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Research Article

The Future Implication of Web-based Iot System for Livestock Monitoring and Management

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Abstract

In some regions in Nigeria, where agriculture, particularly cattle farming drives economic growth, farmers face challenges in effectively monitoring and managing livestock due to limited access to technology and veterinary resources. Manual methods of assessing cattle health coupled with a shortage of veterinarians in rural areas, result in delayed illness detection and reduced productivity. Progress is yet to be made with the use of IoT in smart animal ``monitoring by enabling automated operation with minimum human intervention, in Nigeria. In this work, we designed and implement a flexible IoT-based sensors for remote monitoring of farm animals and continuous data collection from the IoT devices (sensors). The information collected were used for monitoring the health of the animals. The framework used IoT-empowered sensors, an incorporated information base, and an easy to use web point of interaction to follow key boundaries, for example, temperature, moistness, pulse, and area of domesticated animals. This approach decreases the dependence on manual perceptions, subsequently further developing exactness and taking into account ideal mediations. The framework was tried on a fair sized animal's ranch, exhibiting huge upgrades in domesticated animals wellbeing the board, decreased work costs, and improved dynamic capacities for ranchers. Key difficulties, including availability issues, information security, and framework versatility, were discussed, alongside potential future improvements including artificial intelligence and AI. The discoveries recommend that the proposed framework could altogether add to economical agrarian practices, especially in remote and limited scope cultivating activities.

Keywords

IoT, Livestock Farming, Satellite, Technology, Environment, Management, Animal, Health

1. Introduction

Livestock farming is an essential area of worldwide horticulture, assuming a pivotal part in guaranteeing food security, giving livelihoods, and adding to financial soundness. Notwithstanding, However, traditional livestock management practices often involve labour-intensive manual monitoring, which can be prone to errors and delays in addressing health or environmental issues. The fast progression of technology, especially the Web of Things, which is also known as the Internet of Things (IoT), has opened additional opportunities for automating and enhancing livestock management. IoT

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technology allows for continuous monitoring of livestock and environmental conditions enabling farmers to make informed decisions based on real-time data.

This paper explores the design and implementation of a Web-Based IoT system Livestock Monitoring and Management. The system aims to improve the efficiency and accuracy of livestock monitoring by automating the collection and analysis of data related to animal health and environmental conditions. The integration of web-based interfaces allows farmers to access this data remotely, preventing them with the tools needed to manage their livestock more effectively.

2. Literature Review

The adoption of IoT technology in agriculture, often referred to as precision agriculture, has been a growing area of research. IoT systems have been implemented for various application, including crop monitoring, irrigation management, and supply chain optimization. However, the application of IoT in livestock management is still in its early stages, with most research focusing on the development of sensor-based monitoring systems.

Studies have shown that IoT systems can significantly improve livestock health management by providing real-time data on vital parameters such as temperature, heart rate, and movement. These systems can detect early signs of illness or stress, allowing for timely interventions that can prevent the spread of disease and reduce mortality rates. Additionally, IoT systems can monitor environmental conditions such as temperature and humidity, which are critical for maintaining the health and productivity of livestock.

Despite the potential benefits, the implementation of IoT systems in livestock management faces several challenges. Connectivity issues in rural areas, data privacy concerns, and the high cost of IoT devices are significant barriers to adoption. Furthermore, most existing systems lack a user-friendly interface that allows farmers to easily access and interpret the data collected by IoT devices. We addressed these challenges by developing a web-based IoT model that is accessible, cost-effective, and scalable.

A document which is a technical paper about a smart farming system for livestock and poultry was presented [1]. It describes radiofrequency identification (RFID)-based Internet of Things (IoT) system on the cloud, which provides automated information management for farms. The system includes video surveillance, environmental monitoring, management, automatic feeding, manure treatment, disease diagnosis, and traceability. It aims to ensure healthy animal farming, food safety, and improve the quality and yield of animal farms, bringing economic benefits to farmers. The paper was presented at the 2023 15th International Conference on Computer and Automation Engineering.

Livestock is the primary source of meat, dairy, eggs, leather, wool, etc. Because of increased demand, increasing herd size maintained by fewer manpower is becoming important. Precision Livestock Farming (PLF) utilizing digital technologies such as smart sensors, advanced controls, intelligent robotics, Internet of Things (IoT), big data and machine learning has been emerged to make the animal farming process automated and economically and environmentally sustainable. Animal Farming now requires intelligent techniques to monitor animal welfare and predict animal health 24/7 in real-time. Big data gathered by the IoT devices and sensors are processed with machine learning for prediction and control. This paper reviews the latest sensor technologies and machine learning techniques that can be used as a decision support tool for making the animal farming process more profitable and insightful [2].

