A PRELIMENERY REPORT ON

ANALYSIS OF CATTLE ACTIVITY USING IOT

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF TECHNOLOGY (Information Technology)

SUBMITTED BY

BALAJI KHANKRE	**RBT21IT090**
PRATHAM KUMBHARE	**RBT21IT091**
HANUMANT JADHAV	**RBT21IT083**
DEEPAM WAGH	**RBT21IT124**

DEPARTMENT OF INFORMATION TECHNOLOGY

JSPM's RAJARSHI SHAHU COLLEGE OF ENGINEERING

TATHAWADE, PUNE 411033
(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

2024-2025

CERTIFICATE

This is to certify that the project report entitles

"ANALYSIS OF CATTLE ACTIVITY USING IOT"

Submitted by

BALAJI KHANKRE	**RBT21IT090**
PRATHAM KUMBHARE	**RBT21IT091**
HANUMANT JADHAV	**RBT21IT083**
DEEPAM WAGH	**RBT21IT124**

is a bonafide student of this institute and the work has been carried out by him under the supervision of **Prof. Ashika Hirulkar** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University, for the award of the degree of **Bachelor of Technology** (Information Technology).

(Prof. Ashika Hirulkar)
Guide,
Department of Information Technology

(Dr. N. M. Ranjan)
Head,
Department of
Information Technology

(Dr. S. P. Bhosale)
Director,
JSPM's Rajarshi Shahu College of Engineering Pune – 33
(An Autonomous Institute Affiliated to Savitribai Phule Pune University,Pune)

Place : Pune
Date :

ACKNOWLEDGEMENT

It is with a deep sense of gratitude that we would like to express our warm regards and sincere thanks to Prof. Ashika Hirulkar, for her invaluable guidance, inspiration and whole hearted involvement during every stage of this project. Her experience, perception and thorough professional knowledge, has served as an indispensable source of guidance and hope. Her being available beyond the stipulated period of time for all kind of guidance and supervision and ever-willing attitude to help, has undoubtedly been the sole reason for the timely and successful completion of this project.

I would like to extend my sincere thanks to Dr. N.M.Ranjan Head of Department, Department of Information Technology, for his continual support and invaluable assistance rendered towards the presentation of this work. He was always there for suggestions and help in order to achieve this goal.

Finally, I am indebted to Dr. S. P. Bhosale, Director, JSPM's Rajarshi Shahu College of Engineering, Tathawade, Pune, for his encouragement and providing us with the opportunity to translate our thoughts into actions and for providing the institutional facilities to carry this work.

NAME OF THE STUDENTS

Mr. Balaji Khankre (IT4220)

Mr. Pratham Kumbhare (IT4221)

Mr. Hanumant Jadhav (IT4213)

Mr. Deepam Wagh (IT4252)

ABSTRACT

Ensuring animal health is vital for cattle farms, crucial to sustaining milk production and agricultural sustainability. However, challenges in daily surveillance exist, especially in expansive farms. This study proposes IoT technology to analyze cattle activity, improving livestock management. By monitoring heart rate, rumination, body temperature, and GPS location, it aims to assess cattle health comprehensively. Data from various sensors are sent to a centralized platform for analysis using AI and ML algorithms, enabling anomaly detection. This IoT solution offers a cost-effective mechanism for cattle health monitoring, benefiting farmers with improved herd management and agricultural sustainability.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ABBREVIATION	ILLUSTRATION
ML	Machine Learning
AI	Artificial Intelligence
IoT	Information of Things
GPS	Global Positioning System
UI	User Interface

LIST OF FIGURES

1.INTRODUCTION

The agriculture industry is currently grappling with significant challenges, including demographic shifts, food wastage, and the scarcity of natural resources. According to reports, approximately 800 million people worldwide experience hunger, and projections estimate that 650 million individuals will remain undernourished by 2030. Furthermore, by 2050, food production must increase by 70% to meet global demands. Addressing this scarcity requires adopting innovative measures, particularly replacing traditional farming techniques with advancements in technology. These include sensors, automated devices, robotics, and information systems.

The Internet of Things (IoT), a mature and effective technology, has emerged as a key solution for addressing inefficiencies and productivity challenges in agriculture and livestock management. IoT applications in agriculture span several areas, including:

- Agricultural field monitoring,
- Greenhouse monitoring,
- Smart irrigation control,
- Livestock monitoring,
- Agricultural drone usage,
- Warehouse monitoring,
- Soil condition monitoring.

Among these, **cattle health monitoring** is particularly critical for farmers, as the health and well-being of livestock have a direct impact on productivity and profitability. Physical monitoring of cattle becomes increasingly difficult with larger herds. Therefore, an IoT-based system is essential to:

- Digitally register the health parameters of cattle.
- Transmit and store these parameters using IoT devices.
- Notify stakeholders of potential health issues based on data analysis.

This project aims to analyze cattle activity using IoT to enhance livestock management and optimize farming operations. By employing IoT devices to collect parameters like body temperature, humidity, heartbeat, and cattle movement, the system provides actionable insights. If cattle remain stationary for an extended period, farmers can receive real-time alerts to investigate and address the issue.

Projections reveal that by 2020, over 75 million agricultural IoT devices were already in use, and by 2050, an average farm will generate 4.1 million data points daily, up from 190,000 in 2014. To handle such data volumes effectively, the project employs **micro service-based architecture**, which enables:

1. Continuous data reception from IoT devices.
2. Offline data aggregation and transmission when Internet access is unavailable.
3. Modular components for cattle and farm registration, as well as user login for farmers.

This paper introduces a cost-effective and scalable IoT solution for cattle health monitoring, emphasizing its transformative potential in improving agricultural sustainability and livestock management.

1.1 MOTIVATION

The integration of IoT technology has revolutionized the livestock industry. This project investigates how IoT devices can monitor and analyze cattle activity, empowering farmers with insights into their herd's health, behavior, and productivity. The insights derived from IoT-based data analytics promote better management practices and increased operational efficiency.

1.2 OBJECTIVES

The primary objectives of the project are:

1. **Develop a cattle monitoring system:**
    - Create a wearable collar to track cattle health parameters.
2. **Integrate IoT sensors into collars:**
    - Use advanced sensors to collect data on vital health indicators.
3. **Leverage additive manufacturing:**
    - Design and produce collars with integrated electronics.
4. **Implement microcontroller programming:**
    - Utilize Arduino for real-time data processing and transmission.
5. **Analyze sensor data:**
    - Employ data analytics to assess cattle health and behavior.

2. LITERATURE SURVEY

1. **IoT-based Cattle Monitoring Systems and Dashboard:**
    - Authors: Khalid El M., Hamza Jdi, Brahim Jabir, Falih Nour
    - Year: 2023
2. **With Wireless Sensor Network Create Cattle Health Monitoring System:**
    - Authors: Bhisham Sharma, Deepika Koundal
    - Year: 2018
3. **By IoT Create Cow Health Monitoring System:**
    - Authors: Olgierd Unold, Maciej Nic.
    - Year: 2023
4. **Deploy a Smart and Secure Cattle Health Monitoring System:**
    - Authors: Jehangir Arshad, Talha Ahmad, M. Ismail
    - Year: 2023
5. **Smart Wearable Devices and Biosensors for Monitoring Cattle Health Conditions:**
    - Authors: Melchizedek Alipio, Maria Lorena San Pedra Villena
    - Year: 2023
6. **By IoT Create Sustainable Livestock Health Watching System:**
    - Authors: G. Ashmitha, K. Manish Daniel, J. Saravanan, K. Ayyar
    - Year: 2023
7. **A Real-Time Cattle Health Tracking:**
    - Authors: Ayushi Bhatla, Yash Bhadrik Kikani, Joshi Dg, Rahul Jain
    - Year: 2023

3. PROBLEM STATEMENT

Ensuring the health and well-being of cattle is essential for the success of cattle farms, as it directly impacts milk production and agricultural sustainability. However, monitoring cattle health poses significant challenges, particularly in large-scale farms where manual surveillance is time-consuming and inefficient. The lack of timely detection of health issues can lead to productivity losses, increased medical expenses, and even mortality in herds.

