

Research Article

The implementation of Radio Frequency Identification (RFID) in the Smart Farming System

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Abstract: Technological advancements have significantly impacted the livestock industry. Negligence during the tagging of livestock ears poses a risk of disease transmission and can lead to fatalities. Moreover, the large-scale nature of livestock farms contributes to the challenge of effective monitoring, resulting in potential livestock losses. In this regard, the utilization of Radio Frequency Identification (RFID) systems can mitigate the risk of negligence during livestock tagging. Additionally, these systems aid in tracking the whereabouts of livestock within the farm premises. The implementation of such systems has successfully reduced the incidence of livestock infections and deaths associated with tagging. Furthermore, it enables the adoption of more efficient monitoring methods, consequently minimizing livestock losses. Consequently, this system holds immense potential for marketing to livestock farmers. Its existence ensures more comprehensive and efficient livestock monitoring practices. Indirectly, it helps maintain a stable supply chain and food provision by reducing livestock deaths, disease outbreaks, and losses under supervision. Additionally, promoting healthier livestock conditions can lead to reduced veterinary expenses. In conclusion, the research and development of this system not only enables the livestock industry to adapt to technological advancements but also supports the achievement of Sustainable Development Goals (SDG). Specifically, it contributes to addressing zero hunger (Goal 2) by ensuring sufficient supply and food chains, particularly regarding livestock meat. Furthermore, it aligns with industry innovation and infrastructure (Goal 9) by introducing this innovative system to the livestock sector.

Keywords: Radio Frequency Identification; Smart Farming System; Livestock Industry; Sustainable Development Goals



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1. INTRODUCTION

Meat serves as a crucial protein source for the human body, in addition to fish (Eliani, 2021). It plays a significant role in the food chain and is an essential component of a balanced and healthy diet. Insufficient availability of meat, particularly beef, buffalo, and goat, can potentially disturb ecosystems and disrupt the human food chain. Therefore, it is crucial for the livestock industry to prioritize ensuring an ample meat supply. To accomplish this, it is essential to diligently care for and maintain livestock in optimal health conditions, ensuring sustainability and dependability in the meat

production process. However, due to significant limitations, classical methods of animal identification have proven to be less effective (Ahmad *et al.*, 2022). These methods present various issues, including easily damaged marks or difficulties in readability. Techniques like hot or freeze branding involve painful procedures for animals, utilizing burning hot or cold irons. Moreover, they rely on physical observation and readings that can become illegible over time. While ear tagging in cows requires minimal force and restraint, causing little to no pain when performed correctly, it increases the risk of infection. Conversely, ear notching, a widely used and efficient identification method in the livestock industry, is also highly painful. Furthermore, visual reading methods employed for ear notching can result in reading inaccuracies. Tattoos, another painful identification method, may lead to infections if not conducted with proper hygiene practices. Additionally, the livestock industry has been driven to adopt increasingly comprehensive and efficient modern technologies in response to the difficulties of monitoring livestock in vast areas, which can result in the loss of animals. Additionally, the industry is facing a decline in the availability of skilled workers, further emphasizing the need for advanced technological solutions (Brown-Brandl *et al.*, 2019).

Recently, the use of Radio Frequency Identification (RFID) systems in the farming and livestock industry is gaining popularity. The technology allows for the identification, tracking, and management of individual animals in a livestock population. In 2017, Neethirajan highlighted that advancements in engineering and biomaterials research have played a crucial role in the adoption and proliferation of Precision Livestock Farming (PLF). These advancements have facilitated the miniaturization of electronic devices and significantly reduced the cost of electronics, making PLF more accessible and widespread (Aquilani *et al.*, 2022). The RFID system is a highly beneficial technology for animal monitoring, as it enables the storage of specific information such as species, breed, health status, and biometrics (Ahmad *et al.*, 2022). Furthermore, the RFID system's ability to provide unique identification and ease of readability makes it a reliable choice for deployment in livestock management system.

There are three commonly used frequencies in RFID technology for this type of system: Low Frequency (LF) at 125 kHz or 134.2 kHz, High Frequency (HF) at 13.56 MHz, and Ultra High Frequency (UHF) at 865 – 868 MHz or 902 – 928 MHz (Brown-Brandl *et al.*, 2019). The frequency level determines the detection radius between the RFID scanner and RFID tag, as well as the number of RFID tags that can be detected per second. Hence, the selection of frequencies relies on the suitability of the area and the user's specific needs. This decision is influenced by factors such as the distance between the scanning device and RFID tags, as well as the number of RFID tags that need to be scanned concurrently.

