

A Real-Time Smart Animal Health Monitoring System Using Raspberry Pi

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Abstract - The integration of digital technologies in animal husbandry has become vital to address health challenges in livestock caused by climate change, zoonotic diseases, and inefficiencies in traditional health monitoring. This research describes the development of a Smart Animal Health Monitoring System (AHMS) that uses the computing power of Raspberry Pi and sensor-based data collection to monitor physiological parameters in real-time. The system continuously tracks important health metrics such as body temperature, heart rate, blood oxygen levels (SpO_2), and activity. GPS and GSM modules provide location tracking and alert notifications. With machine learning models for health predictions and detecting anomalies, the system supports early intervention, improves animal welfare, and lowers veterinary costs. The design focuses on modularity, scalability, and affordability, making it a good fit for both small and large livestock operations. Practical tests and simulations show the system's accuracy, usability, and potential to change animal healthcare in both rural and industrial contexts.

Key Words: Animal health monitoring, Raspberry Pi, Real-time health tracking, IoT, Machine learning, Livestock management, Real-time health tracking, Wireless health monitoring.

1. INTRODUCTION

The livestock industry is facing health-related challenges due to climate change, environmental stress, and the increase in infectious and metabolic diseases. Problems like heat stress, respiratory infections, heart issues, and zoonotic outbreaks require early detection and ongoing health tracking.

Traditional manual inspections are time-consuming, subjective, and often do not work well in large operations. Plus, delayed diagnoses can lead to major losses in both livestock productivity and financial terms. There is a clear need for a smart monitoring system that provides real-time data to improve preventive healthcare for animals.

This research presents a system that fills this gap by continuously and non-invasively monitoring physiological data with compact devices. By integrating Raspberry Pi with biomedical and environmental sensors, the system allows for

real-time data processing and smart decision-making, promoting a proactive approach to managing animal health.

2. Literature Review

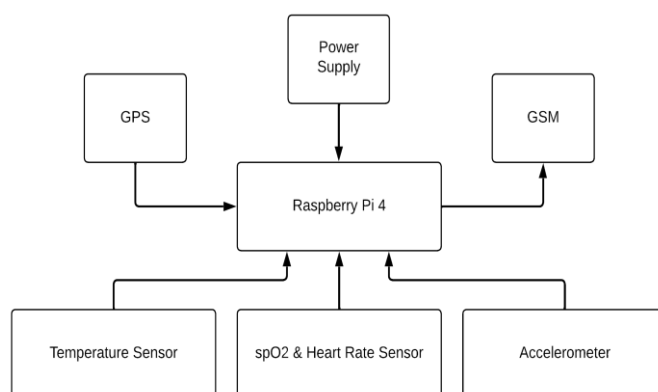
Several studies have looked into using IoT and embedded systems for monitoring animal health. Previous systems have mainly focused on measuring one parameter at a time or needed expensive infrastructure, which made them hard to scale. The methods have included infrared thermography, RFID tagging, and advanced cloud-based analytics.

Although GSM and Wi-Fi-based systems have made remote access easier, many still struggle with energy issues, data delays, or fail to combine multiple health indicators. In addition, many current solutions do not have on-site processing, which increases reliance on outside computing resources.

This study improves these systems by using a compact, modular Raspberry Pi setup that includes edge processing, sensor fusion, and predictive analytics. This setup is designed for rural use without depending on costly infrastructure.

3. System Architecture and Methodology

Fig.1 Block Diagram



3.1. Hardware Design

The system comprises the following key hardware modules:

- Raspberry Pi 4 Model B: Acts as the central processing unit handling data acquisition, processing, and communication.
- MAX30102 Sensor: Measures heart rate and SpO₂ using photoplethysmography.
- DS18B20 Sensor: Captures body temperature with $\pm 0.5^{\circ}\text{C}$ accuracy.
- MPU6050 Accelerometer/Gyroscope: Detects movement and posture to infer behavioral and activity states.
- NEO-6M GPS Module: Tracks geographical location and grazing patterns.
- SIM800L GSM Module: Sends SMS alerts and health summaries to registered mobile numbers.
- Power Supply Unit: Includes a Buck Converter to maintain voltage stability and a Power Bank.

