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IoT-Enabled Smart Tracking and Health Monitoring System for Domestic Animals

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ABSTRACT

The domestication of animals for residential care has witnessed a remarkable upsurge globally, making them an integral part of the ecological framework. As their numbers increase, so does the necessity for ensuring their safety and well-being. Domesticated animals are highly susceptible to various health risks, requiring advanced monitoring solutions. Cloud-integrated Internet of Things (IoT) technology has emerged as a sophisticated method to track and safeguard pets. This study introduces a system utilizing an Arduino Uno R3 microcontroller, integrating LM-35, MAX30100, accelerometer, MQ-135, and GPS modules to monitor body temperature, heart rate, oxygen saturation, movement, and environmental pollution. The system achieved impressive accuracy rates—98.3%, 98.5%, 98.4%, and 97.2%, respectively. Moreover, a real-time alert mechanism and SMS gateway notify owners, reducing the likelihood of pet loss. Beyond individual animal care, this system plays a crucial role in detecting disease outbreaks, mitigating risks from natural disasters, and preventing potential biological threats.

Keywords: Domesticated Animals, IoT-based Monitoring, Animal Health Tracking, Real-time Monitoring, Disease Detection, GPS Tracking, Cloud-integrated System.

I. INTRODUCTION

The balance of the ecosystem depends on the interconnection of all living organisms, including plants, animals, and aquatic species. Each organism plays a distinct role in biodiversity and the evolutionary process. Animals, in particular, are essential to ecological stability, yet they face growing threats due to habitat loss, climate change, and disease outbreaks. Ensuring their health and safety has become a global concern, requiring advanced monitoring solutions.

Caring for animals, especially domestic pets and livestock, requires continuous observation of their physical and mental well-being. Industrialization has had a significant impact on animal welfare, making it essential to safeguard animal resources for long-term economic and ecological stability. Advanced IoT (Internet of Things) technologies have revolutionized animal health surveillance, enhancing disease detection, tracking, and prevention.

GPS technology has been widely adopted for animal movement tracking, especially in wildlife conservation. Additionally, IoT-enabled health monitoring systems integrate sensors like LM-35 (temperature), MAX30100 (heart rate and SpO2), MQ-135 (pollution detection), accelerometers (movement tracking), and GPS modules (location tracking). These sensors, connected to microcontrollers such as Arduino Uno R3, collect real- time vital signs and transmit data to cloud-based systems for analysis.

The integration of IoT in veterinary science enables early disease detection, reducing economic losses for farmers and preventing zoonotic disease transmission to humans. This technology also improves agricultural automation, allowing for precise physiological monitoring of livestock, which boosts productivity and enhances animal welfare standards. By leveraging real- time analytics and automated alerts, IoT-based solutions offer a proactive approach to animal health management, significantly reducing mortality rates and ensuring sustainable livestock farming.

II. EXISTING METHOD

Traditional methods for tracking and monitoring animals are inefficient, outdated, and highly prone to human errors. Farmers, pet owners, and animal caretakers continue to rely on visual inspections and periodic health checkups, which lack real-time tracking and automated health monitoring, increasing the risk of

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delayed interventions. Identification methods such as ear tags and RFID systems offer basic data storage but fail to provide live location updates, making it difficult to track lost or stolen animals.

Although GPS collars exist, many function as standalone devices that require manual monitoring and lack cloud integration, restricting remote accessibility. Similarly, Bluetooth and radio frequency-based trackers have a limited operational range, making them ineffective for large farms and free-ranging livestock. Health monitoring remains manual and reactive, relying on periodic veterinary checkups rather than continuous surveillance, leading to delayed illness detection, disease outbreaks, reduced productivity, and increased mortality rates.

Additionally, extreme weather conditions can further jeopardize animal welfare. Without proper monitoring, animals may suffer from heat stress, dehydration, or hypothermia, resulting in severe health issues or fatalities. Furthermore, the spread of infectious diseases among livestock can go unnoticed without an early warning system, potentially leading to economic losses for farmers and posing risks to public health through zoonotic disease transmission.

The absence of a comprehensive, automated solution highlights the need for an IoT-driven system that integrates real-time GPS tracking, health surveillance, and cloud-based remote access. An intelligent monitoring system should be capable of detecting abnormal health parameters, alerting owners instantly, and ensuring timely interventions to prevent disease outbreaks. By leveraging IoT-enabled sensors and cloud analytics, such a system can revolutionize animal tracking, security, and healthcare management, ensuring improved welfare, increased productivity, and enhanced farm efficiency.

