Biosecurity Farm Portal

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***Abstract*—The rising number of infectious diseases in livestock, along with the continued use of manual farm management methods, has created serious challenges in maintaining animal health and farm biosecurity. This paper presents a web-based Biosecurity Farm Portal that is designed to improve livestock monitoring, support communication between farmers and veterinarians, and strengthen biosecurity practices. The system offers a centralized platform where users can store animal records, track vaccination schedules, manage visitor entries, and receive real-time alerts based on animal health conditions and potential risks.**

To ensure data security, the system uses authentication techniques such as bcrypt and JSON Web Token (JWT), along with role-based access control so that only authorized users can access specific features. A real-time communication module allows farmers and veterinarians to interact easily, helping in faster diagnosis and better treatment decisions. In addition, the health monitoring and alert mechanisms analyze animal data to identify unusual conditions and notify users so that timely action can be taken.

The platform is developed using modern web technologies and follows a scalable architecture that supports efficient data storage and quick retrieval. The results show improvements in maintaining accurate records, reducing response time during veterinary consultation, and detecting possible disease outbreaks at an early stage. The system helps in reducing economic losses, improving farm safety, and supporting sustainable livestock management [1]. Overall, the Biosecurity Farm Portal provides a practical and flexible digital solution for improving biosecurity in modern agriculture.

***Index Terms*—Biosecurity, Livestock Health Monitoring, Veterinary Management System, Disease Detection, Web-Based Ap- plication, Cloud Computing, Animal Health Tracking.**

I. INTRODUCTION

In today's rapidly evolving agricultural landscape, maintaining the health, productivity, and safety of farm animals has become a major challenge. Livestock plays a crucial role in rural economies, food security, and sustainable agricultural development [1]. For many farmers, livestock is not just a source of income but also a key part of their daily livelihood. However, traditional farm management practices still depend heavily on manual record-keeping, which often leads to problems such as data loss, inconsistency, and difficulty in tracking animal health over time. These limitations make it harder for farmers to take timely decisions and increase the chances of disease outbreaks, which can result in serious economic losses. Another major issue in livestock farming is the lack of proper biosecurity measures. In many cases, diseases spread quickly because there is no proper system to monitor animal health, track vaccination schedules, or manage visitor access to farms. Delayed detection of diseases not only affects animal health but can also impact human health and food safety. Therefore, there is a strong need for systems that can help farmers monitor their farms more effectively and take preventive actions at the right time.

With the advancement of digital technologies, there is an increasing need to modernize traditional farming practices using smart and automated solutions [5]. Technologies such as web applications, cloud storage, and real-time data monitoring can significantly improve farm management by making data more organized, accessible, and reliable. Digital systems can also help in improving communication between farmers and veterinarians, allowing faster diagnosis and better treatment decisions.

The BioSecurity Farm Portal is a digital initiative designed to combine technology with biosecurity practices to improve livestock management and disease prevention. The system provides a centralized platform where farmers can maintain livestock records, monitor animal health, track vaccination schedules, and manage visitor entries. It also includes

features such as real-time alerts and reporting, which help in identifying potential risks at an early stage.
By using this system, farmers can reduce manual work, improve data accuracy, and respond quickly to any health- related issues. Veterinarians can also access updated information easily and provide timely guidance. Overall, the system aims to improve farm productivity, reduce disease risks, and support sustainable livestock management [5].

II. LITERATURE REVIEW

The existing research shows that digital technologies are increasingly being used in agriculture, especially for farm management, animal health monitoring, and maintaining biosecurity. As the demand for better livestock management and disease prevention is growing, many researchers and developers have tried different technological approaches to improve productivity and make farming more sustainable. This section discusses important studies, currently available systems, and technological developments that support farm data management, disease tracking, and the overall digital transformation of agriculture.

A. Traditional Farm Management Systems

Earlier farm management systems mainly focused on keeping basic livestock records such as breeding information, feeding schedules, milk production, and inventory details. These systems helped in moving from manual paperwork to digital records and reduced the effort required for maintaining data. However, most of these systems were simple and static, meaning they did not support automation, real-time monitoring, or intelligent decision-making. In addition, they did not include important biosecurity features such as disease tracking, vaccination reminders, or risk analysis, which are very important in modern farming. Because of these limitations, farmers still had to depend on manual observation and delayed actions, which increased the chances of disease outbreaks and financial losses [2].