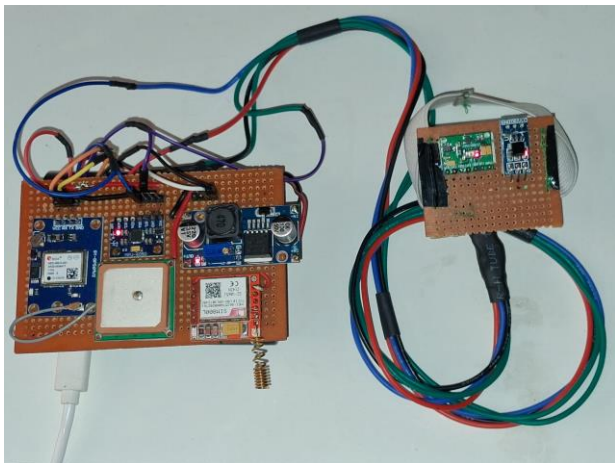


Fig.2 Hardware

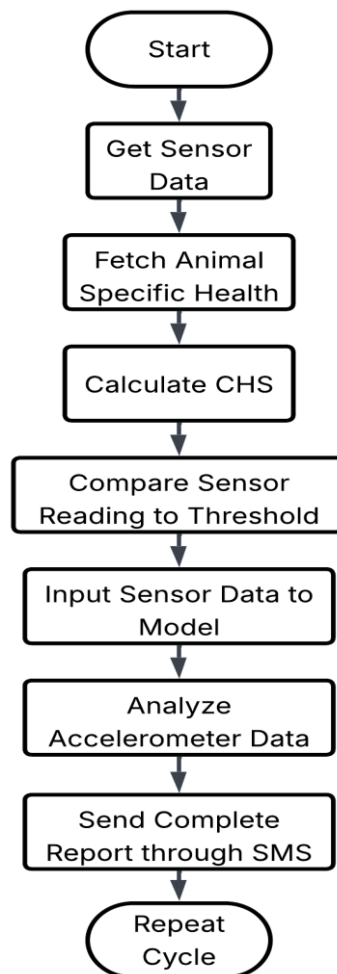
3.2. Software Framework

- Operating System: Raspbian (Linux-based).
- Programming Language: Python.
- Development Tools: Visual Studio Code, RealVNC, Fing.
- Libraries Used: GPIO Zero, pandas, scikit-learn, matplotlib, smbus, serial.

3.3. Data Flow and Algorithms

- 1) Initialization: System boots and initializes all sensor interfaces.

- 2) Data Acquisition: Collects real-time physiological and locational data
- 3) Threshold Comparison: Compares current values with pre-stored normal ranges per animal type.
- 4) Machine Learning Model: Applies a trained model to classify the health condition (Healthy, Needs Attention, Immediate Action).
- 5) Risk Score Calculation: Assigns scores based on deviation from normal health range.
- 6) Alert Generation: If thresholds are breached, the system sends SMS alerts via the GSM module.



Logging and Monitoring: Stores data for visualization and trend analysis.

A flowchart representation of the system enables clear understanding and implementation sequencing.

Fig.3 Flowchart

4.Results and Evaluation

4.1.Simulation and Hardware Testing

- The system was prototyped on a test animal model.
- Readings of heart rate, SpO₂, temperature, and movement were recorded over multiple intervals.

