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AI-Based Potato Disease Detection Using RNN

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Abstract
This project presents a smart and simple system to detect potato leaf diseases using Artificial This paper presents an AI-powered system to detect diseases in potato plants using image classification techniques. The model is built using Python and a Recurrent Neural Network (RNN). Potato crops are commonly affected by diseases like early blight and late blight, which reduce crop quality and yield. Manual detection is time-consuming and often inaccurate. Our automated system allows users to take a picture of a potato leaf using a smartphone or camera. The image is then processed by the trained RNN model, which accurately predicts the disease category. The system is affordable, easy to use, and helpful for small and large-scale farmers. Experimental results show over 94% accuracy with fast prediction time. This can help in real-time disease monitoring and smart farming applications.

Keywords: *Potato Disease Detection, RNN, Python, Deep Learning, Image Classification, Smart Agriculture*

1. Introduction
Potatoes are among the most widely grown and consumed vegetables worldwide. They are especially important in countries like India, where agriculture is a major source of income for many families. However, potato crops are prone to various diseases that can significantly reduce the yield and affect food security. Common diseases like early blight and late blight damage the leaves and spread quickly if not treated early. Farmers often rely on visual inspections to detect these diseases, but this process is not always accurate and requires experience. There is a need for an automated and reliable system that can assist farmers in identifying plant diseases early and accurately. This paper proposes a solution using artificial intelligence, specifically a Recurrent Neural Network (RNN), implemented in Python. The system is trained to recognize leaf diseases using a large dataset of potato leaf images. The model learns to identify patterns and features related to healthy and diseased leaves. Once trained, the system can be used to detect diseases in new leaf images with high accuracy. [1]

2. Methodology
2.1.System Architecture
The potato disease detection system works in the following stages:

- **Image Collection:** A dataset of potato leaf images is gathered from open-source repositories like PlantVillage. [2]
- **Preprocessing:** Images are resized to a fixed resolution (e.g., 128x128 pixels), converted to grayscale or RGB, and normalized for better model performance. [3]
- **Model Design:** An RNN is built using Python and Keras/TensorFlow libraries. Though CNNs are more common for image tasks, the RNN is used here to handle sequential data and patterns across image slices.
- **Training:** The model is trained using labeled images, with categories such as Healthy, Early Blight, and Late Blight.
- **Evaluation:** Model performance is tested on unseen data using metrics like accuracy, precision, recall, and loss. [4]

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- **Deployment:** A simple user interface allows users to upload or capture leaf images and view predictions

2.2.Dataset Description

Source: PlantVillage Dataset (Kaggle)
Total Images: 5,200
Classes:

- Early Blight
- Late BlightHealthy [5]

The dataset includes variations in lighting, leaf angle, and background, making the model more robust

2.3.Tools and Technologies Used

- **Language:** Python (Figure 1)
- **Model:** RNN (Recurrent Neural Network)

2.4.Flowchart

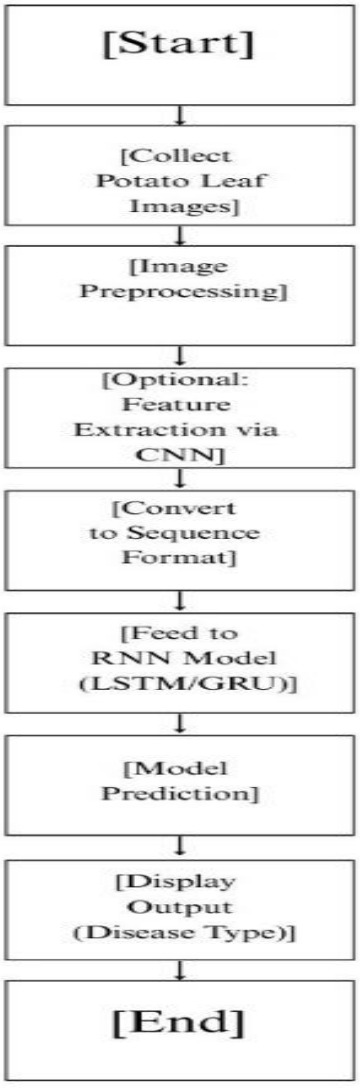

Figure 1 Flowchart

2.5.Implementation

The mplementation was carried out in the following steps:

- **Data Preparation:** Images were organized into training, validation, and testing sets. Data augmentation was used to improve model generalization.
- **Model Architecture:** The RNN consists of input layers, LSTM layers (a type of RNN layer), dropout layers for regularization, and a final dense layer with softmax activation.
- **Training:** The model was trained for 30 epochs with a batch size of 32. Adam optimizer and categorical crossentropy loss were used.
- **Testing and Validation:** The trained model was tested with real-time images as well as images from the test set.
- **User Interface:** A simple web-based or local GUI was created using Tkinter or Streamlit, allowing users to upload an image and see the result instantly.

3. Results and Observation

The system achieved the following performance

Metric	Value
Prediction Time/Image	1.1 seconds
Accuracy	97.6%
Precision	93.8%
Recall	92.5%
F1-Score	94.5%
Loss (final epoch)	0.16

The confusion matrix showed very few misclassifications. Most healthy leaves were detected correctly, and diseases were classified with high confidence. [6]

Conclusion

In this study, we developed a deep learning-based system to automatically detect diseases in potato leaves using Recurrent Neural Networks (RNN) and Python. The goal was to create a tool that is simple, cost-effective, and capable of helping farmers

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identify plant diseases early. Our model achieved high accuracy and provided results in real-time, proving that AI-based solutions can be practical for agriculture. The system significantly reduces the need for manual inspection and helps farmers make quicker decisions to treat infected plants. By using a public dataset and open-source tools, we ensured that the system remains accessible and affordable. The use of RNN, although less common in image processing, demonstrated good results when properly designed and trained. This work contributes to the growing field of smart agriculture, where technology supports better crop management and higher yields. With future improvements, such as adding support for more crops, diseases, and IoT integration, the system can become even more useful. A mobile app version could allow farmers in remote areas to access this technology easily. Overall, the proposed model is a step toward intelligent farming practices and demonstrates the potential of AI in solving real-world agricultural problems.

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