To address these challenges, this study proposes an Internet of Things (IoT)-based solution for cattle health monitoring. The system uses advanced sensors to track vital health parameters such as heart rate, body temperature, rumination, and GPS location, providing a comprehensive overview of each animal's health. These data points are transmitted to a centralized platform where Artificial Intelligence (AI) and Machine Learning (ML) algorithms analyze the information, enabling early detection of anomalies and potential health risks.

The proposed solution is both cost-effective and efficient, offering farmers a reliable method to improve livestock management. By facilitating timely interventions and providing actionable insights, this IoT-enabled system enhances herd health, supports consistent milk production, and promotes agricultural sustainability. This approach not only addresses current challenges but also paves the way for smarter, technology-driven farming practices.

4. SOFTWARE REQUIREMENT SPECIFICATION

4.1 PURPOSE:

The purpose of this study is to leverage IoT technology for comprehensive cattle health monitoring to improve livestock management. By utilizing sensors to track critical health indicators such as heart rate, rumination, body temperature, and GPS location, the system aims to detect anomalies and optimize herd management. The data is analyzed using AI and ML algorithms on a centralized platform, providing a cost-effective solution that enhances agricultural sustainability and benefits farmers by improving the overall health and productivity of their cattle.

4.1.1 SCOPE:

The scope of cattle health monitoring typically includes tracking vital signs, detecting diseases, monitoring behavior, assessing nutritional status, and ensuring overall well-being. Technologies such as sensors, data analytics, and machine learning play a crucial role in gathering and interpreting relevant data for effective livestock management.

4.2 FUNCTIONAL REQUIREMENTS:

1. Cattle Health Monitoring:

- Sensors must track and collect data on critical health parameters, including:
  - Heart rate.
  - Rumination activity.
  - Body temperature.
  - GPS location.

2. Data Transmission:

- The system must transmit data collected by the sensors to a centralized platform.

3. Data Analysis:

- The centralized platform must use AI and ML algorithms to:
  - Analyze sensor data.
  - Detect anomalies in cattle health.
  - Provide actionable insights.

4. Real-Time Alerts:

- The system should notify farmers immediately when anomalies or health issues are detected.

5. Integration and Scalability:

- The IoT system should integrate seamlessly with existing farm management tools.
- It must be scalable to accommodate large herds in expansive farms.

6. User Interface:

- Provide farmers with an accessible interface (e.g., a mobile app or web dashboard) to:
  - View health data and trends.
  - Access alerts and recommendations.

7. Cost-Effectiveness:

- The solution should remain affordable and practical for widespread adoption by farmers.

8. Sustainability Support:

- Ensure the system supports sustainable agricultural practices by improving herd health and productivity.

4.3 NON FUNCTIONAL REQUIREMENTS:

1. Performance:

- The system must process and analyze sensor data in real-time or near real-time to provide timely alerts and recommendations.
- Ensure minimal latency in transmitting data from sensors to the centralized platform.

2. Reliability:

- The system should operate continuously with minimal downtime to ensure uninterrupted monitoring of cattle health.

3. Scalability:

- The system must support an increasing number of cattle and sensors without performance degradation, accommodating large farms.

4. Accuracy:

- AI and ML algorithms should deliver high accuracy in anomaly detection to minimize false positives and false negatives.

5. Security:

- Ensure the secure transmission of sensor data to prevent unauthorized access or tampering.
- Protect the centralized platform from cyber threats.

6. Usability:

- The interface (mobile app or web dashboard) should be intuitive and easy for farmers to use, even with limited technical knowledge.

7. Cost-Effectiveness:

- The system should use affordable sensors and infrastructure to remain accessible to small and medium-sized farms.

8. Energy Efficiency:

- Minimize power consumption of sensors and the centralized platform to reduce operational costs and environmental impact.

9. Maintainability:

- Ensure the system can be easily updated and maintained, including software updates for algorithms and hardware repairs.

10. Interoperability:

- The system should integrate seamlessly with other farm management tools or IoT devices to enhance overall functionality.

11. Resilience:

- The system should handle failures gracefully, such as sensor malfunctions or temporary network outages, without losing critical data.

12. Compliance:

- Adhere to regulations and standards for data privacy, agricultural technology, and animal welfare in the regions where the system is deployed.

4.4 SYSTEM REQUIREMENTS

4.4.1 HARDWARE REQUIREMENTS

1. IoT Sensors:

- Sensors for monitoring:
  - Heart rate.
  - Rumination activity.

- Body temperature.

- GPS location for cattle tracking.

- Sensors must be durable, weather-resistant, and suitable for attachment to cattle.

3. Centralized Platform:

- Servers or cloud infrastructure to store and process data.
- Sufficient computational resources for running AI/ML algorithms.

4. Power Supply:

- Battery-powered sensors with long battery life or renewable power options (e.g., solar-powered units).

5. Communication Modules:

- Wireless communication technologies (e.g., Wi-Fi, LoRa, Zigbee, or cellular networks) to enable data transmission.

fig.4.4.1.Arduino Uno

fig.4.4.2.ADXL345

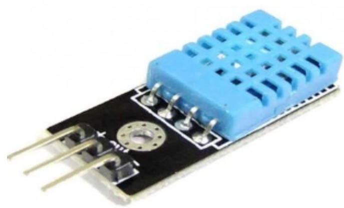


fig.4.4.3.DHT11

Fig.4.4.4.ESP8266

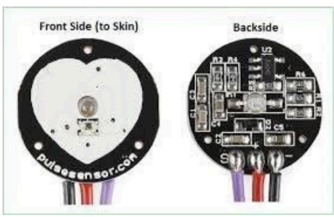


fig.4.4.5.Heart rate

fig.4.4.6.GPS

4.4.2 SOFTWARE REQUIREMENTS

1. Data Collection Software:

- Embedded software on sensors for data acquisition and preprocessing.

2.Data Transmission Protocols:

- Support for IoT communication protocols (e.g., MQTT, HTTP, CoAP) for reliable data transfer.

3. AI/ML Algorithms:

- Algorithms for analyzing sensor data to detect anomalies in cattle health.
- Model training and validation capabilities for improving detection accuracy.

4. User Interface:

- A web-based dashboard or mobile application for farmers to:
- Monitor cattle health metrics.
- Receive alerts and recommendations.
- View historical data and trends.

5. Database Management System:

- A robust database for storing sensor data and analysis results.

4.5. Analysis Model: SDLC Model to be Applied:

To choose an appropriate **Software Development Life Cycle (SDLC) model** for the cattle health monitoring project, let's analyze its requirements and align them with the characteristics of different SDLC models. Here's an explanation of the SDLC model most suitable for this project, elaborated in a detailed manner:

4.5.1 Recommended SDLC Model: Agile Model:

The Agile SDLC model is the most suitable for this project due to its iterative and flexible approach. Cattle health monitoring involves IoT-based hardware integration (Arduino, pulse sensor, Bluetooth module) and software components (data analysis, Java-based processing module, visualization dashboards). These systems often need continuous refinement based on real-time data and feedback.

Why Agile?

1. Iterative Development:

- Agile supports breaking the project into smaller, manageable modules (data collection, data transmission, data processing, etc.), allowing incremental delivery.
- Modules like the sensor integration, LEACH algorithm implementation, and dashboard visualization can be developed and tested in iterations.

2. Flexibility:

- The requirements for health monitoring might change as new thresholds or parameters are identified (e.g., adding GPS tracking or new health metrics). Agile allows accommodating such changes easily.

3. Continuous Feedback:

- This project requires constant interaction with end-users (e.g., farmers, veterinarians) for validating health alerts, usability of dashboards, and effectiveness of recommendations.

