ThingSpeak, showing the last 15 data points collected from DHT11 Temperature & Humidity Data, Heart Rate Sensor Data, ADXL345 Accelerometer Data.

- Temperature & Humidity: Normal and stable, showing proper environmental control.
- Heart Rate: Fluctuations likely correspond to different activity levels or environmental stress.
- Accelerometer: Movement patterns captured; increased activity detected at specific points.

V. CONCLUSION

The system introduced in this paper allows for real-time, minute-by-minute monitoring of a cow's health. If anything unusual shows up in the animal's health data, the system can detect it right away. It's built using affordable electronic components, making it a cost-effective solution. There's no need for the user to constantly check on the animal, the system keeps and eye on things automatically and sends an alert via email if something goes wrong.

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