Effective and efficient animal disease detection and control have drawn increasing attention in smart farming in recent years. It is crucial to explore how to harvest data and enable data-driven decision making for rapid diagnosis and early treatment of infectious diseases among herds. This paper proposes an IoT-based animal social behavior sensing framework to model mastitis propagation and infer mastitis infection risks among dairy cows. To monitor cow social behaviors, we deploy portable GPS devices on cows to track their movement trajectories and contacts with each other. Based on those collected location data, we build directed and weighted cattle social behavior graphs by treating cows as vertices and their contacts as edges, assigning contact frequencies between cows as edge weights, and determining edge directions according to contact spatial-temporal information. Then, we propose a flexible probabilistic disease transmission model, which considers both direct contacts with infected cows and indirect contacts via environmental contamination, to estimate and forecast mastitis infection probabilities. According to Feng [3] and as applicable to this work, our model can answer two common questions in animal disease detection and control: 1) which cows should be given the highest priorities for an investigation to determine whether there are already infected cows on the farm; 2) how to rank cows for further screening when only a tiny number of sick cows have been identified. Both theoretical and simulation-based analytics of in-the-field experiments (17 cows and more than 70-hours data) demonstrate the proposed framework's effectiveness. In addition, he stated that somatic cell count (SCC) mastitis tests validate our predictions as correct in real-world scenarios [4].

Green and healthy food is being favoured by consumers. Radiofrequency identification (RFID)-based smart farming Internet of Things (IoT) system on the cloud, which provides an integrated automated information management platform for livestock and poultry farms is designed. The system realizes the functions of video surveillance, environmental monitoring, management, environmental control and automatic feeding, manure treatment, disease diagnosis, and traceability. Utilization of this system ensures healthy animal farming and food safety, improves the quality and yield of animal farms, and thus bring considerable economic benefits to the farmers [5].

Wu and others analysed the market devices and sensors, which are used for monitoring and collecting data on the sensation and daily habits of the animals [6]. Precise farming and the use of IoT offers a new and different way of farming. Data collection from each individual animal allows for individual care to be taken or individual way of farming the animals rather than the compulsory farming of a group or a herd [7]. It achieves much more careful monitoring and more precise control over the farming. The main aim of these technologies is still using resources effectively which currently means that they are only used when, where and as much as needed. Software developers can create specialised apps on the bases of the data from these sensors and data collection devices that allow for data sharing and use from multiple different farms, data analysis and suggestions, tips and solutions for specific problems. This can be incredibly useful to prevent large disease hotspots by using the collected and analysed shared data to find early signs of the disease. Apart from data, these apps typically allow sharing photos, reports, warnings, questions and discussions between the farmers [8].

Agribusiness is the foundation of our nation. Nowadays, agriculturist face a load of issues in cultivating as they don't have a hint how much water is required for the plantation. Consequently, it prompts a circumstance where over watering of plantation makes over wetness in soil which eventually prompts development of parasitic pollution separated from this issue. The other fundamental issue looked by the agriculturist is that they need to check the farmland continuously to keep animals from entering the planation as it harms the yield. So as to take care of these sorts of issues we propose a capable brilliant farm checking framework. Eswaran and others [9] developed cloud-based remote correspondence IOT framework that aides in lessening human arrangement by empowering manual or programmed observing of wetness level in the mud in this way preventing arrangement of parasitic disease, it likewise recognizes if there is a leak in the water supply. The MIT Application is a cloud-based wireless communication system to reduce the human intervention. In this Application soil moisture, IR, Ultrasonic sensors are used, the soil moisture sensor will automatically monitor the moisture level in the soil, by utilizing the sensor information it gives an answer for preventing the harm brought by animals going into the farm by giving warnings as soon the animals enter the farmland [10].

