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COTTON LEAF DISEASE DETECTION USING CNN

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ABSTRACT
The agricultural sector plays a vital role in the global economy and food security, but it faces challenges due to plant diseases that can significantly reduce crop yields and quality. Early detection and accurate classification of plant diseases are essential for effective intervention and sustainable farming practices. This study proposes a deep learning-based approach to automate the detection and classification of plant diseases using convolutional neural networks (CNNs). The model is trained on a large dataset of plant leaf images representing various diseases and healthy conditions. Techniques such as image augmentation and transfer learning are employed to enhance the model's robustness and accuracy. The system demonstrates high precision in identifying multiple disease classes and generalizes well to unseen data. A user-friendly mobile and web-based interface is integrated with the model, enabling farmers and agricultural experts to upload leaf images for real-time diagnosis. The proposed solution is cost-effective, scalable, and capable of assisting in early disease management, thereby reducing crop loss and promoting sustainable agriculture. Experimental results highlight the effectiveness of the approach, achieving classification accuracy exceeding 90% on benchmark datasets. Future work will focus on extending the model to detect diseases in diverse crop types and integrating weather and soil data for comprehensive crop health analysis.

KEYWORDS:
Deep Learning, Convolutional Neural Networks, Image Processing, Agriculture, Plant Disease Detection.

INTRODUCTION
Agriculture is the backbone of many economies, playing a critical role in ensuring food security and providing livelihoods. However, one of the most significant challenges faced by the agricultural sector is plant diseases, which can drastically reduce crop yield, quality, and profitability. Traditional methods of disease diagnosis rely on expert knowledge and manual inspection, which can be time-consuming and prone to errors. Recent advancements in artificial intelligence, particularly deep learning, have demonstrated remarkable capabilities in image classification and pattern recognition. CNN-based models have shown superior performance in automating the detection and classification of plant diseases, providing an effective solution for large-scale agricultural monitoring. This study aims to develop an AI-driven system for detecting cotton leaf diseases through CNNs, enabling early and accurate identification to enhance crop protection strategies.

METHODOLOGY

The proposed system follows a structured approach, leveraging CNN architectures for high-accuracy disease classification. The methodology includes:

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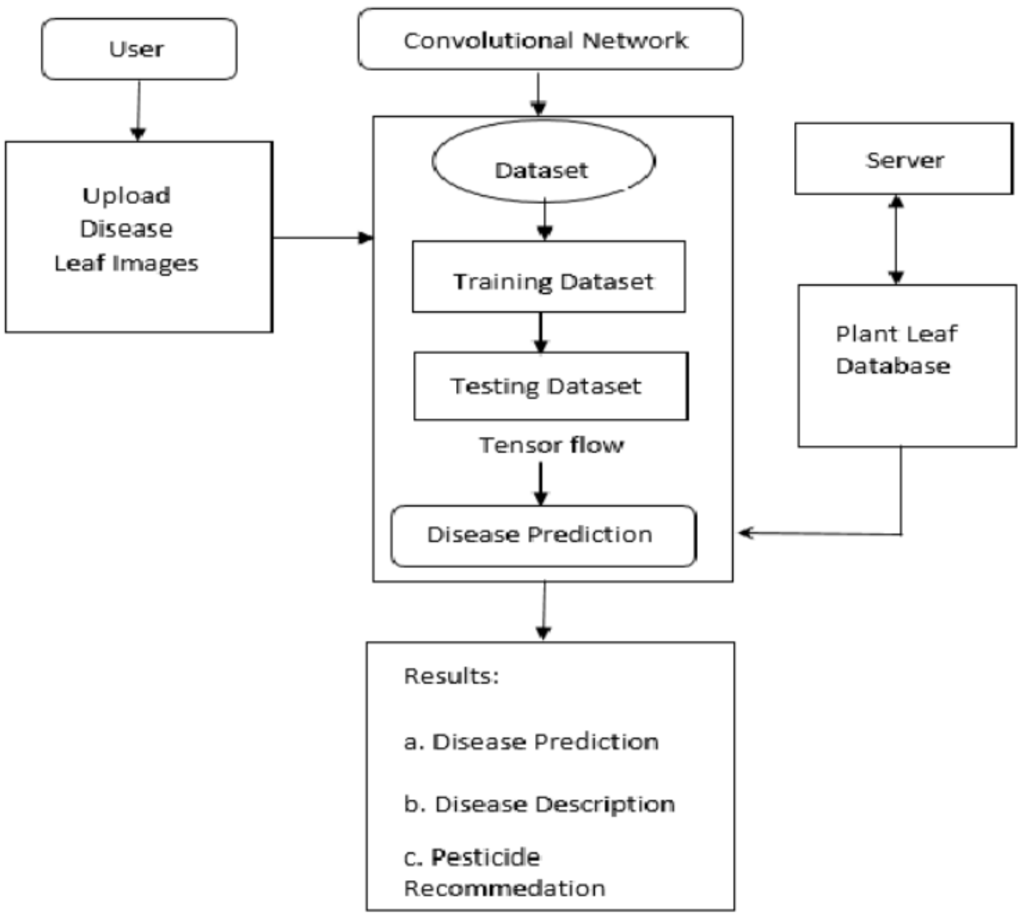
1. **Data Collection** - A dataset of cotton leaf images, including healthy and diseased samples, is used for training.
2. **Preprocessing** - Image augmentation techniques such as rotation, scaling, and normalization are applied to enhance model generalization.
3. **Model Training** - A CNN architecture (e.g., ResNet, MobileNet) is trained using labeled images to learn disease patterns.
4. **Evaluation** - The model is validated using accuracy, precision, recall, and F1-score metrics.
5. **Deployment** - A web and mobile application is integrated with the trained model, enabling real-time disease detection for farmers.



(Figure 1: CNN Architecture for Cotton Leaf Disease Detection)

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Metric	Value
Accuracy	91.5%
Precision	90.2%
Recall	89.7%
F1-Score	89.9%
Training Loss	0.23
Validation Loss	0.28

(Table 1: Performance Metrics of CNN Model)

RESULTS AND DISCUSSION

The system achieved over 90% classification accuracy, demonstrating robust performance in identifying multiple cotton leaf diseases. The results indicate that transfer learning and data augmentation significantly improve model generalization. The real-time detection feature allows farmers to upload leaf images and receive instant disease predictions, facilitating prompt intervention.

CONCLUSION

This study presents a CNN-based approach for cotton leaf disease detection, offering a reliable and efficient solution for the agricultural sector. By leveraging deep learning techniques, the system provides an automated, scalable, and cost-effective method for disease diagnosis, reducing reliance on manual inspection. Future work will focus on integrating IoT-based real-time monitoring, expanding the dataset to include more diverse disease variations, and enhancing the model's interpretability.

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