B. Web-Based Agricultural Systems

With the growth of web technologies like HTML, CSS, JavaScript, and backend frameworks such as Node.js and Django, web-based agricultural systems have become more common. These systems provide a centralized platform where farmers can store, manage, and access farm data from any- were. They improve accessibility, scalability, and ease of use when compared to traditional systems. Some platforms also allow multiple users, such as farmers, veterinarians, and experts, to work together on the same system. However, many of these systems mainly focus on storing and managing data and do not include advanced features. They often lack real- time health monitoring, automatic alert generation, and proper biosecurity modules, which limits their ability to support proactive farm management [5].

C. Database-Driven Management Systems

Modern agricultural systems make use of relational databases like MySQL and PostgreSQL to store and man- age structured data effectively. These systems handle large amounts of data such as livestock records, vaccination details, farm activities, and user interactions. The use of structured queries improves data accuracy, consistency, and retrieval speed. Techniques like normalization and integrity constraints help in making the system more reliable. Even though these systems are efficient in storing data, many of them act only as storage solutions and are not connected with real-time monitoring or alert systems. Without features like data analysis and automatic notifications, they are not able to provide timely insights that are required for better decision-making and disease prevention [3].

D. Digital Animal Health Monitoring Systems

Recent developments have focused on creating digital plat- forms that can monitor animal health and manage vaccination records more effectively. These systems help reduce manual work, improve accuracy, and allow better tracking of livestock conditions over time. Some advanced systems also use sensors and remote monitoring to collect data such as body temperature, movement, and environmental conditions. Although these systems improve monitoring, many of them do not connect well with communication tools, alert systems, or centralized databases. They also often lack a complete biosecurity framework that includes risk analysis, disease detection, and coordinated response mechanisms [7], [8].

E. Integrated Web Portals for Farm Management

Integrated web portals represent a more advanced solution by combining frontend and backend

technologies into a single platform. These portals allow users to manage data, generate reports, analyze trends, and access information from remote locations. Some systems also support role-based access control, which allows different users to perform actions based on their roles. Despite these improvements, there is still a need for simple, scalable, and user-friendly systems that bring together all important features such as real-time health monitoring, visitor tracking, automated alerts, and biosecurity management in one platform. Many existing solutions are either too complex for small farmers or do not provide all the necessary features required for complete farm safety [4].

III. METHODOLOGY

The methodology used for the Biosecurity Farm Portal is focused on building a practical and easy-to-use digital system that helps in managing farm activities, monitoring animal health, and maintaining proper biosecurity. The system is developed in a structured way so that all the important components such as data handling, real-time monitoring, and secure access work together smoothly. The main aim is to reduce manual work, support better decision-making, and help in detecting diseases at an early stage so that preventive actions can be taken on time [5].

The overall methodology includes requirement analysis, system planning, database design, authentication, data management, health monitoring, and alert generation. These steps ensure that farmers and veterinarians can interact easily while maintaining accurate and secure data.

A. Requirement Analysis

In this phase, the system requirements are identified by studying the real challenges faced in livestock management and farm biosecurity. Most traditional farms still depend on manual record-keeping methods such as notebooks or registers. This often leads to problems like data loss, inconsistency, and difficulty in tracking animal health over time. Because of this, decisions are delayed and diseases are sometimes detected too late, which results in financial losses for farmers [2].

To solve these problems, both functional and non-functional requirements are clearly defined. Functional requirements include maintaining livestock records, tracking animal health, managing vaccination schedules, recording visitor entries, and enabling communication between farmers and veterinarians. The system also includes features like real-time health monitoring, alert generation for unusual conditions or missed vaccinations, and report generation to help farmers understand farm activities better [5].

Non-functional requirements focus on making the system reliable, easy to use, scalable, and secure so that it performs efficiently in real-world conditions.

B. System Planning

In this phase, the overall structure of the system is planned by understanding how different parts of the system will work together. The same real-world problems of manual record- keeping are considered again, where issues like data duplication, inconsistency, and poor tracking make farm management difficult. These problems often delay important decisions and increase the chances of disease outbreaks and productivity loss [2].

The system is designed by identifying user needs and defining features accordingly. It includes maintaining detailed animal records such as identification, breed, age, and health history, tracking animal health regularly, managing vaccinations, recording visitor details for biosecurity, and enabling communication with veterinarians. These features help in organizing farm data properly and make it easy to access and update whenever needed.

The system also includes additional features like real- time monitoring, automatic alert generation, and reporting tools. These help farmers understand disease patterns and take preventive actions quickly, improving overall farm safety [5]. Non-functional aspects such as system performance, reliability, ease of use, and data security are also considered during planning. The system is designed to handle large data, provide quick responses, and ensure continuous availability without failure.

