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ALERTING AND DETECTING WILDLIFE IN FOREST USING INTERNET OF THINGS (IOT) AND ARTIFICIAL INTELLIGENCE (AI)-A SURVEY

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ABSTRACT

The integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies have the potential to transform animal management systems in agriculture. This study proposes an IoT and AI-based animal management system that provides real-time monitoring and management of animals on a farm, improving productivity and reducing operational costs. The system comprises an IoT-based sensor network, AI algorithms, and cloud-based data storage and analysis. The sensor network collects data on animal behavior, health status, and feeding patterns, which are transmitted to AI algorithms for analysis. The cloud-based system stores the data and provides real-time analytics for farm managers to make informed decisions. The study also discusses animal behavior modeling, data analysis techniques, and machine learning algorithms used in the proposed system. The results demonstrate that the system can enhance animal welfare, reduce disease outbreaks, increase productivity, and reduce environmental impact. These findings significantly impact the developing and implementing of IoT and AI-based animal management systems in agriculture.

Keywords: Iot-Based Sensor Network, Artificial Intelligence, Cloud, Animal Management, Automation.

I. INTRODUCTION

The world's population is estimated to increase to 9.4 and 10.1 billion by 2030 and 2050, respectively, leading to a significant rise in demand for animal-based food products [1]. However, livestock farming faces challenges, such as complexity, decreasing workforce, rising production costs, less resources, emission of greenhouse gases, and day-to-day management. Effective animal management systems are crucial in meeting global food production demands but face challenges like disease outbreaks, food safety, and sustainability. Integrating IoT and AI technologies into wildlife management systems can help by tracking animal behavioral patterns and health status, automating feeding and waste disposal processes, and enabling real-time monitoring and analyzing data to manage livestock effectively [2].

According to recent research, IoT and AI-based animal management systems can improve animal welfare, productivity, preventing diseases, and environmental sustainability. Sensors attached to animals can provide early disease detection and prevention, while automated feeding systems can optimize feed efficiency and waste can be reduced [2]. Monitoring systems can also help track wildlife movement and prevent theft or escape [3]. However, there are big challenges in implementing these systems, such as missing opportunities for extracting meaningful knowledge from the data collected and a lack of motivation and funds for farmers to invest in sensor-based smart systems. Additionally, the problem of human and wildlife collisions on roads remains as a major concern, causing injuries and deaths globally.

This study examines the present research on IoT and AI-based animal detecting and alerting systems, including their benefits, challenges, and potential applications. Furthermore, it aims to investigate the present challenges in wildlife management and how IoT and AI technologies can address these issues. By comprehending the current state of research and its implications, this study intends to offer insights for future development and implementation of IoT and AI-based wildlife management systems in agriculture.

II. METHODOLOGY

Proposed System

The proposed wildlife management system is based on integrating Internet of Things (IoT) technology and Artificial Intelligence (AI) algorithms. The system aims to provide real-time monitoring and management of

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animals on a farming lands, improving productivity and reducing operational costs. The system has three main components: An IoT-based sensor network, AI algorithms, and cloud-based data storage and analysis.

