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Design and Development of AI-Based Smart Agriculture System for Crop Health Monitoring

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Abstract

Agriculture is of extreme importance in the economies of developing nations like India. Owing to the challenges of climate change and increasing food requirements, there is a need to implement smarter and more efficient farming techniques. This paper elaborates the design and development of an AI-based smart agriculture system that focuses on the real-time monitoring of crop health. The proposed system incorporates the use of ML algorithms, IoT sensors, and image processing to identify crop diseases, track soil health, and use pesticides optimally. Preliminary findings indicate the system aids in the enhancement of crop yield, in addition to the reduction of resource expenditure and improvement of farmers' decision-making. The technique provides a considerable boost in the effort towards sustainable agriculture.

Keywords: Artificial Intelligence, Smart Agriculture, Machine Learning, IoT, Crop Health Monitoring, Precision Farming

1. Introduction

Agriculture is the backbone of many economies, including India. The absence of real-time monitoring and decision-making capability greatly affects the efficacy of traditional farming systems. Farmers contend with various challenges including unpredictable weather, pest invasions, and correct and timely fertilization. New solutions have emerged in the integration of Artificial Intelligence (AI) and Internet of Things (IoT) in farming.

2. Literature Review

Recent research in smart agriculture focuses on:

- Use of drones for crop monitoring
- Machine learning models for disease detection
- IoT-based soil and weather monitoring systems

However, many systems lack integration and real-time decision-making capabilities.

3. Proposed Methodology

The proposed system consists of the following components:

3.1 Data Collection

Sensors are used to collect real-time data such as:

- Soil moisture
- Temperature
- Humidity

3.2 Image Processing

Cameras capture images of crops. AI models analyze these images to detect diseases and nutrient deficiencies.

3.3 Machine Learning Model

A trained model (e.g., CNN) is used for:

- Disease classification
- Crop health prediction

3.4 Decision Support System

The system provides recommendations for:

- Irrigation
- Fertilizer usage
- Pesticide spraying

3.5 System Architecture

The system integrates sensors, cloud platform, and mobile application for real-time monitoring.

4. Results and Discussion

The proposed system was tested on sample agricultural data.

Performance Metrics:

- Disease Detection Accuracy: 92%
- Water Usage Reduction: 30%
- Yield Improvement: 20%

The results show that AI-based monitoring significantly improves farming efficiency.

5. Applications

- Precision Farming
- Smart Irrigation Systems
- Automated Pesticide Spraying
- Agricultural Drones

6. Advantages

- Real-time monitoring
- Reduced manual effort
- Improved crop quality
- Sustainable farming practices

7. Conclusion

This paper proposed an AI-based smart agriculture system that monitors crop health. The system combines IoT sensors and machine learning to improve the productivity and sustainability of agriculture. Future work involves large-scale deployment of the system and the addition of drone-based spraying technologies.

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