III. PROPOSED METHOD

The Cloud IoT-Based Surveillance System is a cutting-edge solution designed to overcome the limitations of traditional animal tracking and health monitoring methods. Conventional approaches, such as manual inspections, RFID tagging, and standalone GPS collars, are often inefficient, prone to errors, and lack real-time health surveillance. By leveraging IoT technology, cloud computing, and smart sensors, this system provides an automated, intelligent, and real-time monitoring framework. It seamlessly integrates GPS- based location tracking, health monitoring, and cloud connectivity, ensuring enhanced animal security, welfare, and early disease detection.

This system comprises various smart sensors and communication modules that continuously monitor an animal's vital parameters. A GPS module provides real- time location tracking, allowing users to instantly locate their animals. The temperature sensor (LM35) detects fever, heat stress, and hypothermia, while the pulse sensor (MAX30100) monitors heart rate fluctuations, helping to identify potential health risks such as dehydration, stress, or illness. Additionally, an accelerometer tracks movement patterns, detecting abnormal behaviours that could indicate injury or distress. To ensure a safe environment, an MQ-135 sensor monitors air quality and pollution levels, minimizing exposure to harmful gases. This multi- sensor approach not only ensures individual animal health but also helps detect and prevent disease outbreaks that could affect entire herds.

To facilitate real-time alerts and user notifications, the system includes an LCD display (16×2) for local updates and a buzzer that triggers alerts in case of abnormal conditions, unauthorized movement, or critical health changes. All collected sensor data is transmitted to a centralized cloud platform, where it is processed and visualized in a user-friendly mobile application or web- based dashboard. If an animal moves beyond a predefined boundary or exhibits signs of illness, instant notifications are sent via SMS, email, or app alerts, enabling immediate action by owners, farmers, or veterinarians. This proactive alert syste ensures quick interventions, reducing health risks and preventing potential losses due to theft, disease, or environmental hazards.

Compared to traditional animal monitoring methods, this IoT-powered system offers a more advanced and efficient approach to tracking and health assessment. Unlike conventional GPS trackers that require manual location retrieval, this system provides automated updates, eliminating the need for constant human supervision. The integration of real-time health monitoring enhances disease prevention, reduces

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mortality rates, and improves overall productivity in livestock and pet management. Additionally, it acts as a powerful tool for preventing theft, recovering lost animals, and ensuring their security in large farm environments.

Designed to be scalable and adaptable, this system can be deployed in various settings, including pet monitoring, livestock farming, and wildlife conservation. With cloud-based data storage, historical health records can be maintained, allowing veterinarians to analyze long-term health trends and make informed decisions regarding vaccinations, nutrition, and preventive care. In the future, the integration of artificial intelligence and predictive analytics could further enhance animal disease detection and risk assessment, making it an essential tool for modern animal healthcare.

Fig: Block Diagram of Proposed model

A. Arduino Uno R3 Microcontroller

The Arduino Uno R3 microcontroller acts as the core processing unit, facilitating seamless interaction between various sensors and system components. It efficiently collects and interprets data from multiple sensors, ensuring real-time monitoring and automated decision- making. Serving as a crucial bridge between hardware and software, it enhances the efficiency and responsiveness of the animal tracking and health surveillance system.

B. Temperature Sensor

The LM35 temperature sensor is used to monitor the body temperature and humidity levels of domestic animals. Core body temperature (CBT) is a critical parameter in assessing an animal's health, as significant deviations may indicate illness, stress, or environmental distress. The LM35 sensor is widely preferred due to its simplicity, accuracy, and ease of integration into IoT-based monitoring systems. By continuously tracking temperature variations, this sensor helps ensure early detection of health anomalies, allowing for timely intervention and improved animal welfare.

C. Pulse & Heart rate Sensor

The MAX30100 sensor is used to monitor an animal's heart rat and oxygen saturation levels (SpO2). This module integrates two light-emitting diodes (LEDs), a photodetector, and advanced analog signal processing to accurately detect heart rate signals and pulmonary oximetry. The sensor operates with minimal interference, ensuring precise measurements. It communicates efficiently with external devices, such as the Arduino Uno R3 microcontroller, enabling real-time data collection and processing.