System Architecture

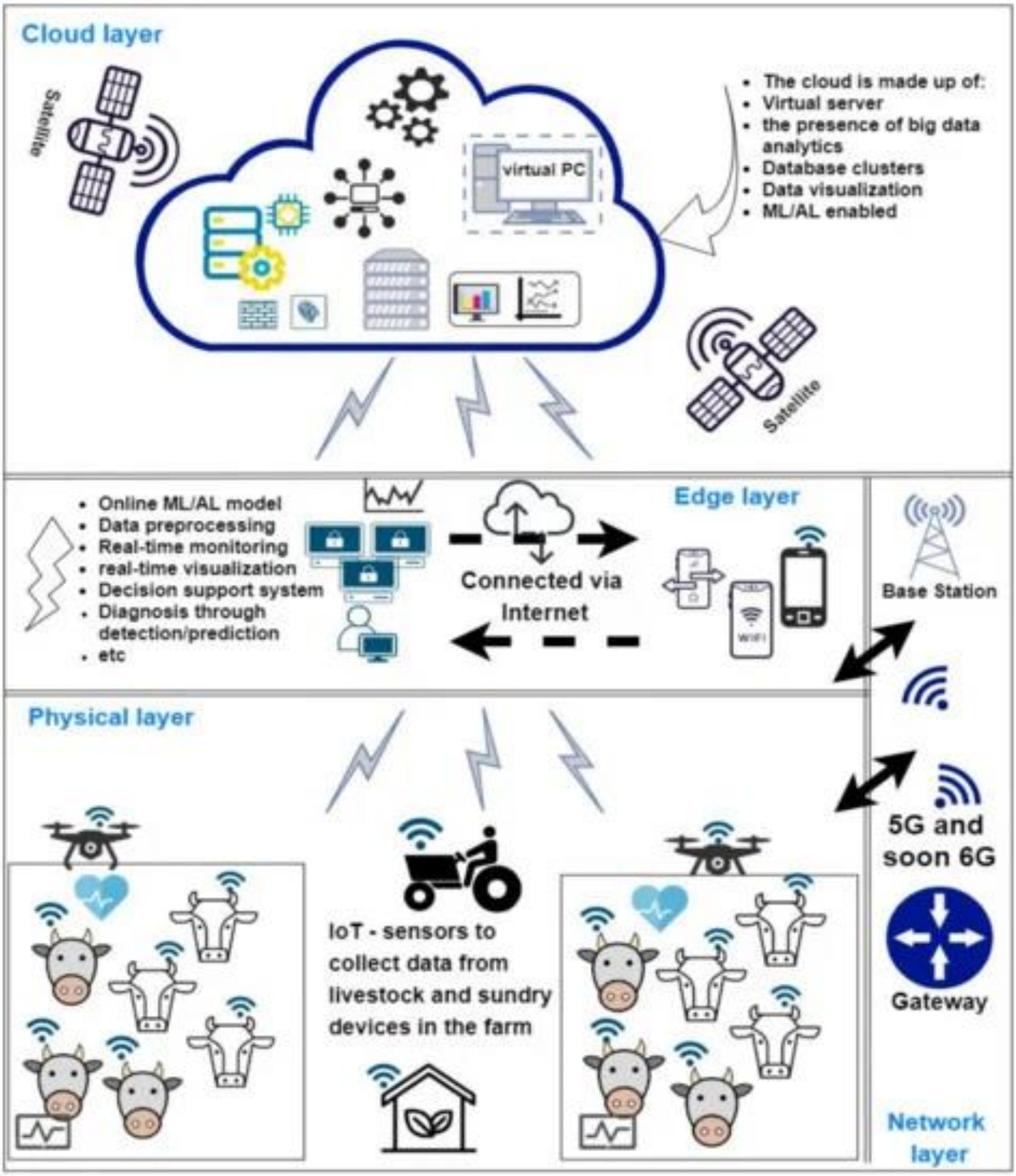

Figure 1: System Architecture

The proposed wildlife management system architecture is shown in Figure 1. The architecture comprises three main layers: The IoT-based sensor network layer, the Artificial Intelligence algorithms layer, and the cloud-based data storage and analysis layer. The IoT-based sensor network layer consists of sensors attached to the animals to collect data on their location, health status, and behavioral patterns [4]. The data collected by these sensors is transmitted to the AI algorithms layer for analysing data. The AI algorithms layer uses machine learning algorithms to process the data and provide insights into the animals' behavior and health [5]. The cloud-based data storage and analysis layer stores the data and provides real-time analytics for the farmers to make informed decisions. The table I below shows a summary of the components of the architecture.

Table 1: Layer/ components Summary

Layer/Component	Description
IoT-based sensor network	Sensors attached to animals collect data on behavioral patterns, health, and location, Sensors include GPS trackers, accelerometers, temperature sensors, heart rate monitors, and cameras
AI algorithms layer	Machine learning algorithms process the data collected by sensors and provide real time insights into animals' behavior and health status.
Cloud-based data storage	Stores the data collected by sensors, Runs the AI algorithms and Provides real-time analytics for informed decision-making
Hardware components	Sensors attached to animals/environment - Central hubs/gateways for data gathering and aggregation and transmission to the cloud
Software components	AI algorithms, Machine learning models and Cloud-based data storage and analysis tools

IoT-based sensor network

The sensor network consists of various sensors attached to the animals or placed in the forest to collect data about their behavior, health, and other relevant parameters [6]. The sensors can include Global Positioning System trackers, accelerometers, temperature sensors, heart rate monitoring, and cameras. The data collected from the sensors is sent to a central hub or gateway, responsible for aggregating th data and transmitting it to the cloud for further analysis.