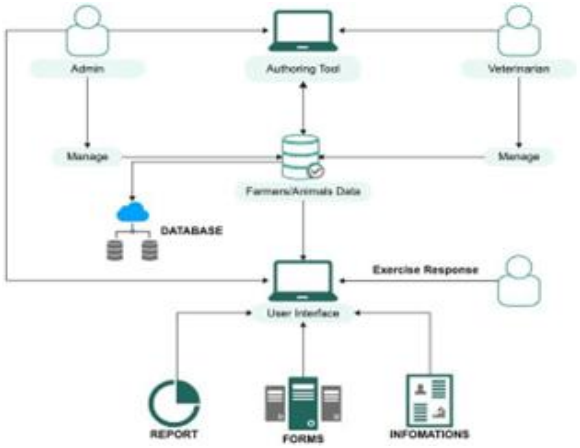

Fig. 1. System design

C. Database Design

The database is designed to store and manage all farm-related data in an organized way. A relational database model is used so that data remains consistent and can be retrieved efficiently. This approach helps the system handle large amounts of data while reducing redundancy [3].

Different tables are created for livestock details, health records, vaccination schedules, veterinarian reports, user in- formation, and visitor logs. These tables are connected using primary and foreign keys, which makes it easy to link related data. For example, each animal record is connected to its health history and vaccination details.

Normalization is used to remove duplicate data and improve performance. Constraints such as unique keys and validation rules ensure that the data remains accurate. Indexing is also used to speed up data retrieval. In addition, proper security measures are applied to protect sensitive information, and backup mechanisms can be used to avoid data loss.

D. User Authentication

The system includes a secure login mechanism to ensure that only authorized users can access the platform. Users need to register and log in with valid credentials. Password encryption and session handling techniques are used to protect user data.

Role-based access control (RBAC) is implemented so that different users have different levels of access. Farmers can manage animal data, veterinarians can review and update health records, and administrators can control the overall system. This ensures data security and proper system usage.

E. Data Management

The system provides a simple and user-friendly interface for managing data. Farmers can easily enter and update animal details such as species, age, health status, and vaccination records. Veterinarians can also access and update treatment information.

Data validation is used to ensure that the entered information is correct and complete. The system supports real-time updates so that data is always up to date. By replacing manual records with a digital system, errors are reduced and data becomes easier to access and analyze.

F. Health Monitoring

Health monitoring is an important part of the system that continuously tracks the condition of animals. It analyzes health records, vaccination data, and symptoms to detect any unusual changes.

The system identifies issues such as missed vaccinations or abnormal health conditions. This helps in detecting diseases early and taking preventive action before the situation becomes serious [8], [9].

Feedback from veterinarians further improves the accuracy of monitoring. This approach helps in maintaining biosecurity and reducing the spread of diseases.

G. Alert Mechanism

The system includes an alert mechanism to inform users about important events and risks. Alerts are generated when conditions such as missed vaccinations, unusual health up- dates, or biosecurity threats are detected.

These notifications are sent to farmers and veterinarians so that they can take quick action. This helps in preventing disease outbreaks and improving farm safety.

Overall, the alert system ensures that no important event is missed and improves the responsiveness and efficiency of farm operations [5].

IV. ALGORITHMS AND MODELS

The performance of the Biosecurity Farm Portal mainly depends on how effectively different algorithms handle tasks such as user authentication, communication, health monitoring, and decision-making. This section explains the main algorithms and models used in the system to support livestock

tracking, interaction with veterinarians, and overall biosecurity management [5].

A. User Authentication using Bcrypt JWT (IAM Module)

Input: User credentials (email, password) Output: Authenticated session with JWT token the authentication system is designed to provide secure access to the platform by using password hashing and token- based authorization [5]. Instead of storing plain passwords, the system stores hashed values, which improves security.

Steps: User enters credentials → Password is hashed using bcrypt → The hashed password is compared with the stored value → If it matches, a JWT token is generated → The token is used to manage the session → Otherwise, access is denied.

The authentication validation can be represented as:

$$Auth = bcrypt(password, salt) == stored_hash \quad (1)$$

B. Role-Based Access Control (RBAC Model)

The RBAC model is used to control access to system features based on user roles. Each user is assigned a role such as Farmer, Veterinarian, or Admin, and each role has specific permissions.

When a request is made, the system checks the JWT token, identifies the user's role, and verifies whether that role is allowed to perform the requested action. If permitted, access is granted; otherwise, it is denied [5].

Mathematically, the RBAC model is defined as:

$$\text{Access}(u, a) = \begin{cases} 1, & \text{if } role(u) \in Permissions(a) \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

where u represents the user, a represents the requested action, and $Permissions(a)$ denotes the set of roles authorized to perform action a.

