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Potato Leaf Disease Identification Using Deep Learning

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Abstract - Plant diseases pose a major threat to global food security, with potato crops being particularly vulnerable to fungal and bacterial infections such as early blight, late blight, and leaf spot. Early detection and monitoring are critical for preventing large-scale yield loss and minimizing chemical pesticide usage. This paper presents a Potato Leaf Disease Monitoring System that leverages computer vision and deep learning to automatically identify and classify leaf diseases from digital images. The proposed model integrates convolutional neural networks (CNNs) and IoT-based monitoring to provide real-time disease detection and alert mechanisms. The system enables precision farming by offering accessible, scalable, and cost-effective solutions to farmers for early intervention and crop protection.

Key Words: Potato leaf disease, deep learning, computer vision, IoT, precision agriculture.

1. INTRODUCTION

Agriculture remains the cornerstone of the global economy, and ensuring the health of crops is vital for achieving sustainable food production. Among staple crops, the potato (Solanum tuberosum) plays a crucial role due to its high nutritional value and widespread cultivation. However, potato plants are highly susceptible to several leaf diseases, such as early blight caused by Alternaria solani and late blight caused by Phytophthora infestans, which can drastically reduce yield and quality. Traditionally, disease detection relies on manual inspection, which is time-consuming and prone to human error.

Advancements in artificial intelligence and image processing have created new possibilities for automated crop monitoring and disease detection. By employing deep learning techniques, particularly convolutional neural networks (CNNs), leaf diseases can be accurately recognized from captured images without requiring manual feature extraction. When combined with Internet of Things (IoT) devices such as cameras and environmental sensors, these systems enable continuous monitoring of crop health in real-time.

The proposed Potato Leaf Disease Monitoring System aims to bridge the gap between technology and field application by offering an intelligent, user-friendly, and cost-efficient solution. The system's architecture includes image acquisition, preprocessing, model training, disease classification, and alert notification modules. Farmers can access the results through a mobile or web interface, empowering them to take timely preventive measures. This study focuses on enhancing disease detection accuracy, improving real-time response, and promoting sustainable farming practices.

2. LITERATURE REVIEW

Several research works have addressed the challenge of potato leaf disease detection through machine learning and deep learning techniques. Each study contributes unique perspectives on model architecture, dataset diversity, and accuracy improvement for precision agriculture.

R. Kumar et al. (2023) introduced a CNN-based approach classifying potato leaves into early blight, late blight, and healthy categories using 4,072 images. The model showed strong accuracy but limited generalization due to small

datasets and environmental variability.

S. Durai et al. (2023) proposed a ResNet50 CNN model trained on the Plant Village dataset, achieving 98.28% accuracy. While highly efficient, its reliance on controlled datasets reduced adaptability in real-world field conditions.

A. Walid et al. (2023) developed a CNN with transfer learning and augmentation, reaching 99.22% accuracy. Despite exceptional performance, the lack of diverse datasets limited climate adaptability.

S.R. Bogireddy and H. Murari (2024) presented a hybrid UNet–EfficientNetB7 model for segmentation and classification, yielding 98.64% accuracy. The approach improved precision but required high computational resources.

R. Verma et al. (2023) implemented a LeNet CNN model for potato leaf disease detection, achieving 97% accuracy and suggesting mobile app deployment. However, its simplicity limits scalability to multi-class datasets.

S. Ghosh et al. (2024) compared multiple CNNs—VGG16, ResNet50, and InceptionV3—achieving 96% accuracy. The study demonstrated the trade-off between model depth and computational cost.

J. Pasalkar et al. (2023) fine-tuned a VGG16 model on 600 images to classify healthy and diseased leaves, achieving 97.4% accuracy. The limited dataset, however, affects robustness in natural conditions.

T.S. Shiffa and M.S. Suchithra (2023) proposed a DenseNet201-based model classifying five diseases, reaching 97.2% accuracy. It addressed class imbalance but lacked real-field validation.

M. Ashikuzzaman et al. (2024) applied transfer learning using DenseNet201 on regional datasets, achieving 96% accuracy. The model performed well but required multi-region validation for scalability.

B. Goyal et al. (2023) built a CNN-based multi-class model classifying five disease types, attaining near 100% accuracy. Yet, the absence of real-time deployment limits its agricultural practicality.

The key findings from the above literature review are summarized in Table 1.

TABLE-1 : LITERATURE SURVEY SUMMARY

Authors	Title	Methodology	Remarks
R. Kumar et al. (2023)	Deep Learning Based Analysis and Detection of Potato Leaf Disease	CNN classification of early blight, late blight, and healthy leaves using 4,072 images.	Accurate but limited generalization due to dataset size and variability.
S. Durai et al. (2023)	Image Classification for Potato Plant Leaf Disease Detection Using Deep Learning	ResNet50 CNN with PlantVillage dataset and augmentation.	98.28% accuracy; effective in lab, limited in field.
A. Walid et al. (2023)	Deep Learning-Based Potato Leaf Disease Detection Using CNN	CNN with transfer learning and augmentation for high performance.	99.22% accuracy; lacks diverse field data.
S.R. Bogireddy & H. Murari (2024)	Hybrid Deep Learning Model for Accurate Potato Leaf Disease Detection	Hybrid UNet–EfficientNetB7 segmentation and classification model.	98.64% accuracy; computationally expensive.
R. Verma et al. (2023)	CNN-Based Leaves Disease Detection in Potato Plant	LeNet CNN detecting early blight, late blight, and healthy leaves.	97% accuracy; good for mobile use but low scalability.
S. Ghosh et al. (2024)	Potato Diseases Detection Using Image Classification Models	Comparative study using VGG16, ResNet50, InceptionV3.	96% accuracy; demonstrates depth vs. efficiency trade-off.
J. Pasalkar et al. (2023)	Potato Leaf Disease Detection Using Machine Learning	Fine-tuned VGG16 on 600 images with augmentation.	97.4% accuracy; limited dataset, promising outcomes.
T.S. Shiffa & M.S. Suchithra (2023)	Potato Leaf Diseases Detection Using Machine and Deep Learning	Modified DenseNet201 with reweighted loss function for 5-class classification.	97.2% accuracy; needs real-world validation.
M. Ashikuzzaman et al. (2024)	Potato Leaf Disease Detection by Deep Learning: A Comparative Study	DenseNet201 with transfer learning on regional datasets.	96% accuracy; lacks geographic generalization.
B. Goyal et al. (2023)	Disease Detection in Potato Leaves Using Deep Learning Model	CNN-based 5-class model compared to AlexNet, VGG, and RCNN.	Near 100% accuracy; lacks real-time deployment.

CONCLUSIONS

This study consolidates findings from various research papers on potato leaf disease detection and introduces a deep learning-based monitoring system integrating CNN and IoT technologies. Most studies demonstrate high accuracy under controlled conditions, with models such as ResNet, DenseNet, and EfficientNet showing superior performance. However, key challenges persist in dataset diversity, computational demand, and real-time adaptability.

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