Taking into account the earlier discussion, UHF has been implemented in this project to fulfil the user's needs. The utilization of UHF offers several advantages, such as the capability of the scanner to read multiple tags simultaneously and the flexibility to install the scanner in strategic and secure locations, minimizing interference from livestock.

2. METHOD

Essentially, the system framework comprises three key components: the system's engine, Application Programming Interface (API), and User Interface (UI). The engine serves as the communication hub between the database and other system functionalities. The API acts as the events handler and facilitates hardware integration. The UI encompasses the forms, tables, and information that are displayed to the user.

Generally, both the animals and tags must be registered in the system individually. All relevant information about each animal must be accurately recorded based on its corresponding tag number. Whenever an animal passes by a location equipped with a scanner, the scanner will scan the tag

attached to the animal, allowing the system to determine the animal's presence in that specific location. Figure 1 provides an illustration of the system's floor plan. Additionally, the system provides accessibility to comprehensive information about each animal, including its health condition, required vaccinations, breed, and assigned veterinarian.

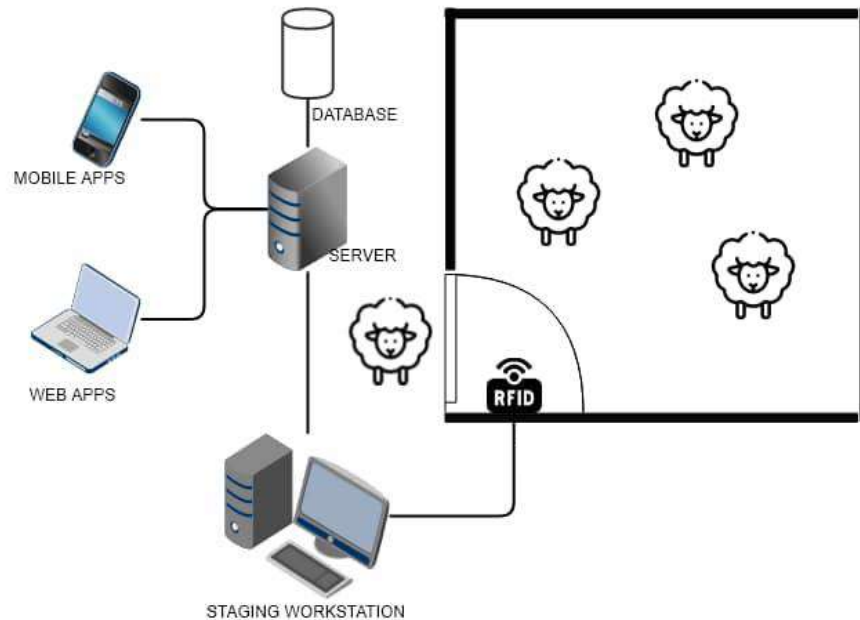


Figure 1. Illustration of the system's floor plan

According to Figure 1, the monitoring of animals is conveniently facilitated through smart devices. Scanners are strategically positioned at key locations within the farm, such as gates and doors. Each time an animal passes by or stays within the scanner's range, the relevant information is sent to the workstation, automatically uploaded to the server, and stored in the database. Consequently, end users can actively monitor the animals in real-time through their smart devices.

3. FINDINGS

The findings of this project provide compelling evidence that the utilization of RFID systems is remarkably effective for livestock tagging. This method is non-invasive, devoid of harm, and does not pose any health risks to the animals. Notably, the conservative tagging approach ensures that the animals are not exposed to disease transmission risks. Furthermore, the livestock exhibits a stress-free response during the tag application process.

Monitoring becomes significantly more effective as livestock can be tracked in real-time through smart devices, provided there is internet access. This enables the precise determination of each livestock's location within the farm or grazing area. Such monitoring capabilities effectively prevent instances of livestock loss or theft from transpiring.

The implementation of this system has resolved the issue of skilled labour shortages in the livestock industry. It enables meticulous control over monitoring and supervision, serving as a centralized hub of livestock information for farmers. Vital details such as health status, breeding, vaccination requirements, current treatments, medications, and attending veterinarians are easily accessible through the system. Consequently, effective monitoring of all cared-for livestock is achieved without the need for a large workforce, reducing the industry's reliance on human labour.

Ultimately, with the implementation of this system, the livestock industry gains the ability to forecast the quantity of meat supply for both domestic and international markets. Consequently, the industry can indirectly estimate profit margins derived from the sale of livestock and meat products.