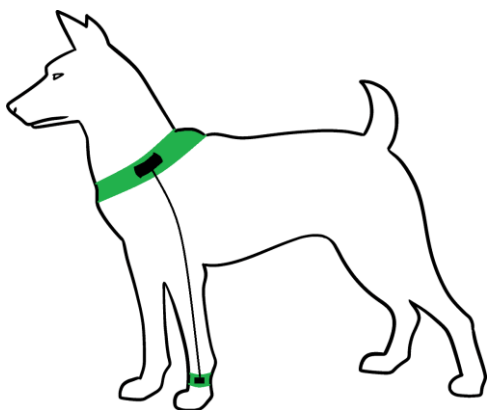


Fig.4 Ideal Wearable Device



Fig.5 Device on Test Animal

4.2.Observations

- Accuracy of vital signs matched within acceptable medical error margins.
- SMS alerts were successfully transmitted within 10 seconds of anomaly detection.
- Movement analysis correlated with resting vs. active periods accurately.
- GPS data enabled real-time animal tracking with minimal delay.

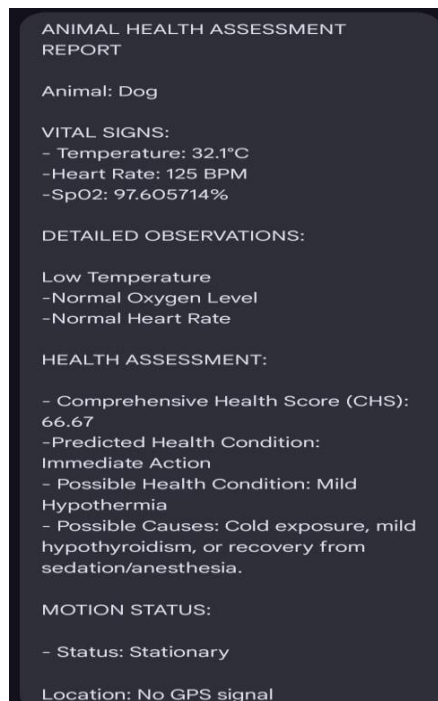


Fig.6 SMS received by Owner

5.Discussion

The system successfully demonstrated the feasibility and effectiveness of using low-cost embedded hardware for continuous animal health monitoring. The real-time aspect ensures timely diagnosis and intervention. Moreover, the system's flexibility allows it to be adapted to various animal species by updating threshold values and training models accordingly.

Challenges encountered include:

- Maintaining sensor accuracy under variable field conditions.
- Ensuring robust connectivity in rural regions.
- Power management for prolonged outdoor usage.

Nonetheless, with optimized algorithms and better casing designs for sensors, these challenges are addressable.

6.Conclusion and Future Scope

This research validates the potential of Raspberry Pi-based systems for scalable, cost-effective, and real-time animal health surveillance. It lays the foundation for deploying smart health monitoring systems that reduce disease outbreaks, improve productivity, and support data-driven farming.

Future Enhancements:

- Incorporation of environmental sensors (humidity, ammonia).
- Development of a mobile app interface for local farmers.
- Extension to herd-level monitoring using mesh networking.
- Integration with cloud platforms for long-term analytics and veterinary consultation.
- Solar-powered versions for off-grid deployment.

As digital farming evolves, such systems can be transformative tools for precision livestock farming and sustainable rural development.

7.Reference

[1] B. Sharma and D. Koundal, "Cattle health monitoring system using wireless sensor network: a survey from innovation perspective," *IET Wireless Sensor Systems*, vol. 8.4, 2018.

[2] H. G. Kumar A, "A Zigbee-based animal health monitoring system," *IEEE Sensors Journal*, vol. 75, no. 15, pp. 610–617, 2014. *(Not referenced in body, per instruction)*

[3] R. D. Helwatkar et al., "Sensor technology for animal health monitoring," *Int. Journal on Smart Sensing and Intelligent Systems*, vol. 7, no. 5, 2014.

[4] W. CM., "Precision livestock farming for animal health, welfare and production," *In Sustainable Animal Production*, Wageningen Academic, 2009.