4. Hardware-Software Integration:

- IoT systems like this require frequent testing and debugging to ensure seamless interaction between hardware (pulse sensors, Arduino) and software (LEACH routing, data processing, dashboards). Agile allows testing these integrations in sprints.

4.5.2 Phases of Agile SDLC Applied to the Project:

1. Concept/Initiation Phase:

- Objective: Define the core purpose of the system.
- Activities:
    - Identify key goals: Monitor cattle health, transmit data wirelessly, and generate actionable reports.
    - Conduct feasibility analysis for using WSN, Arduino, and LEACH algorithm.
    - Draft requirements for hardware (pulse sensors, GPS, Bluetooth module) and software (Java module for threshold checking, dashboards).

2. Iteration Planning Phase:

- Objective: Break the project into smaller deliverables and prioritize tasks.
- Activities:
    - Iteration 1: Develop and test the heart rate data collection module using Arduino and pulse sensors.
    - Iteration 2: Implement the LEACH algorithm for data transmission to the base station.
    - Iteration 3: Create the Java-based threshold-checking module to analyze health parameters.
    - Iteration 4: Develop the dashboard for visualizing health metrics, activity trends, and alerts.

3. Iterative Development and Testing Phase:

Each iteration involves designing, developing, and testing specific modules.

- Iteration 1: Data Collection Module:

- Integrate pulse sensors with Arduino.
- Test heart rate measurement accuracy.
- Debug Bluetooth connectivity with Android mobile devices.

- Iteration 2: Data Transmission Module:

- Implement the LEACH protocol for energy-efficient data routing.
- Validate cluster-head selection and data forwarding to the base station.

- Iteration 3: Data Processing and Validation Module:

- Develop Java code to analyze collected data against predefined thresholds.
- Test the detection of abnormal conditions like stress, estrus, and illness.

- Iteration 4: Visualization and Alerts:

- Build dashboards to display real-time data.
- Generate automated alerts for abnormalities and provide actionable recommendations.

4. Deployment Phase:

- Deploy the system on a small-scale farm for pilot testing.
- Ensure seamless integration of hardware and software components.
- Collect feedback from users to refine the system.

5. Maintenance Phase:

- Regularly monitor system performance and fix issues.
- Update threshold values and health metrics based on new research or user feedback.
- Add new features like enhanced visualization, additional health parameters, or predictive analytics.

4.5.3 Advantages of Agile for This Project:

1. Frequent Testing: Ensures each component (sensor, WSN, software) works as intended before moving to the next stage.
2. User-Centric: Farmers and veterinarians can give feedback at every iteration, leading to a more practical and user-friendly system.

3. Reduced Risk: Early detection of issues during iterative testing minimizes the risk of failure.
4. Scalability: The system can be expanded by adding more sensors or new analysis modules in future iterations.

4.5.4 Alternative SDLC Models (If Agile Is Not Used):

1. Waterfall Model (Less Suitable):

- The Waterfall model is rigid and does not accommodate changes easily, which makes it unsuitable for a dynamic project like this, where feedback and iterative testing are essential.

2. V-Model (Moderately Suitable):

- The V-Model emphasizes thorough testing at every stage. However, it still lacks flexibility for incorporating new requirements.

3. Prototype Model (Can Be Combined with Agile):

- Prototypes of modules (e.g., dashboards, health monitoring) can be developed early and tested with users, making it a good choice for initial stages.

4.6 System Implementation Plan:

1. Introduction

The project aims to implement an IoT-based system for cattle health monitoring, addressing the challenges of manual surveillance on large farms. The system will collect and analyze data on critical cattle health parameters using IoT sensors and AI/ML algorithms to enhance herd management and improve agricultural sustainability.

2. Implementation Phases

Phase 1: System Setup

- **Objective:** Prepare the infrastructure and hardware for data collection and transmission.
- **Tasks:**
    1. Procure hardware components: IoT sensors (heart rate, temperature, GPS), Arduino/ESP32 microcontrollers, and communication modules (e.g., Bluetooth, Wi-Fi, or LoRa).
    2. Configure wearable devices for cattle, ensuring durability and animal comfort.
    3. Set up a cloud-based platform for data storage and analysis.

Phase 2: Data Collection Module Development

- **Objective:** Enable real-time collection of cattle health data.
- **Tasks:**
    1. Program microcontrollers to read data from sensors.
    2. Calibrate sensors to ensure accurate measurements.
    3. Test the reliability of data collection in a controlled environment.

Phase 3: Data Transmission and Integration

- **Objective:** Transmit data from sensors to the centralized system.
- **Tasks:**
    1. Integrate communication modules for wireless data transfer.
    2. Implement protocols (e.g., MQTT, HTTP) for secure and reliable data transmission.
    3. Test the transmission range and identify potential connectivity issues, especially in large farms.

Phase 4: Data Processing and AI/ML Integration

- **Objective:** Process collected data to identify anomalies using AI/ML algorithms.
- **Tasks:**
    1. Develop a data pipeline to clean and preprocess sensor data.
    2. Train machine learning models for anomaly detection based on historical data.
    3. Deploy AI/ML models on the cloud or edge devices for real-time analysis.
    4. Implement threshold-based algorithms to assess health parameters (e.g., abnormal heart rate or temperature).

Phase 5: User Interface Development

- **Objective:** Provide farmers with actionable insights through a user-friendly dashboard.
- **Tasks:**
    1. Design a mobile/web application for data visualization.
    2. Create features to display:
        - Real-time health metrics (heart rate, body temperature, etc.).
        - GPS location and movement patterns.
        - Alerts for abnormal conditions.
    3. Test the UI/UX for ease of use and responsiveness.

Phase 6: Testing and Validation

- **Objective:** Ensure the system is robust and reliable in real-world conditions.
- **Tasks:**
    1. Conduct functional testing of all modules (data collection, transmission, processing, and UI).
    2. Validate sensor accuracy and model predictions using real farm data.
    3. Perform stress testing to check the system's performance under heavy data loads.

Phase 7: Deployment

- **Objective:** Roll out the system on a pilot farm for real-world testing.
- **Tasks:**
    1. Deploy wearable devices on cattle and set up the centralized platform.
    2. Monitor system performance over a trial period.
    3. Collect feedback from farmers and refine the system based on their input.

Phase 8: Maintenance and Updates

- **Objective:** Ensure the system remains operational and effective over time.
- **Tasks:**
    1. Schedule periodic calibration and maintenance of sensors and devices.
    2. Update AI/ML models with new data to improve anomaly detection accuracy.

3. Provide technical support and training for farmers.

3. Deliverables

1. Functional IoT devices for cattle health monitoring.
2. A cloud-based platform with integrated AI/ML algorithms.
3. A mobile/web application for real-time health tracking and alerts.
4. A deployment report with performance metrics from the pilot implementation.

4. Resources

- Hardware: IoT sensors, microcontrollers, communication modules.
- Software: Cloud services, AI/ML frameworks, mobile/web development tools.
- Team: Engineers (hardware and software), AI/ML specialists, testers.