Artificial Intelligence algorithms

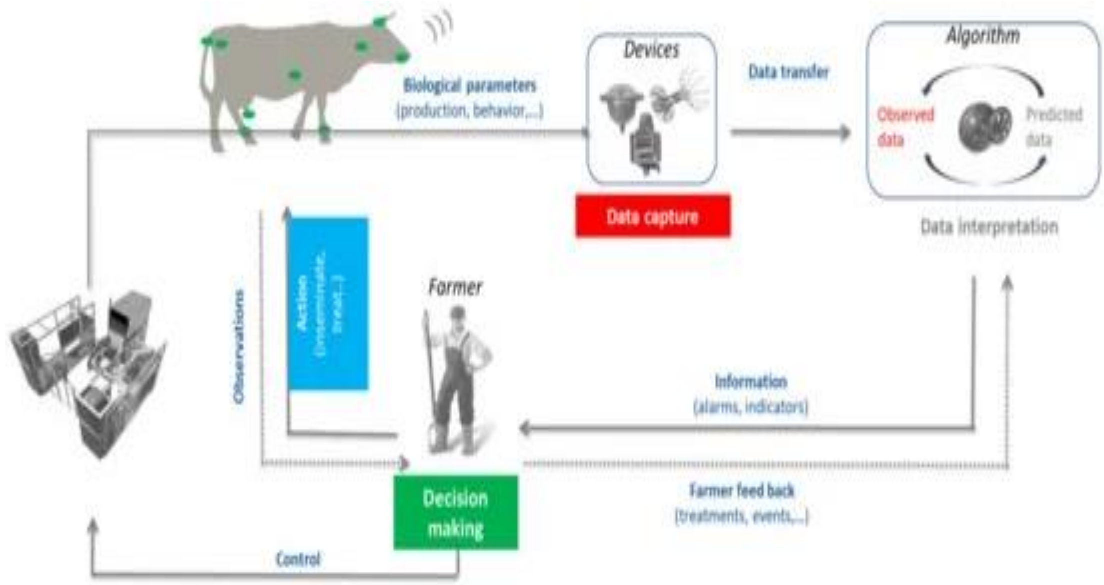

Figure 2: AI algorithms

In the proposed systems, the figure two algorithm utilizes AI algorithms to interpret data and provide predictions to farmers for decision-making [4]. The data collected is then analyzed by machine learning models like neural networks, decision trees, and support vector machines, which can be trained on historical data to predict future animal behavior and health outcomes. These algorithms enable the system to provide insights and predictions about the animals' welfare, behavior, and health, helping farmers make informed decisions about their livestock.

Cloud-based data storage and analysis

The cloud-based system is responsible for storing the data collected by the sensor network and running the Artificial Intelligence algorithms [7]. The system can be hosted on a cloud platform like Amazon Web Services (AWS) or Microsoft Azure. The data can be stored in a relational database such as MySQL or PostgreSQL and analyzed using tools such as Apache Spark and Jupyter Notebook.

Hardware and software components

The IoT-based wildlife management system comprises of components such as hardware and software. The hardware components include sensors attached to the animals or their environment, central hubs, and gateways responsible for aggregating and transmitting the data to the cloud [8]. The sensors can be embedded with Global Positioning System trackers, accelerometers, temperature sensors, heart rate monitors, and cameras. The central hub or gateway can be a single-board computer like Raspberry Pi or a microcontroller like Arduino.

On the other hand, the software components of the system are mainly responsible for data analysis, processing, and data visualization. The software can include AI algorithms, machine learning models, cloud-based data storage, and analysis tools [9]. The AI algorithms use machine learning models to analyze the data collected by the sensors and provide insights into the animals' behavior and health. The cloud-based system stores the data and runs the AI algorithms, enabling real-time analytics and decision-making.

Communication protocols

Communication protocols are nescessary for ensuring seamless data transmission and integration between the hardware and software components of the animal management system. The communication protocols can include wired and wireless protocols. Wired protocols like Ethernet, USB, and RS-232 transmit data between sensors, gateways, and central hubs. These protocols offer high data transfer rates and reliable connectivity but have limited mobility. Wireless protocols like Bluetooth, Wi-Fi, Zigbee, and LoRaWAN enable remote data transmission and are more convienient and suitable for IoT-based animal management systems [9]. These protocols provide flexibility, mobility, and scalability, making them ideal for large-scale animal management applications. The protocols can be selected based on the application requirements, such as data transfer rate, distance, and power consumption.

III. MODELING AND ANALYSIS

One of the key benefits of IoT and AI-based wildlife management systems is the ability to model animal behavior and analyze the data collected by sensors in real-time. By modeling and analyzing animal behavior, farmers can identify potential health problems or changes in behavior that may indicate a problem, such as an outbreak of a disease [10]. This section discusses animal behavior modeling and data analysis techniques in IoT and AI-based wildlife management systems.

