CHAPTER-3

SOFTWARE REQUIREMENTS SPECIFICATION

1. Introduction

1.1 Purpose

The purpose of this Software Requirements Specification (SRS) is to provide a detailed and comprehensive description of MobilePlantViT, a lightweight hybrid Vision Transformer model designed for efficient and accurate plant disease classification. This document outlines the functional and non-functional requirements that the software system must satisfy to meet the needs of its users and stakeholders. It serves as a foundational document for all subsequent development, testing, and deployment activities, ensuring a shared understanding among all parties involved in the project.

1.2 Scope

MobilePlantViT is a lightweight AI-based mobile and desktop solution that utilizes deep learning models for plant disease detection. The system captures leaf images, classifies plant diseases using the Vision Transformer architecture, and provides actionable insights for farmers. It integrates efficient modules such as Ghost Convolutions, Coordinate Attention, and Fused-Inverted Residual Blocks to achieve high accuracy with reduced computational cost. The software is intended for agricultural researchers, farmers, and institutions to improve crop health monitoring and yield management.

1.3 Definitions, Acronyms, and Abbreviations

SRS: Software Requirements Specification

FR: Functional Requirement

NFR: Non-Functional Requirement

AI: Artificial Intelligence

CNN: Convolutional Neural Network

ViT: Vision Transformer

FFN: Feed Forward Network

DL: Deep Learning

ML: Machine Learning

UI: User Interface

UX: User Experience

MobilePlantViT: Lightweight hybrid Vision Transformer architecture for efficient plant disease classification

Plant Disease: Any abnormal condition in plants that negatively affects growth, yield, or quality, typically caused by pathogens, pests, or environmental factors

1.4 References

[1] K. Han, Y. Wang, Q. Tian, J. Guo, C. Xu, and C. Xu, “GhostNet: More Features fromCheap Operations,” in *Proc. IEEE/CVF Conf. on Computer Vision and Pattern Recognition(CVPR)*, 2020, pp. 1580–1589. https://doi.org/10.48550/arXiv.1911.11907

[2] Q. Hou, D. Zhou, and J. Feng, “Coordinate Attention for Efficient Mobile NetworkDesign,” in *Proc. IEEE/CVF Conf. on Computer Vision and Pattern Recognition(CVPR)*, 2021, pp. 13713–13722. https://doi.org/10.48550/arXiv.2103.02907

1.5 Overview

This SRS document is structured into several main sections. Section 1 provides an introduction to **MobilePlantViT**, its purpose, scope, and a glossary of terms. Section 2 offers an overall description of the product, including its architecture, general functionality, user characteristics, and operational constraints. Section 3 details the specific functional and nonfunctional requirements.

2. Overall Description

2.1 Product Perspective

MobilePlantViT is a standalone AI system that integrates with mobile and edge devices for real-time plant disease classification. It is designed to assist farmers and researchers by providing accurate and efficient disease detection from leaf images. While it operates independently, it relies on hybrid Vision Transformer models for image processing and classification. It is not intended to replace agricultural experts but to augment their decision-making with AI-powered predictions.

2.2 Product Functions

The primary functions of MobilePlantViT include:

- Capturing plant leaf images via camera or gallery.
- Detecting and identifying plant diseases from images.
- Displaying the predicted disease name to the user.
- Providing suggested treatments or actions for detected diseases.
- Saving and managing analysed images for future reference.
- Enabling real-time disease detection on mobile and edge devices.

2.3 User Characteristics

The target users of MobilePlantViT are farmers, agricultural researchers, and agronomists who require accurate and timely identification of plant diseases to enhance crop management and reduce losses. Users may have

varying levels of technical proficiency, from individuals experienced with mobile applications to those with limited familiarity. Users are typically Android smartphone or tablet operators who rely on mobile solutions for field-based decision-making, monitoring plant health, and implementing effective disease management practices.