5. Timeline

Phase	Duration
System Setup	2 weeks
Data Collection	2 weeks
Data Transmission	2 weeks
AI/ML Integration	3 weeks
UI Development	3 weeks
Testing and Validation	4 weeks
Deployment	3 weeks
Maintenance	Ongoing

6. Expected Outcomes

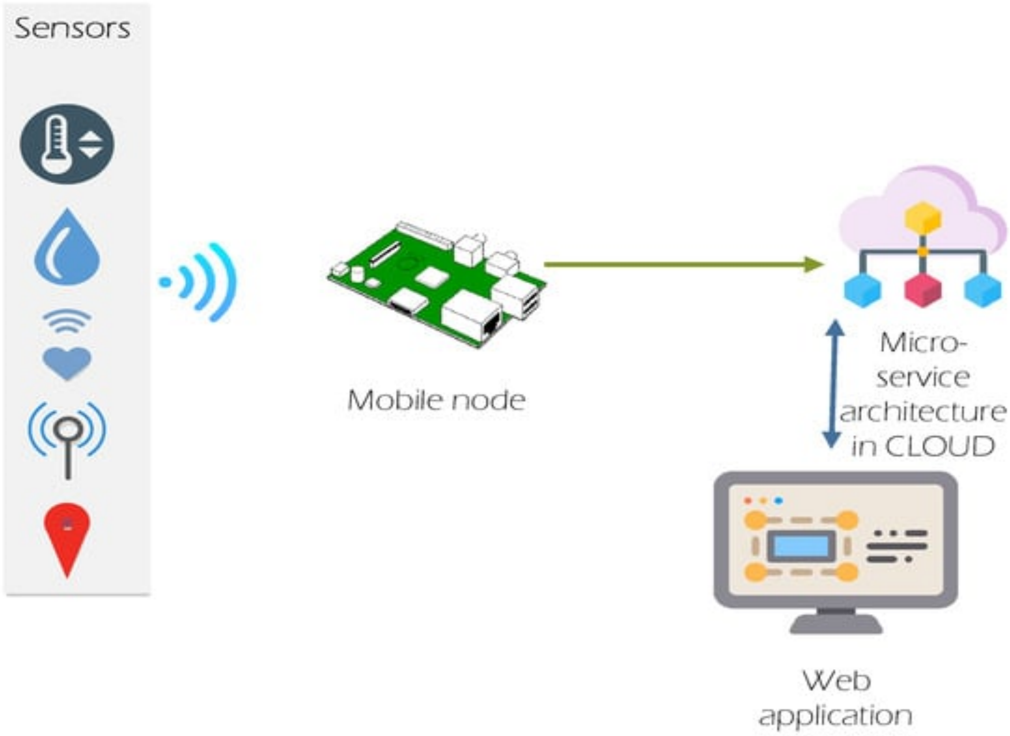
- Enhanced ability to monitor cattle health in real-time.
- Automated detection of anomalies, enabling timely interventions.
- Improved herd management, resulting in higher productivity and sustainability.

7. Conclusion

The implementation of this IoT-based cattle health monitoring system will streamline livestock management, reduce manual labor, and contribute to agricultural sustainability through data-driven insights and timely decision-making.

5 SYSTEM DESIGN

5.1 SYSTEM ARCHITECTURE:



(Fig 5.1.1 Architecture)

The project aims at monitoring the cattle health using wireless sensor network. It includes a module to collect the health data using Arduino as the hardware unit Next it comprises of another module transmit the collected data to the respective base station through LEACH algorithm for further processing of the data. It also includes a module in JAVA to test the threshold values of various health parameters like temperature, heart rate etc and

generate the periodic reports to the health centers.

For collection of the data, we used a pulse sensor which determines the heart rate serving as the basis to identify the health status of an animal. Heart rate is an extremely fundamental wellbeing parameter that is specifically identified with the soundness of the human cardiovascular framework. This project depicts a method of measuring the heart rate through a fingertip utilizing a

Arduino. While the heart is thumping, it is really pumping blood all through the body, and that makes the blood volume inside the finger artery route to change as well.

This vacillation of blood can be recognized through an optical detecting component put around the fingertip. The signal can be intensified further for the microcontroller to tally the rate of change, which is really the heart rate. This project module uses the pulse sensor with Arduino uno and Bluetooth HC-05 module, The pulse sensor is placed on the finger and it measures the heart rate and then sends the heart rate to android mobile via bluetooth device.

1. Routing the Data to the Base Station:

Wireless Sensor Network (WSN) have a major role as they maintain the routes in the network, data forwarding, and provide reliable multi-hop communication. The main requirement of a wireless sensor network is to prolong network energy efficiency and lifetime. Wide known scholars have developed protocols like Low Energy Adaptive Clustering Hierarchy (LEACH) for optimizing the energy consumption in the network.

LEACH offers significance importance because a node in the network is futile when its battery dies while LEACH protocol allows to space out the lifespan of the nodes, providing it to do only the minimum work needs to transmit data as the following FIG 7
shows.

The LEACH algorithm works in two phases: -

§ The Set-Up Phase:

▪ It is the phase where cluster heads are chosen

§ The Steady-State:

▪ It is the phase where the cluster head is maintained and data is
transmitted between nodes 26 Cluster-heads are chosen stochastically (randomly) in the module where: -

If n < T(n), then that node becomes a cluster-head

The Stochastic Threshold Algorithm algorithm works in the way so that each node becomes a cluster-head at least once.

2. Monitoring and processing the data at the base station

In this module we validate the information collected by the sensor and apply the threshold to check the condition of the cattle animal in the farm, thereby notifying the results. Characteristics of cattle abnormal condition Cattle animal have motion and pronunciation to communicate their expression and behavior.

This information can be used to check cattle's status that is physiological, mental and disease state. When animal ie cow here has a abnormality, characteristics of unusual condition. Are classified as stress, estruses, death and stolen. At the point when dairy animals have malady, delivery, stress, estruses, demise of cow and stolen status, demonstrate qualities of strange condition. Mating season estruses is attributing that expansion development and group than common day and enhance action around 3~4times then non-estruses dairy animals. The vast majority of dairy animals before the delivery diminish development and movement, they will make new gathering after out of group. At the point when bovines get push, which is atmosphere, commotion, condition of search and water, conduct progresses toward becoming to build more successive extreme exercise and development by harming delicate, muscle solidness, enlarged breath and ascent of circulatory strain and height of glucose levels. Demise of dairy animals is non-action and stolen of bovine is out of cattle farm which can't identify them in domesticated animals cultivate. It has objects such as Temperature-Humidity, Pressure index, Daily activity and normal value. To provide proposed alarm service with user, compare collected information from cattle farm with standard value.

Data Collection: GPS and accelerometer data from wearable devices on cattle are collected.

Data Transmission: Data is transmitted wirelessly to a central hub.

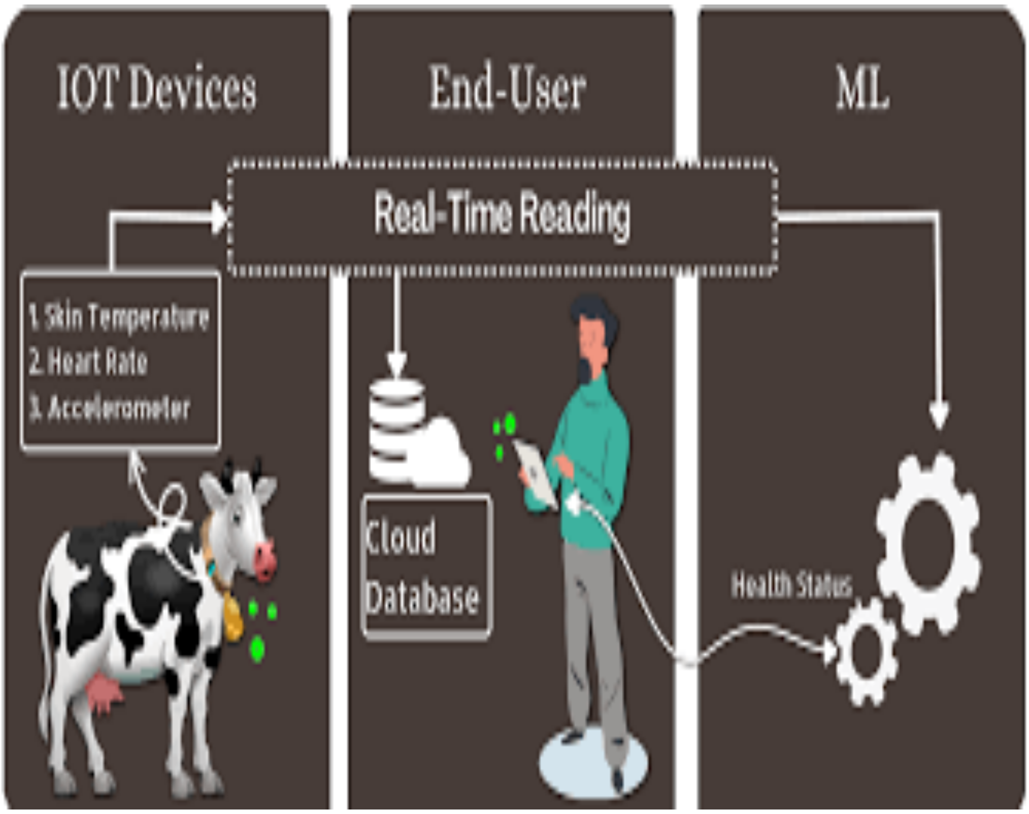
Data Storage: The data is stored in a cloud database.

