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Department of Computer Engineering

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Project Synopsis (2024-25) - Sem VII

Dhaanya: AI-Powered Disease Incidence Prediction System for Paddy Crops

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Abstract

Paddy cultivation is crucial for farmers and consumers alike, particularly for those relying on rice as a staple food. Ensuring disease-free crops with high yield is vital for maintaining both economic stability and food security. This project aims to develop an intelligent application that leverages Machine Learning (ML) and real-time weather data to predict disease risk in paddy crops within Maharashtra. The app will forecast disease incidence areas by evaluating environmental conditions, susceptibility of the host, and pathogen presence. Additionally, it will provide farmers with actionable insights and recommendations to manage disease risk effectively through a user-friendly interface, while also maintaining a record of inputs and results for future predictions.

Introduction

Paddy cultivation is a major agricultural activity in Maharashtra, India, which contributes significantly to India's total rice production. Maharashtra plays a vital role in rice cultivation, particularly in regions like Konkan, where rice is the primary crop. Paddy farming provides livelihoods to thousands of farmers and supports related industries like milling and export.

Rice is a staple food for the majority of the Indian population and a crucial source of carbohydrates, energy, and nutrition. In many regions, especially rural areas, it forms a significant portion of the daily diet. Ensuring a high yield of disease-free rice crops is essential for addressing food security and the nutritional needs of the population.

Despite its importance, paddy crops are susceptible to a range of diseases that can significantly impact both yield and quality. Common diseases include fungal infections like rice blast, sheath blight, and bacterial leaf blight. These diseases can lead to substantial yield losses if not managed in time. For instance, rice blast can cause lesions on leaves and stems, while bacterial blight can result in wilting and the death of plants. Economic losses due to these diseases can be severe, with crop losses ranging from 20% to 50% in serious cases.

Traditional methods of disease management often rely on manual monitoring and preventive measures, which are labor-intensive and reactive rather than proactive. With the advancement of modern technologies, there is an opportunity to enhance disease prediction and management through advanced data analytics.

Machine Learning (ML) and Artificial Intelligence (AI) have shown significant promise in various fields, including agriculture. These technologies can analyze complex datasets, such as real-time weather conditions, historical disease records, and environmental factors, to develop predictive models for disease outbreaks. For example, weather parameters like temperature, humidity, and rainfall greatly influence the prevalence and severity of paddy diseases. Integrating these factors with ML algorithms allows for accurate disease risk predictions.

This project aims to address the challenges faced by paddy farmers by developing an innovative application that combines real-time weather data, environmental conditions, and ML models to predict disease risk. The application will provide farmers with actionable insights and recommendations, allowing them to proactively manage crop health. By reducing dependence on traditional methods and incorporating cutting-edge technology, this solution aims to improve crop yield, reduce losses, and support the economic and nutritional well-being of the community.

Problem Statement

The paddy farming sector in Maharashtra faces significant challenges due to diseases that severely affect crop yield and quality. Farmers need accurate and timely information to predict disease outbreaks and manage them effectively. Traditional methods of disease prediction are often insufficient due to their reliance on manual monitoring and limited data integration. There is an urgent need for a technological solution that integrates real-time weather data, environmental factors, and machine learning to predict disease risks and provide actionable insights, ensuring high yield and quality of paddy crops.

Proposed Solution

The proposed solution is a comprehensive mobile application designed to:

- Predict disease incidence areas by analyzing real-time weather data, susceptibility of paddy crops, and pathogen availability.
- Provide farmers with a user-friendly interface to input data, receive disease risk predictions, and obtain management recommendations.
- Maintain records of inputs and results to enhance prediction accuracy and support future decision-making.

Methodology / Block Diagram

Methodology:

1. **Data Collection:**
- Gather historical data on pomegranate diseases, weather conditions, and pathogen prevalence.
- Integrate real-time weather data (temperature, humidity, wind speed, rain).

2. **Model Development:**

- Develop a machine learning model to predict disease risk based on collected data.
- Train and validate the model using historical data and real-time inputs.

3. **Application Development:**

- Design a user-friendly interface for farmers to input data and view predictions.
- Implement features for disease risk prediction, management recommendations, and record-keeping.

4. **Deployment and Testing:**

- Deploy the application and test it with real users to ensure accuracy and usability.
- Gather feedback and refine the application based on user input.