2.4 Operating Environment

2.4.1 Software Requirements

Operating System: Windows 10/11, Linux (Ubuntu 20.04+), or macOS (for development); Android 10.0+ (for deployment).

Programming Language: Python 3.8+

Libraries: PyTorch/Torch Vision, PIL (Pillow), Transformers

2.4.2: Hardware Requirements

Recommended:

CPU: Intel i5 or

equivalent RAM: 8 GB

GPU: NVIDIA GTX 1050 or equivalent

(optional) Storage: 10 GB free space

3. Specific Requirements

This section details the functional and non-functional requirements for MobilePlantViT.

3.1 Functional Requirements (FRs)

Functional requirements define the specific actions or services the system must perform. Each requirement is uniquely identified for traceability.

FR1: Image Input and Preprocessing

Description: The system shall accept plant leaf images from the user (via camera or gallery) and perform preprocessing (resizing, normalization, and augmentation) before classification.

Input: Image captured or uploaded by the user.

Output: Pre-processed image ready for model inference.

Acceptance Criteria: Image preprocessing completes without distortion or quality loss.

FR2: Disease Classification

Description: The system shall accurately classify plant leaf images into predefined disease categories using the MobilePlantViT model.

Input: Pre-processed image data.

Output: Predicted disease label and confidence score.

Acceptance Criteria: Classification accuracy meets NFR2.

FR3: Model Inference on Edge Devices

Description: The system shall support real-time disease prediction on mobile or edge devices using optimized TensorFlow Lite or PyTorch Mobile versions of the model.

Input: Trained MobilePlantViT model and input image.

Output: Disease prediction result displayed within specified latency.

Acceptance Criteria: Inference latency meets NFR1.

FR4: Custom Dataset Training

Description: The system shall allow users or researchers to retrain or fine-tune the model on new plant datasets for improved adaptability.

Input: Custom dataset images and labels.

Output: Updated MobilePlantViT weights reflecting new training data.

Acceptance Criteria: Retrained model achieves comparable or improved performance over the base model.

FR5: Model Optimization

Description: The system shall apply pruning and quantization to reduce model size and computation cost for mobile deployment.

Input: Trained model parameters.

Output: Optimized lightweight model.

Acceptance Criteria: Model size reduced by at least 30% with minimal loss in accuracy.

FR6: Result Visualization and Feedback

Description: The system shall display predicted disease results along with probability scores and provide users an option to submit feedback on correctness.

Input: Classification output and user feedback.

Output: User feedback stored for performance improvement.

Acceptance Criteria: Feedback is successfully recorded and acknowledged by the system.

3.2 Non-Functional Requirements (NFRs)

Non-functional requirements specify criteria that can be used to judge the operation of a system, rather than specific behaviors. They are crucial for system quality and user satisfaction.

NFR1: Performance (Inference Latency)

Description: The system shall classify plant disease images with a latency of no more than 800 milliseconds on mobile devices.

NFR2: Accuracy (Classification Performance)

Description: The system shall achieve a classification accuracy of at least 95% on benchmark plant disease datasets (e.g., PlantVillage).

NFR3: Security (Data Privacy)

Description: The system shall ensure all image data and model parameters are securely stored and processed locally or transmitted using encryption standards such as AES-256.

NFR4: Usability (User Interface Navigation)

Description: The mobile interface shall provide intuitive navigation, allowing users to capture or upload an image and receive classification results within three taps from the home screen.

NFR5: Reliability (Service Availability)

Description: The application shall maintain 99.5% uptime and handle input image errors gracefully without crashing.

NFR6: Scalability (Dataset and Model Expansion)

Description: The system shall support the addition of new plant species or disease classes without major architectural changes.

NFR7: Compatibility (Deployment Platforms)

Description: The model shall be compatible with Android (version 10.0 and above), and also deployable on edge devices such as Raspberry Pi or Jetson Nano.

NFR8: Maintainability (Code Quality)

Description: The codebase shall follow modular design principles and PEP8 coding standards, allowing easy maintenance by a team of up to five developers.