4. DISCUSSION

This section will explore the advantages and disadvantages of system implementation, as presents in Table 1.

Table 1. Advantages and Disadvantages.

Advantages		Disadvantages	
1.	A humane and non-invasive approach to tagging or identifying livestock that ensures their well-being.	1.	Livestock subjected to prolonged exposure to radiation from specific frequencies.
2.	Daily tasks can be carried out with efficiency and thoroughness.	2.	Decrease in employment opportunities.
3.	Decrease reliance on skilled workers.		

According to Table 1, one notable advantage is the implementation of a humane and non-invasive approach to tagging or identifying livestock, which places a strong emphasis on prioritizing the well-being and welfare of the animals. This method ensures that the tagging or identification process is conducted in a manner that avoids causing harm, pain, or unnecessary distress to the livestock. By adopting such an approach, farmers can effectively reduce stress and discomfort experienced by the animals, thereby promoting improved animal welfare outcomes. Ultimately, the use of a humane and non-invasive approach to tagging or identifying livestock demonstrates a commitment to ethical practices and responsible animal management within the livestock industry.

The second advantage lies in the implementation of this system, which enables daily tasks to be carried out with enhanced efficiency and meticulousness. By leveraging advanced technologies, streamlined processes, and automated workflows, the system optimizes operations, leading to increased productivity, reduced errors, and improved task accuracy. Real-time data collection and analysis enable informed decision-making and proactive management strategies. As a result, farmers and workers can effectively carry out essential activities such as feeding, monitoring, health management, and record-keeping with greater precision and attention to detail. This improved efficiency and meticulousness contribute to the overall effectiveness of livestock management, benefiting both the animals and the industry as a whole.

The third advantage is the ability to reduce dependence on skilled workers within the livestock industry. With the implementation of this system, certain tasks that previously required specialized knowledge and expertise can now be automated or simplified. By leveraging advanced technologies and streamlined processes, the system enables less-skilled workers to carry out tasks that were previously reserved for highly skilled individuals. This decreases the reliance on a limited pool of skilled workers, which can be beneficial in situations where skilled labour is scarce or expensive. Moreover, the system helps to standardize procedures and workflows, making it easier for new or less-experienced workers to perform their duties effectively. This not only reduces operational costs but also increases the overall flexibility and scalability of the workforce. By decreasing reliance on skilled workers, the system contributes to a more efficient and sustainable approach to livestock management.

However, one potential drawback of implementing this system is the prolonged exposure of livestock to radiation emitted from specific frequencies. The frequencies used in technologies like RFID

systems may emit low levels of radiation that animals are continuously exposed to over time. It is important to carefully consider the potential effects of this radiation on the health and well-being of the livestock. Prolonged exposure to radiation can have various adverse effects on animals, including cellular damage, genetic mutations, and increased susceptibility to certain diseases. Therefore, it is crucial to ensure that the radiation emitted by the frequencies used in the system remains within safe limits and does not pose significant harm to the animals. Strict adherence to regulatory guidelines and continuous monitoring of radiation levels are essential to protect the welfare of the livestock and maintain a safe and healthy environment for them.

The second drawback of implementing this system is the potential reduction in employment opportunities within the livestock industry. As the system optimizes processes and automates certain tasks, there may be a decreased demand for manual labor. This could lead to a decline in job positions, especially those involving repetitive or routine tasks that can now be performed more efficiently by the system. The automation of these operations may result in the displacement of workers who previously handled such tasks. Consequently, there could be a decrease in employment opportunities, particularly for individuals who lack the necessary skills or training to transition into more specialized or technologically oriented roles. It is crucial for stakeholders to carefully consider the potential impact on the workforce and explore strategies to mitigate any adverse effects. This could include implementing retraining programs or identifying alternative employment opportunities within the evolving landscape of the industry.

5. CONCLUSION

Technological advancements have had a significant impact on the livestock industry, addressing challenges such as disease transmission and monitoring difficulties. Radio Frequency Identification (RFID) systems have emerged as effective solutions for livestock tagging and monitoring, reducing infections and losses. The implementation of these systems promotes comprehensive livestock monitoring, resulting in a stable supply chain and reduced veterinary expenses. Moreover, the adoption of such technology aligns with Sustainable Development Goals, specifically zero hunger and industry innovation and infrastructure. Overall, these advancements enhance the livestock industry's resilience and contribute to sustainable development.

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