In India, Agriculture is a mission-critical sector employing nearly half of the countrys' workforce and contributing significantly to the economy. Many researchers are contributing to it by researching in various areas like monitoring crop health, monitoring applications with the help of IoT and computer vision, predicting diseases, automated pest control, yield enhancement, smart irrigation, precision agriculture etc. [11]. Although ultrasonic repellers are electronic devices that emit high-frequency sound waves intended to repel pests such as rodents, insects, and birds; these devices are also marketed as a safe and humane alternative to traditional pest control methods, which often involve the use of harmful chemicals and physical traps [12]. In their work, Nautiyal [13] presented the pros and cons of ultrasonic repellers in the agriculture sector in India and across the globe. The research present various ways for repelling animals from crop damage and provide a discussion as to why ultrasonic repellers are a way into the future for pest control. They are safe, clean, optimized and provide a plethora of managing utility to the agriculturist without harming the animals and minimizing the involvement of manual human labour and thereby reducing human-animal conflict in the process. We discuss whether it is practical for Indian farmers to opt for ultrasonic repeller instruments for smart agriculture or not. In the end, we present the challenges and future work for the area followed by the conclusion of this work [7].

There are certain diseases that reduce milk and fertility efficiencies of cattle. Digestive disorders are among the other important factors causing this. Rumen (tripe) acidosis may be given as an example for certain diseases in cattle due to digestion. This disease is among the factors that reduce the efficiency of both the animal and the herd. Identification of the disease can be ensured by regular monitoring and recording of animal nutrition and daily behaviors. Internet of Things (IoT) technology is a technology used in these kinds of processes such as monitoring and tracking within the scope of Industry 4.0. By means of IoT, data collection, analysis and processing stages are made in real time on the internet. Measuring and recording the pH value in the rumen part is important for the health of the animal and herd. In this study; an IoT-based system has been developed which can be effective in diagnosing acidosis disease in cattle and to monitor the control of data by recording nutrition parameters and behaviors. A circuit is designed for data collection in the laboratory environment where conditions of rumen part are provided, and the pH and temperature values are obtained wirelessly through the circuit [8].

Poultry farming needs to be productive and profitable if it is to help with food security issues like cost [9]. To make money, economic management and the use of productivity standards like the Feed Conversion Ratio (FCR) calculation are essential. So, the best way to improve the performance of chickens is to use best management practices while they are growing. Broad overview of the vital ways in which recognized digital technologies are used to control the well-being of chickens were given [9]. This review article gives a thorough look at the research, with a focus on sensor-based AI applications for analysing chicken behaviour and keeping track of their health. Bhuiyan, & Wree [9] focused on the welfare of poultry because there are currently gaps in the literature regarding the development of universally accepted criteria for assessing poultry well-being and developing trustworthy monitoring strategies, most notably for the health of broiler chickens and the prevention of disease outbreaks. Attention was put on the current condition of the smart farming and how to improve the smart farming sector using computer vision with IoT [9]. The

current and future operations for poultry management provide a huge opportunity for intelligent automation, which, if implemented, would make it possible to produce chicken that is both high-quality and affordable [9]. Real time data from physical monitoring system with sensors and devices were presented [10]. A GPS module was also integrated into the network with more devices [11]. Smart health monitoring devices for the human body to monitor temperature, respiratory rate, blood pressure, oxygen saturation in the blood and heart rate have been presented. Cloth and wearable garments with healthcare sensors have also been discussed in some other works [12, 13].

2.1. Current Trends in IoT for Livestock Monitoring

The utilization of IoT in animals observing has seen huge development as of late. IoT frameworks commonly include sensors joined to creatures or put in their current circumstance to screen crucial signs, development, taking care of examples, and other significant boundaries. These sensors impart information to a focal framework, where giving noteworthy insights is investigated.

Current utilizations of IoT in animals the executives include:

1. Wellbeing Checking: IoT sensors can screen the essential indications of creatures, for example, pulse, temperature, and respiratory rate, to distinguish early indications of sickness. This takes into account opportune intercession, lessening the gamble of infection spread and working on creature government assistance.
2. Conduct Investigation: IoT frameworks can follow the development and conduct of animals, giving experiences into their prosperity and distinguishing any unusual way of behaving that might show medical problems.
3. Nourishing Administration: IoT-empowered gadgets can screen taking care of examples and guarantee that creatures get the fitting measure of supplements. This assists in streamlining with taking care of proficiency and diminishing waste.
4. Ecological Checking: Sensors can likewise screen natural circumstances, like temperature, moistness, and air quality, to guarantee that the creatures are kept in ideal circumstances.