C. Health Monitoring Model

The health monitoring model is responsible for continuously checking the condition of animals. It analyzes data such as symptoms, vaccination records, and environmental factors to identify any unusual patterns [8], [9].

If any abnormal condition is detected, the system marks the animal status as critical and generates alerts so that timely action can be taken.

$$\text{Health}_{status} = \begin{cases} \text{Normal}, & \text{if parameters are within threshold} \\ \text{Alert}, & \text{if abnormal condition is detected} \end{cases} \quad (3)$$

where the parameters include symptoms, vaccination records, and environmental conditions.

D. Vaccination Scheduling Model

This model ensures that animals receive vaccinations on time. It compares the current date with the scheduled vaccination date.

$$Delay = CurrentDate - ScheduledDate \quad (4)$$

$$Delay > 0 \Rightarrow Alert \quad (5)$$

If the delay is greater than zero, it means the vaccination is overdue, and the system generates an alert.

E. Alert Generation Model

The alert system combines multiple factors such as animal health, vaccination delays, and biosecurity risks to notify users [5].

$$Alert = f(health, vaccination, risk) \quad (6)$$

This helps farmers and veterinarians take immediate action whenever any issue is detected.

F. Real-Time Communication Model

The system supports real-time communication between farmers and veterinarians using socket-based messaging [5]. This allows quick exchange of information and faster decision- making.

$$Message_{delivery} = f(userId, socketId) \quad (7)$$

where *userId* identifies the user and *socketId* represents the active connection.

G. Secure File Storage Model

To avoid file overwriting, the system generates a unique filename by combining a timestamp with the original filename.

$$Filename = Timestamp + OriginalName \quad (8)$$

This ensures that all uploaded files are stored safely without conflicts.

H. Deep Learning and Neural Networks

Deep learning techniques are used to analyze large amounts of unstructured data such as user feedback and reports. These models help in identifying patterns and improving system recommendations.

Natural Language Processing (NLP) is used to understand user feedback written in text form [12]. For example, feedback from users can help identify issues

or trends related to animal health and farm conditions. Neural networks compute outputs through a weighted sum and activation function as shown below [12].

$$y = f(W \cdot x + b) \quad (9)$$

where W is the weight matrix, x is the input, b is the bias, and f is the activation function.

I. Database Relationship Model

The system maintains proper relationships between different entities such as animals, health records, and treatments to ensure structured data management [3].

$$Animal \rightarrow HealthRecords \rightarrow Treatment \quad (10)$$

This structure helps in efficient data retrieval and maintains consistency across the system.

V. CONCLUSION AND FUTURE WORK

The BioSecurity Farm Portal provides a practical and efficient solution for improving farm management, animal health monitoring, and biosecurity practices. The system brings together modern web technologies to create a centralized platform where farmers can maintain livestock records, track vaccination schedules, manage visitor entries, and receive real-time alerts and reports [5]. By replacing manual record- keeping methods, the portal makes data handling more accurate, easily accessible, and less time-consuming. In addition, secure authentication and role-based access control ensure that sensitive farm information is protected while still allowing proper access to farmers, veterinarians, and administrators.

The system is developed using technologies such as HTML, CSS, JavaScript, Node.js, and MySQL, which makes it reliable, scalable, and easy to use [5]. It allows farmers and veterinarians to monitor farm activities in real time, identify possible health issues early, and take quick action to prevent disease spread and financial losses. Features like health monitoring, vaccination tracking, and automatic alert generation play an important role in improving biosecurity and making farm management more proactive [8], [9]. The structured database and real-time communication features also help different users work together efficiently and make better decisions [3].

Overall, this system supports the digital transformation of agriculture by encouraging data-driven decisions, improving farm safety, and promoting sustainable livestock management [1]. The BioSecurity Farm Portal can be considered a useful and adaptable solution for modern farming needs, especially in managing biosecurity effectively.

In the future, the system can be improved further by adding advanced technologies. For example, IoT devices can be used to collect real-time data such as temperature, humidity, and animal health conditions automatically. Machine learning and artificial intelligence techniques can help predict diseases at an early stage and prevent outbreaks [8], [9]. The use of GIS can help visualize and track disease spread, which can support better planning and control. A mobile application can also be developed to make the system more accessible for farmers, especially in rural areas, by allowing offline data entry and instant alerts. Additionally, blockchain technology can be used to improve data security, transparency, and traceability. These improvements can make the system smarter, more automated, and more scalable, further strengthening biosecurity practices and supporting sustainable agriculture [1].

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