Data Processing: Raw data is cleaned and transformed into relevant features (e.g., activity levels, movement patterns).

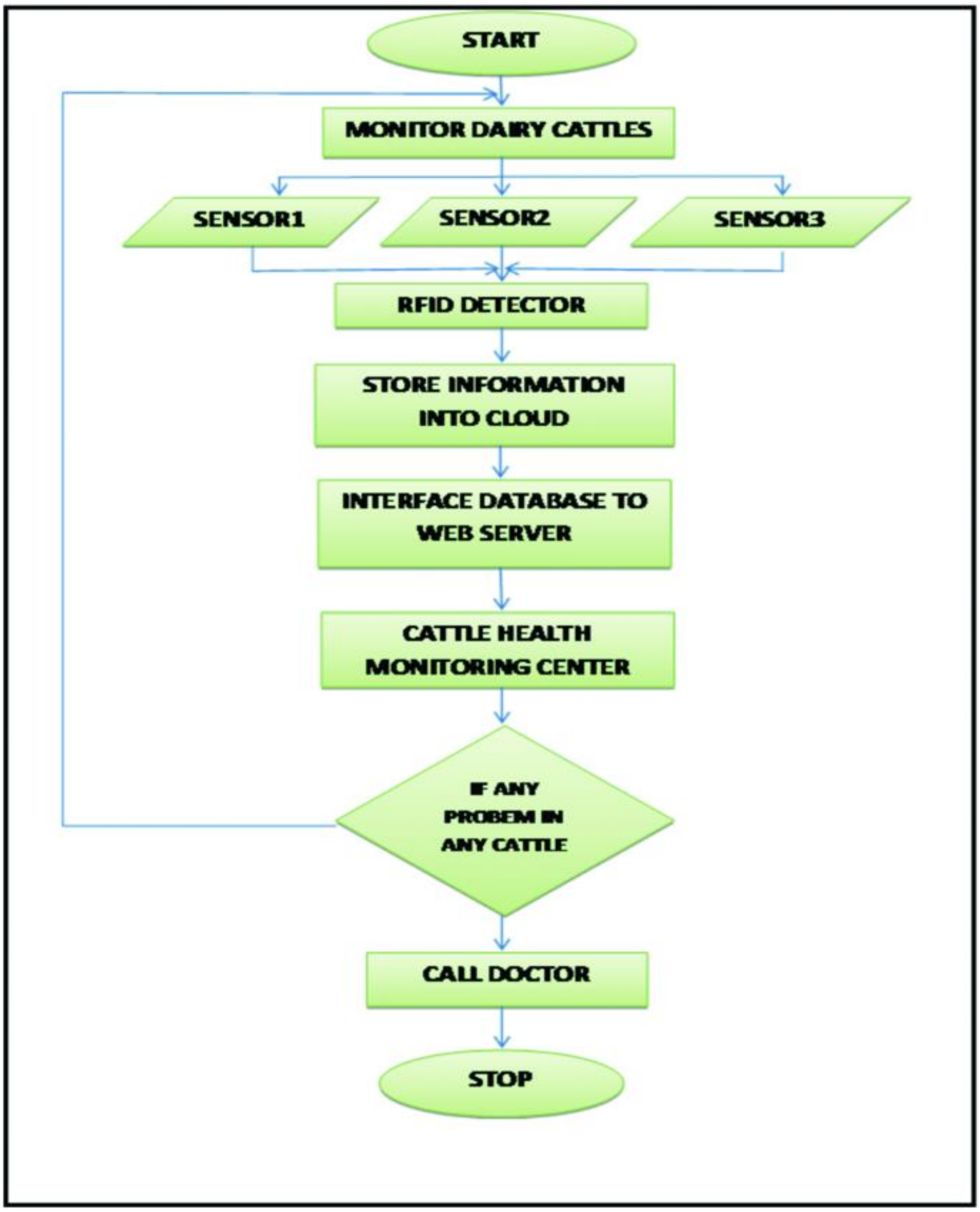
Analysis and Modeling: Machine learning models analyze the data to identify any abnormal behavior indicating potential health issues.

Visualization: Results are displayed on a dashboard, showing the location, activity levels, and health status of each cow.

Decision Support: Alerts are generated for any detected issues, and recommendations are provided for further action.



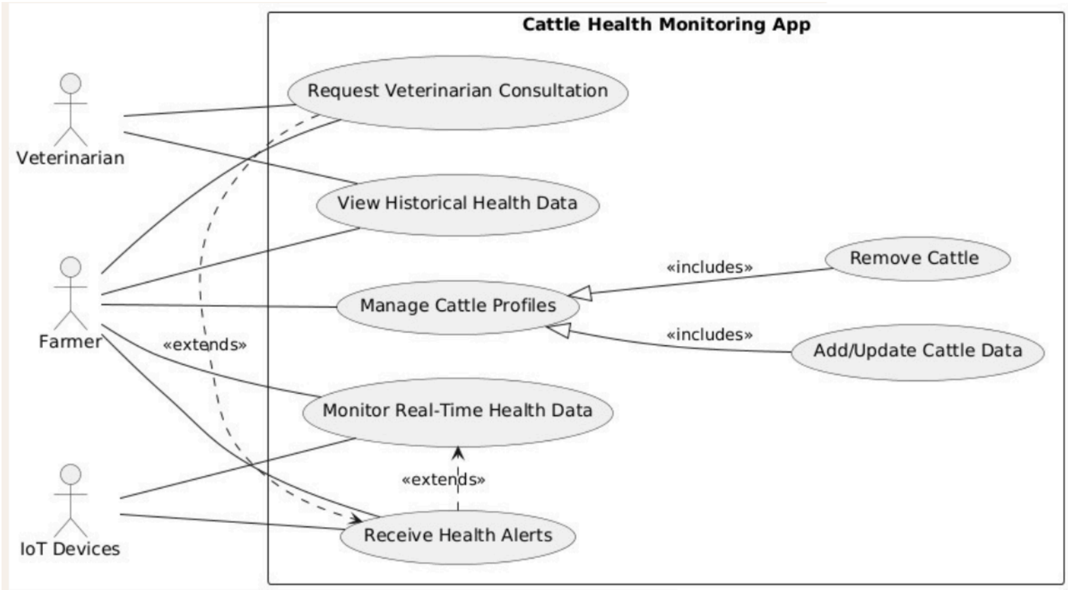
(Fig 5.1.2 Proposed Diagram)