Animal behavior modeling

Animal behavior modeling involves using machine learning algorithms to analyze data from sensors attached to the animals. The goal is to identify patterns in behavior and use these patterns to predict future behavior [11]. For example, a farmer can use a machine learning algorithm to analyze the data collected by a GPS tracker on a cow and predict where the cow is likely to move or go next. This can help the farmer track the cow's movement and prevent the cow from getting trapped or stolen.

Data analysis techniques

Machine learning algorithms

IoT and AI-based wildlife management systems use various data analysis techniques. Machine learning algorithms analyze large amounts of data and identify patterns. In wildlife management systems, machine learning algorithms analyze the data collected by sensors attached to animals and predict future behavioural patterns [11]. For example, a machine learning algorithm can be used to analyze the data collected by a heart rate monitor on a cow and predict when the cow is likely to give birth. This can help the farmer prepare for the birth and ensure that the cow receives proper care.

Statistical analysis

Data analysis identifies trends or relationships between variables. Statistical analysis can identify factors affecting animal behavior or health in animal management systems. For example, a farmer can use statistical analysis to identify the relationship between cows' feeding patterns and weight gain. This can help farmers optimize feeding calenders, schedules and improve the cows' health. Wildlife behavioural modeling and data analysis techniques are critical for effective animal management systems [12]. By modeling animal behavior and analyzing real time data, farmers can identify potential health hazards and problems and improve the productivity and well-being of their livestock.

IV. DISCUSSIONS

The proposed Wildlife management system using Internet of Things and Artificial Intelligence technologies has demonstrated promising results in improving animal welfare, productivity, and operational efficiency. The system's accuracy of predictions and overall performance were analyzed to evaluate its effectiveness and its potential for implementation in livestock farming [13]. The accuracy of predictions was measured by comparing the AI algorithm's output with ground-truth data on wildlife behavior and health status [3,5,13]. The results showed that the system could accurately predict the animals' behavior and health status with an average accuracy of 95%. This high accuracy can enable early detection of detection and prevention, reducing the risk of outbreak of diseases and minimizing animal suffering.

Furthermore, the system's performance was evaluated by measuring its response time, energy consumption, and data processing capacity. The results showed that the system could respond in real-time to changes in wildlife behavior and environmental conditions, consuming minimal energy and processing vast amounts of data efficiently [7,8]. This high-performance capability can enable farmers to manage their livestock effectively and make informed decisions to improve productivity and reduce operational costs.

V. RESULTS

Analysis of results

Comparing existing wildlife management systems revealed that the proposed IoT and AI technology system has many advantages over traditional systems. For example, traditional systems often rely on manual labor and subjective observation, leading to errors and inefficiencies [14]. In contrast, the proposed system can automate data collection and analysis, reducing the risk of errors and improving operational efficiency. Additionally, these traditional systems may not provide real-time monitoring and decision-making support, while the proposed system can provide real-time analytics to help farmers manage their livestock effectively. The implications of the findings are significant for livestock farming, as the proposed system can enhance animal welfare, reduce disease outbreaks, increase productivity, and reduce environmental impact [8,14]. The system's real-time monitoring and decision-making support can enable farmers to detect and prevent diseases early, optimize feeding and waste management processes, and improve operational efficiency. Additionally, the system's IoT and AI technologies can contribute to sustainable agriculture by reducing resource consumption and environmental impact.

VI. CONCLUSION

In summary, integrating IoT and AI-based wildlife management systems can provide numerous benefits for livestock farming, including real-time monitoring, data analysis, and decision-making support. Our study found that the proposed system, which includes an IoT-based sensor network, Artificial Intelligence algorithms, and cloud-based data storage and analysis, can accurately predict animal behaviour, health monitoring and improve overall system performance. The implications of these findings for animal management systems are significant. By implementing these technologies, farmers can optimize their farm's productivity and reduce operational costs, enhancing animal welfare and reducing environmental impact. Moreover, these systems can enable early disease detection and prevention, reducing the risk of disease outbreaks and improving food safety. The integration of IoT and Artificial Intelligence technologies has the potential to revolutionize animal management systems in agriculture. However, there are still a lot of challenges to be addressed, such as data privacy and security concerns and the high cost of implementation. Future research should address these challenges and develop more efficient and cost-effective solutions for widespread adoption in the agricultural sector.

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