Block Diagram:

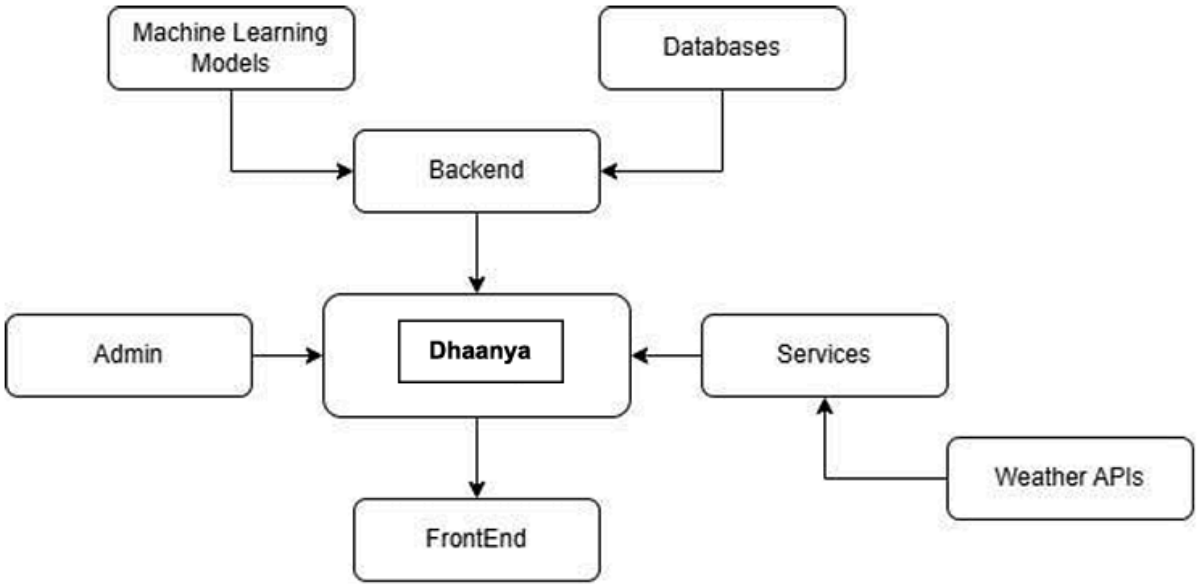

Fig 1. Proposed Block Diagram for Dhaanya Application

Hardware , Software and Tools Requirements

Hardware

1. **Camera Equipment**:

   High-resolution cameras, Mobile cameras

2. **Cloud and Network Infrastructure**:

   Servers, Networking equipment

Software

1. **Machine Learning & AI**:

   TensorFlow / Keras, PyTorch, Scikit-Learn

2. **Mobile app development tools** Android Studio, Flutter)

3. **Development Environments & IDEs**:

   Visual Studio Code / PyCharm, Jupyter Notebooks

4. **Database Management**:

   SQL databases ,NoSQL databases

5. **Cloud Platforms**:

   AWS / Google Cloud / Azure

6. **APIs and Integration**:

   Weather APIs, Geo Tracking APIs

7. **Data Storage and Backup**:

   Cloud storage (Amazon S3, Google Cloud Storage)

Proposed Evaluation Measures

1. **Accuracy of Predictions:**
   Assess the accuracy of the disease risk predictions generated by the application by comparing them with actual disease occurrences reported in the field. This involves calculating metrics such as precision, recall, and the F1 score, which provide a comprehensive measure of the model's performance.
2. **User Feedback**
   Gather detailed feedback from farmers regarding the usability, effectiveness, and overall satisfaction with the application. This can be achieved through surveys, interviews, and focus groups.
3. **Model Performance:**
   Evaluate the performance of the machine learning model using various metrics such as accuracy, precision, recall, and the F1 score. Additionally, assess the model's ability to generalize to new, unseen data.
4. **Application Stability:**

Monitor the application for stability and performance issues, including response time, data processing efficiency, and error rates. Conduct stress testing to evaluate how the app performs under different loads and usage conditions.

5. **Impact on Farming Practices:**
   Measure the improvements in disease management and crop yield resulting from the use of the application. This can be assessed by comparing pre- and post-implementation data on disease incidence, crop yield, and farmer productivity.

Conclusion

The proposed application represents a significant advancement in disease management for paddy cultivation. By integrating Machine Learning with real-time weather data, the app aims to provide accurate disease predictions and actionable insights to farmers. This solution has the potential to improve crop yield, reduce losses, and enhance the health of paddy crops in Maharashtra. By addressing the limitations of current disease prediction methods, the app will contribute to sustainable agricultural practices, support the economic stability of farmers, and improve food security for communities reliant on rice.

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