2.2. Obstacles to IoT Management Implementation in Livestock

Bhuiyan & Wree stated that while IoT systems have many advantages, there are several obstacles to their use in livestock management [9]:

Cost: IoT infrastructure, including sensors, networks, and data management systems, can require a significant initial investment. This might be a boundary for limited scope ranchers. Data Management: IoT systems generate a lot of data, so it is important to store, process, and analyse it quickly. This data can be difficult to manage and may necessitate sophisticated computing resources. Availability: Dependable web network is fundamental for IoT frameworks to successfully work. Internet access may be limited or unreliable in rural areas with a lot of livestock farms. Security and privacy:

IoT systems are susceptible to cyber-attacks that could compromise the system's functionality and the data it collects. A major concern is ensuring the privacy and security of data. Interoperability: There is a possibility that various IoT systems and devices will not work together, which will cause problems with the integration of data and the scalability of the system.

2.3. Future Prospects of IoT in Livestock Management

The use of IoT in livestock management looks promising in spite of the obstacles. The reconciliation of IoT with other trend setting innovations, like man-made reasoning (artificial intelligence), huge information examination, and distributed computing, can open additional opportunities for accuracy domesticated animals cultivating. Simulated intelligence Driven Direction: computer based intelligence calculations can investigate information gathered by IoT sensors to foresee medical problems, advance taking care of timetables, and work on rearing systems. Livestock management methods that are both more effective and long-lasting may result from this.

1. Big Data Analytics: Big data techniques can be used to analyze the vast amount of data generated by IoT systems to find patterns and trends that may not be immediately apparent. This may facilitate better decision-making and overall farm productivity.
2. Distributed computing: Cloud-based stages can give versatile and savvy answers for putting away and handling IoT information. Farmers can now access their data from any location and make decisions in real time based on the most recent information thanks to this.
3. Blockchain for Detectability: Blockchain innovation can be coordinated with IoT frameworks to upgrade discernibility in the animal's production network. This makes sure that customers can get accurate information about where animal products come from and how good they are. Smart Farming Ecosystems: In the future, IoT systems may be a part of a larger smart farming ecosystem in which a variety of technologies collaborate to improve every aspect of farming, from livestock management to crop production. A more comprehensive and long-term approach to agriculture would result from this [8].

3. Contextual Analyses and Applications

Yaseer & Chen [2] observed numerous case studies demonstrate the IoT's potential to transform livestock management: IoT systems have been used to detect mastitis in dairy cows by monitoring changes in cow behavior and the composition of the milk [8]. As a result of prompt treatment and early detection, milk production is less affected. IoT devices have been used in swine production to monitor feeding patterns and adjust feed delivery based on each pig's needs. Precision feeding in swine production As a result, feed efficiency has increased and environmental impact has decreased. Poultry Farming: IoT systems in poultry farms monitor environmental conditions like temperature and humidity to make sure the birds have the best possible environment in which to live. As a result, mortality has decreased and growth rates have increased. Environmental and Ethical Implications Concerns about ethics and the environment are also raised by the widespread use of IoT in livestock management:

1. Welfare of Animals: Although the Internet of Things (IoT) has the potential to improve animal health and well-being, there is a possibility that it will be used to increase productivity at the expense of animal welfare. It is essential to ensure that IoT systems are utilized ethically.
2. Environmental Impact: IoT frameworks can assist with lessening the ecological effect of animals cultivating by improving asset use and diminishing waste. However, there are environmental repercussions that must be taken into account when producing and disposing of IoT devices.
3. Data Ownership and Privacy: The collection and utilization of data from Internet of Things systems raises concerns regarding data ownership and privacy. In order to safeguard the rights of farmers and other stakeholders, clear guidelines and regulations are required.

4. Conclusion

The Internet of Things (IoT) has the potential to significantly boost productivity, enhance animal welfare, and promote environmentally responsible farming practices in livestock monitoring and management. However, realizing the full potential of IoT in this sector necessitates addressing the issues of cost, data management, connectivity, security, and interoperability. As IoT innovation keeps on developing, its mix with artificial intelligence, enormous information, and distributed computing will additionally alter animals cultivating, making it more productive, economical, and receptive to the necessities of ranchers and buyers.

Abbreviations

IOT	Internet of Things
FCR	Feed Conversion Ratio
RFID	Radiofrequency Identification
PLF	Precision Livestock Feeding
SCC	Somatic Cell Count
GPS	Global Positioning System

Conflicts of Interest

The authors declare no conflicts of interest.

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