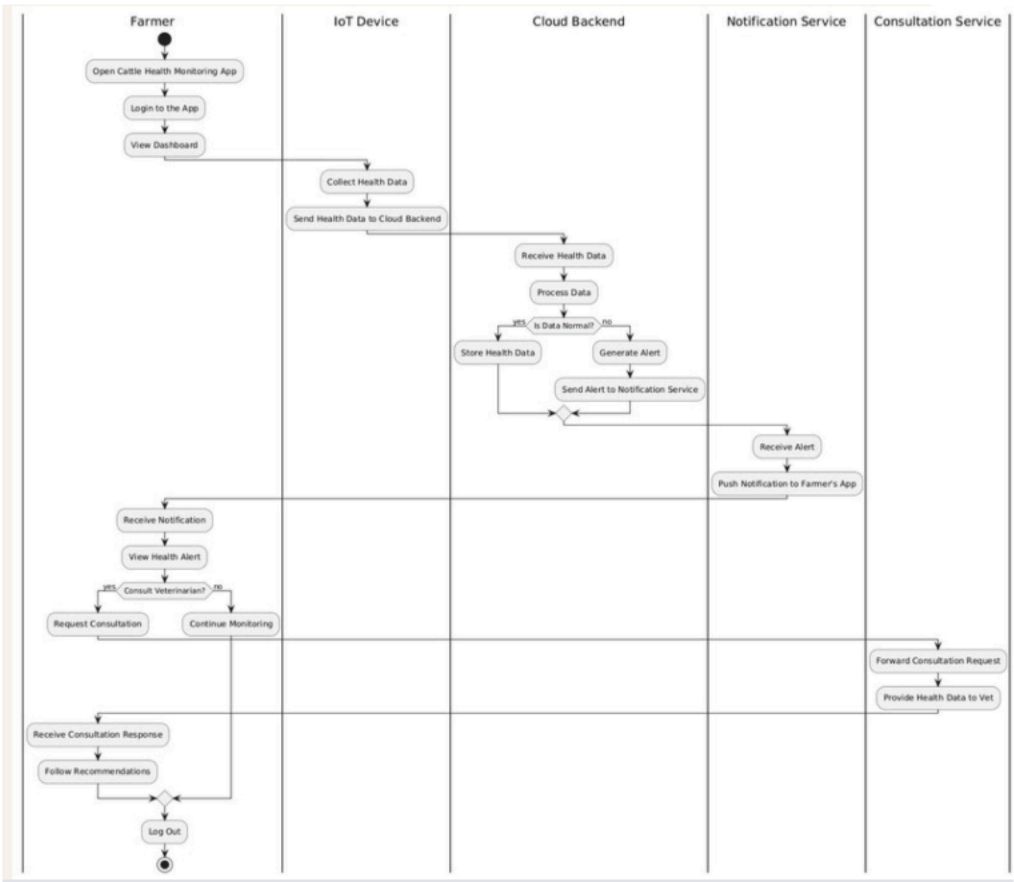
(Fig. 5.1.3 Flowchart)

5.2 UML DIAGRAMS:

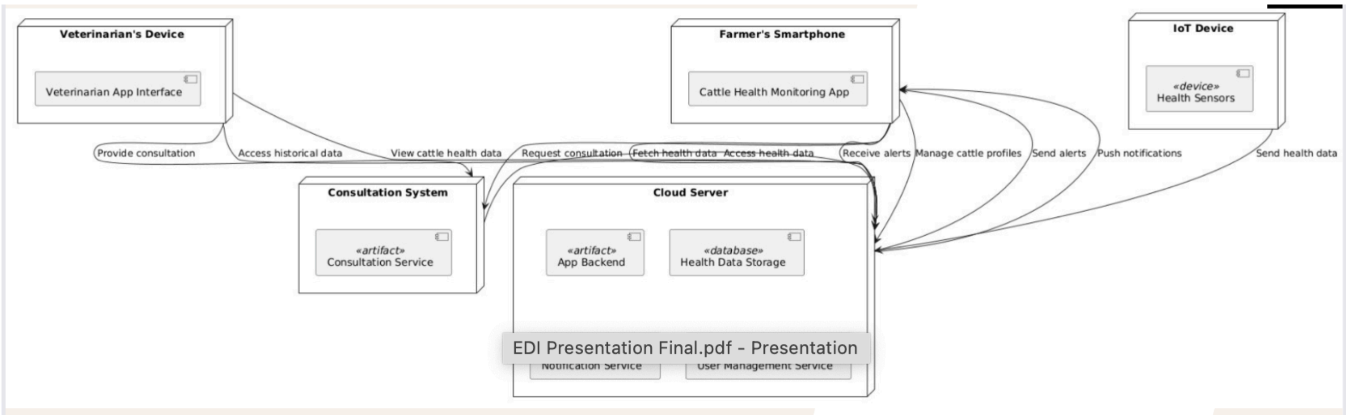
(Fig. 5.2.1 Use Case Diagram)



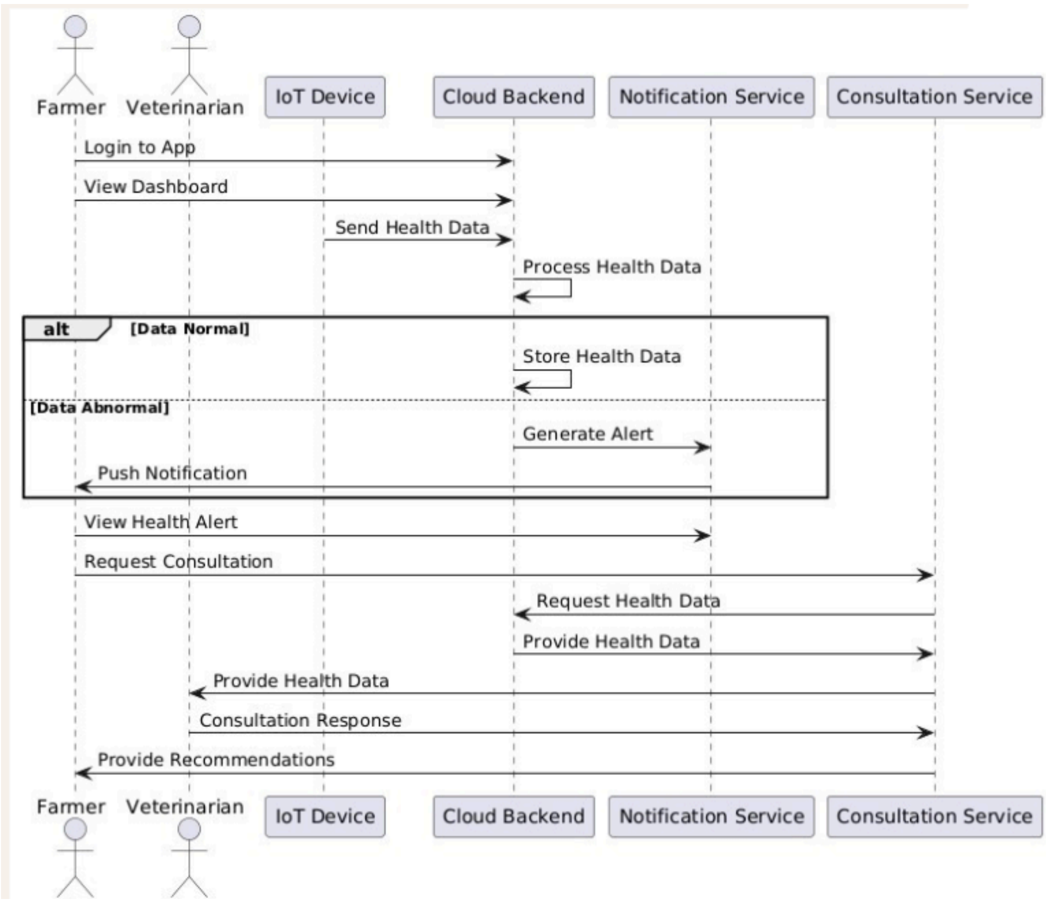
(Fig 5.2.2 Activity Diagram)



