Project Report

Name: Abdul Rafay
C.M.S : 2293-2022
Course : ML-LAB
Program : Bs (Ai)7th

Smart Agriculture: Plant Disease Detection System

1. Problem Statement

Agriculture is a critical pillar of the economy; however, plant diseases lead to substantial crop yield losses each year. Farmers often face challenges in identifying plant diseases accurately and at an early stage due to limited access to expert knowledge and diagnostic tools. This project proposes an AI-based solution capable of automatically detecting **38 different plant leaf diseases** and providing **immediate treatment recommendations** to support timely decision-making and reduce crop damage.

2. Dataset Collection and Preprocessing

- **Dataset:** The PlantVillage Dataset was used, consisting of **54,305 high-quality leaf images**.
- **Classes:** The dataset includes **38 categories**, covering both healthy and diseased leaves from crops such as **Tomato, Potato, Apple, and Corn**.
- **Preprocessing:**
    - All images were resized to **256 × 256 pixels**.
    - Images were converted to **RGB format**.
    - Standardization ensured consistent input and enabled the model to capture fine-grained features such as **spots, color variations, and texture patterns**.

3. Model Implementation

- **Architecture:** A **custom Convolutional Neural Network (CNN)** was designed and implemented.
- **Layers:**

    - Multiple **Convolutional** and **Max-Pooling** layers were used for hierarchical feature extraction.
    - **Fully Connected (Dense)** layers were employed for final classification.
- **Optimization:**
    - Optimizer: **Adam**
    - Loss Function: **Categorical Crossentropy**
    - This configuration ensured stable convergence and improved classification performance.

4. Training and Testing Environment

- **Hardware:** Model training was performed on an **NVIDIA GeForce RTX 3090 GPU**, significantly reducing training time and enabling efficient handling of large-scale image data.
- **Software Environment:**
    - Python **3.10**
    - **TensorFlow** and **Keras** for deep learning implementation

5. Evaluation Metrics

The model was evaluated on a separate validation dataset using standard performance metrics:

- **Accuracy: 92.85%** (approximately **93%**)
- **F1-Score (Weighted Average): 0.93**, indicating a strong balance between precision and recall across all classes.

6. Results and Discussion

The proposed system successfully detects complex plant diseases such as **Tomato Late Blight** and **Apple Scab** with high reliability. Unlike basic classification models, this system also generates a **Disease Summary** and a **recommended Action Plan** for each detected disease. As a result, the solution functions not only as a disease classifier but also as a **comprehensive Decision Support System** for farmers.

7. Demo and GitHub Repository

- **Live Demo:** A real-time web-based dashboard was developed using **Streamlit**, allowing users to upload leaf images and receive instant disease predictions along with recommended solutions.
- **GitHub Repository:** The complete source code, trained model, and environment configuration files are available at:
    - https://github.com/abdulrafayza01/Plant-Disease-Detection-RTX3090.git

End of Report