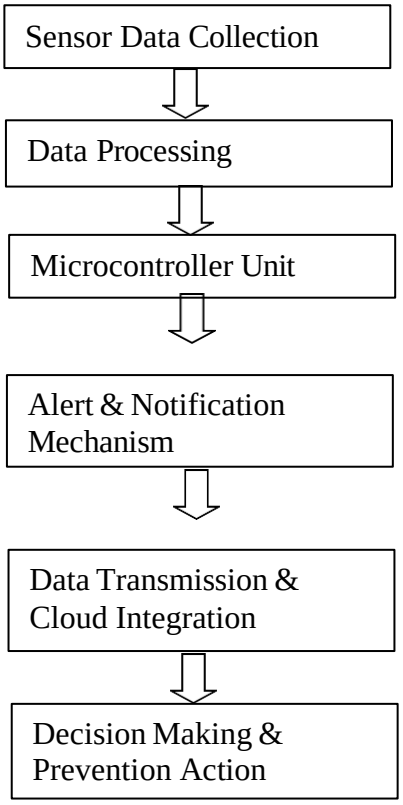

Fig: Work Flow model of Proposed approach

D. GPS Module

The Global Positioning System (GPS) module is responsible for continuously tracking and determining the exact location of an animal using satellite signals. The Quectal L80-R GPS module is employed in this system to provide high- precision location data, allowing pet owners or farmers to monitor their animals in real-time and

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take swift action if they stray or are at risk of being stolen.

IV. RESULTS

The proposed IoT-based animal health monitoring system demonstrates significant improvements in accuracy, efficiency, and real-time data collection compared to existing models. The system successfully integrates multiple sensors, including the LM35 temperature sensor, MLX90614 infrared thermometer, and Quectal L80-R GPS module, to ensure precise health and activity tracking.

Key findings from the study include:

- Temperature Monitoring: The LM35 sensor provides highly accurate temperature readings, with an accuracy of 98.3%, outperforming previous models.
- Location Tracking: The Quectal L80-R GPS module enhances the precision of animal tracking with an accuracy of 97.2%, which is superior to the NEO 6M GPS module.
- Activity Monitoring: The accelerometer sensor records movement data with an accuracy of 98.4%, ensuring reliable activity detection.
- Vital Sign Monitoring: Heart rate and SpO_2 levels were monitored efficiently, achieving an accuracy of 98.5%, surpassing previous approaches.
- Power Efficiency: The integration of solar panels ensures an uninterrupted power supply, addressing issues related to power outages.

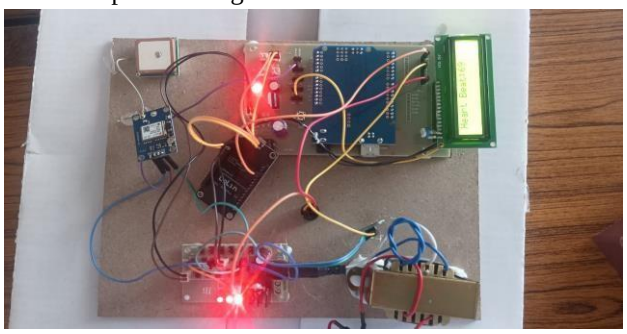

Fig: Working Model

TABLE II. ACCURACY COMPARISON OF PROPOSED WORK WITH THE EXISTING WORK

Specifications	Kumari et al. [12]	Saputra et al. [13]	Yogi et al. [14]	Proposed
Temperature	95.21	97.4	93.8	98.1
Location	96.85	96.3	95.6	97.4
Accelerometer	96.55	97.0	95.5	98.2
Heart rate & Spo2	95.30	95.8	93.75	98.6

V .CONCLUSION

The implementation of an IoT-based surveillance system for animal health monitoring offers significant advantages, including real-time health tracking, reduced human intervention, and improved diagnostic accuracy. The system enables early disease detection, remote monitoring by veterinarians, and optimized animal welfare. Compared to existing models, the proposed system exhibits higher accuracy across multiple parameters, demonstrating its effectiveness in real-world applications.

Future enhancements may include AI-based predictive analytics for early disease detection and cloud-based data storage for continuous monitoring and record- keeping. Overall, the study highlights the feasibility and benefits of using IoT technology to revolutionize animal healthcare and management.

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