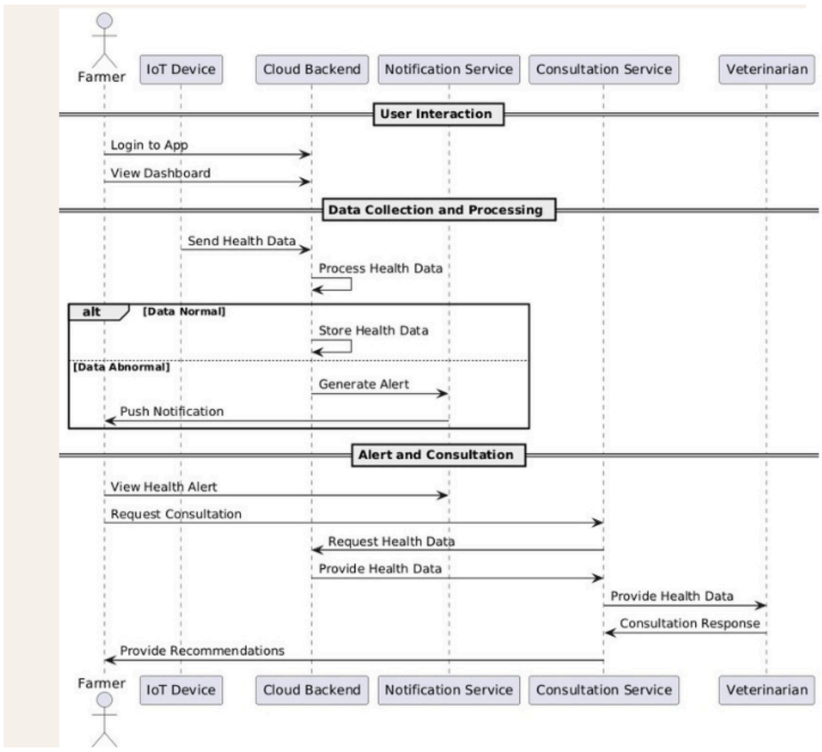
(Fig. 5.2.3 Deployment Diagram)



(Fig.5.2.4.Communication Diagram)



(Fig.5.2.5.Interaction Diagram)



6. SPECIFICATIONS

6.1 ADVANTAGES:

1. **Comprehensive Monitoring:**
    - Tracks multiple health indicators (heart rate, rumination, body temperature, GPS) for a holistic understanding of cattle health.
2. **Improved Livestock Management:**
    - Enables proactive decision-making by detecting health anomalies early, preventing severe illnesses.
3. **Cost-Effectiveness:**
    - Reduces the need for manual labor and frequent veterinary check-ups, lowering overall monitoring costs.
4. **Increased Productivity:**
    - Healthier cattle lead to sustained or improved milk production, directly benefiting the farm's profitability.
5. **Agricultural Sustainability:**
    - Optimized cattle health management reduces waste and supports eco-friendly farming practices.
6. **Scalability:**
    - Suitable for expansive farms, where manual monitoring would be inefficient and impractical.
7. **Data-Driven Insights:**
    - AI and ML algorithms analyze patterns and trends, offering valuable insights for long-term health management.

8. **Real-Time Alerts:**

    ◦ Immediate notifications allow farmers to act quickly, reducing the risk of disease outbreaks.

9. **Remote Monitoring:**

    ◦ Farmers can monitor their herd's health from anywhere using a centralized platform or mobile application.

6.2 LIMITATIONS:

1. High Initial Setup Costs:

- While the system is described as cost-effective in the long run, the initial investment in IoT devices (sensors, GPS modules, central platform setup) and infrastructure may be prohibitively expensive for small-scale farmers.

2. Dependence on Network Connectivity:

- The effectiveness of the system relies on stable and reliable wireless connectivity for transmitting data from sensors to the central platform. Remote or rural areas with limited internet or cellular network coverage may face challenges in implementing the system.

3. Sensor Reliability and Maintenance:

- Sensors used for monitoring parameters like heart rate, temperature, and rumination may suffer from wear and tear, environmental damage, or loss of accuracy over time, requiring regular maintenance and calibration.

4. Data Overload and Processing Challenges:

- Collecting data from multiple sensors across a large herd can lead to significant data volume. Efficient storage, processing, and management of this data may pose technical challenges, especially if AI/ML algorithms are not optimized.

5. Energy Constraints of IoT Devices:

- IoT sensors and GPS modules are typically battery-powered, which could lead to frequent battery replacement or recharging, increasing operational overhead for farmers.

6. Complexity of AI/ML Models:

- Training and deploying AI/ML algorithms for anomaly detection requires expertise and computational resources, which might not be accessible to all farmers or regions.

7. Environmental Factors Affecting Accuracy:

- Environmental conditions (e.g., heat, rain, dust) may impact the performance of sensors and GPS devices, leading to inaccuracies in data collection.

8. Ethical Concerns with Continuous Monitoring:

- Constant tracking of animals through sensors and GPS may raise concerns about animal welfare and privacy, especially if invasive techniques are involved.

9. Scalability Issues for Large Farms:

- In expansive farms with thousands of cattle, scaling the system to monitor all animals may require significant investments in additional hardware, software, and network infrastructure.

10. Limited Accessibility to Small Farmers:

- Despite its potential benefits, small-scale or resource-constrained farmers might find it difficult to adopt the system due to financial, technical, or logistical barriers.

11. Data Security and Privacy Concerns:

- Transmitting sensitive farm data (e.g., livestock health metrics, GPS location) over wireless networks introduces risks of data breaches, hacking, or misuse.

12. Learning Curve for Farmers:

- Farmers with limited technical knowledge may find it challenging to operate and interpret the system, requiring training and support for effective use.

13. Dependency on AI Predictions:

- Over-reliance on AI/ML-based anomaly detection might result in false positives or negatives, affecting decision-making in cattle health management.

These limitations highlight areas that need to be addressed to improve the feasibility, scalability, and accessibility of IoT-based cattle health monitoring solutions.

6.3 APPLICATIONS:

1. Livestock Health Management:

- Continuous monitoring of vital health parameters such as heart rate, rumination, and body temperature helps in early detection of diseases or health issues, enabling timely veterinary intervention.

2. Improved Milk Production:

- By maintaining optimal health conditions for cattle, the system supports consistent milk production, reducing losses due to illness or stress in the animals.

3. Behavioral Analysis:

- Monitoring cattle activity, such as movement and rumination patterns, helps detect behavioral changes linked to stress, estrus cycles, or abnormal health conditions.

4. Disease Detection and Prevention:

- Anomaly detection using AI and ML algorithms helps identify early signs of diseases like mastitis, digestive disorders, or lameness, preventing widespread outbreaks in herds.

5. Efficient Farm Management:

- The centralized platform allows farmers to manage large herds more effectively by providing real-time insights and prioritizing animals needing attention.

6. Herd Tracking and Security:

- GPS location tracking helps monitor the movement of cattle, ensuring they remain within designated areas and enabling quick recovery of lost or stolen animals.

7. Optimized Feeding and Nutrition:

- Analysis of rumination and activity levels provides insights into feeding habits, helping farmers optimize diets to meet the nutritional needs of cattle.

8. Reproductive Cycle Monitoring:

- Detecting estrus cycles through activity patterns aids in timely breeding, improving reproductive efficiency and herd growth.

9. Reduced Labor Costs:

- Automating cattle monitoring reduces the need for constant manual surveillance, saving time and labor costs, especially in large-scale farms.

10. Sustainability and Environmental Impact:

- Better health management reduces resource wastage (e.g., overfeeding, unnecessary medications), contributing to sustainable farming practices and minimizing the farm's environmental footprint.

11. Custom Alerts and Notifications:

- The system generates alerts for abnormal conditions such as illness, estrus, or inactivity, enabling prompt action by farmers or veterinarians.

12. Data-Driven Decision-Making:

- Historical and real-time data from sensors can be analyzed to improve herd management strategies, predict trends, and optimize farm operations.

13. Veterinary Support and Collaboration:

- Centralized health data can be shared with veterinarians for accurate diagnosis and treatment planning, improving overall animal healthcare.

14. Adaptation to Changing Climatic Conditions:

- Monitoring temperature and environmental conditions helps farmers adjust shelter or watering schedules to protect cattle during extreme weather.

15. Enhanced Agricultural Sustainability:

- Healthy cattle lead to better productivity, reducing the need for expanding herd sizes, which supports sustainable use of agricultural resources.

These applications demonstrate how IoT, combined with AI/ML, can revolutionize livestock management, ensuring better health outcomes for cattle and greater efficiency for farmers.

7. PROJECT PLAN

1. Introduction and Objective:

- Goal: Develop an IoT-based system to monitor cattle health efficiently in large-scale farms.

- Objective: Address challenges in manual health surveillance by implementing a cost-effective and automated monitoring solution.

- Scope: The system will monitor key cattle health parameters, process data using AI and ML, and notify anomalies for timely intervention.

2. Project Phases:

Phase 1: Requirement Analysis

- Identify the specific needs of cattle farms:

  - Parameters to monitor: Heart rate, body temperature, rumination, and GPS location.

  - Technical requirements: Sensor hardware, communication protocols, AI/ML algorithms.

- Determine cost constraints and deployment challenges.

Phase 2: System Design

- Design the architecture for an IoT-based solution:

  - Data Collection Module: Integrate sensors for health monitoring.

  - Data Transmission Module: Use wireless protocols like Bluetooth, Wi-Fi, or LoRa for data transfer.

  - Centralized Platform: Set up cloud storage and processing system.

  - AI/ML Module: Develop models for anomaly detection and health analysis.

  - Notification System: Design alerts for health risks.

Phase 3: Development

- Hardware Integration:

  - Select sensors for heart rate, temperature, and GPS.

  - Develop wearable devices for cattle.
- Software Development:
  - Create a cloud-based platform for data storage and analytics.
  - Implement AI/ML models for real-time analysis.
  - Develop a user-friendly dashboard for farmers.

Phase 4: Testing

- Conduct functional testing for:
  - Sensor accuracy.
  - Data transmission reliability.
  - AI/ML anomaly detection performance.
- Perform system integration testing to ensure modules work seamlessly.

Phase 5: Deployment

- Deploy the IoT system in a pilot farm to validate real-world performance.
- Monitor and optimize system performance over a trial period.

Phase 6: Maintenance and Updates

- Provide regular updates to improve AI/ML algorithms based on field data.
- Ensure hardware maintenance and sensor calibration.

3. Deliverables:

- Fully functional IoT system for cattle health monitoring.
- Centralized platform for real-time health analytics.
- Mobile or web-based application for data visualization and alerts.

4. Timeline:

Phase	Duration
Requirement Analysis	2 weeks
System Design	3 weeks
Development	6 weeks
Testing	4 weeks
Deployment	3 weeks
Maintenance & Updates	Ongoing

5. Resources:

- Hardware: Sensors (heart rate, temperature, GPS), wearable devices, communication modules.

- Software: Cloud services, AI/ML frameworks, dashboard development tools.

- Team: Hardware engineers, software developers, AI/ML specialists, testers.

6. Risks and Mitigation:

- **Risk**: Sensor malfunctions.

  Mitigation: Use robust and tested hardware.

- Risk: AI/ML model inaccuracies.

  Mitigation: Train models with diverse datasets and continuously refine.

- Risk: Connectivity issues in remote areas.

  Mitigation: Use low-power wide-area networks (e.g., LoRa).

7. Expected Outcomes:

- Enhanced cattle health monitoring with real-time alerts.
- Improved herd management and agricultural sustainability.
- Reduced costs and labor for farmers through automated solutions.

8. CONCLUSION AND FUTURE WORK

Conclusion:

The IoT-based cattle health monitoring system will revolutionize livestock management by leveraging AI and ML technologies. It provides a scalable, cost-effective solution to overcome the limitations of traditional methods, ensuring healthier herds and sustainable farming practices.

Future Work:

1. **Integration of Advanced Technologies**
   - **IoT (Internet of Things):** Sophisticated sensors and devices for real-time monitoring of vital signs and behaviors.
   - **AI and Machine Learning:** Analyze datasets for health predictions and farm optimization.
   - **Blockchain:** Ensure traceability and transparency in the cattle supply chain.
2. **Improved Data Analytics**
   - **Predictive Analytics:** Algorithms to predict disease outbreaks or health trends.
   - **Big Data:** Comprehensive analysis from health, environmental, and genetic data.
3. **Enhanced Diagnostics and Treatments**
   - **Wearable Technologies:** Advanced, comfortable devices for real-time health monitoring.
   - **Genetic Analysis:** Identification of disease-resistant traits for herd improvement.

4. **Sustainability and Welfare**

    ◦ **Sustainable Practices:** Precision feeding for reduced environmental impact.
    ◦ **Animal Welfare:** Stress reduction systems to enhance health and productivity.

5. **Regulatory and Ethical Considerations**

    ◦ **Data Privacy:** Secure and ethical use of collected data.
    ◦ **Compliance:** Adherence to animal health standards.

6. **Economic and Social Impacts**

    ◦ **Cost-Effectiveness:** Making systems affordable for small-scale farmers.
    ◦ **Education and Training:** Providing knowledge for effective system use.

7. **Collaboration and Research**

    ◦ **Interdisciplinary Research:** Collaboration between diverse professionals for innovation.
    ◦ **Open Data Platforms:** Sharing global insights to improve monitoring systems.

8. **Market Growth and Adoption**

    ◦ **Market Expansion:** Increasing adoption due to reliability and cost efficiency.
    ◦ **Global Reach:** Extending technology to underserved regions for food security.

REFERENCES

1. Khalid El Moutaouakil, Hamza Jdi, Brahim Jabir, Noureddine Falih : Digital Farming: Survey on IoT-based Cattle Monitoring Systems and Dashboards LIMATI Laboratory, Polydisciplinary Faculty, Sultan Moulay Slimane University, Beni Mellal, Morocco.

2. Bhisham Sharma, Deepika Koundal : Cattle health monitoring system by wireless sensor network: Survey from innovation perspective.

3. Maciej Nikodem Henryk Maciejewski ,Marek Piasecki ,Marek Bawiec, Kamil Szyc : Olgierd Unold(B) IoT-Based Cow Health Monitoring System: , Pawe Dobrowolski and Michal Zdunek

4. Arshad Siddiqui T, Sheikh MI, Waseem MS, Nawaz MAB: Deployment of an intelligent and secure cattle health monitoring system:, et al.(2023) Egyptian Informatics Journal 24(2):265-275

5. Alipio M, Villena : Intelligent wearable devices and biosensors for monitoring cattle health conditions: A review and classification. ML (2023) Smart Health 27: 100369.

6. Ashmitha G, Daniel KM, Saravanan J, Ayyar K, Jaibhavani KS :IoT Based Sustainable Live Stock Health Monitoring System: (2023) (ICDCECE). India

7. Global Animal Health Monitoring Software Market by Animal Type (Cattle, Equine, Poultry), Deployment (On Cloud, OnPremise), End User-Cumulative Impact of High, Inflation Forecast 2023-2030 by Research and Markets.

8. : Rahul Jain: Real Time Cattle Health Monitoring Using IoT, ThingSpeak, and a Mobile Application, (2023) DOI: 10.23880/ jeasc16000131.

9. Sahabani, Biba T, Cico B (2022): Design of a Cattle-Health-Monitoring System Using Microservices and IoT Devices. Computers 11(5): 79

10. A Survey. Advances in Intelligent Systems and Computing pp: Gamei M, Gaber T (2019) Wireless Sensor Networks- Based Solutions for Cattle Health Monitoring: 779- 788.

11. : Kavitha B C, Sahana M D, Sandhya G, Thejaswini G, Ganavi: Cattle health monitoring using Iot DS (2019) JETIR May 2019, www.jetir.org (ISSN-2349-5162)

12. Snehal. Skharde," Advanced cattle health monitoring system using Arduino and IOT", IJARE, electronics, and instrumentation engineering, vol.5, issue 4, April 2016.