CHAPTER

3

LEAF SEGMENTATION WITH HSV-SAM

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3.1 INTRODUCTION

Plant diseases are a critical area of study within plant pathology. They cover many harmful conditions caused by pathogens, such as fungi, bacteria, viruses, and nematodes. These diseases significantly impact agricultural productivity, natural ecosystems, and global food security. Understanding how these pathogens infect and damage their host plants is essential for developing effective management strategies. Despite advancements in agricultural practices, rapidly identifying and managing crop diseases remains challenging. In recent years, computer vision techniques have shown immense potential in detecting crop diseases. Accurate segmentation of plant leaves from complex backgrounds is crucial for various agricultural applications, including biomass estimation, disease classification, and plant growth monitoring (Trivedi & Gupta, 2021). A combination of computer vision and robust algorithms can be a powerful disease detection and crop management method. However, detecting tomato leaf diseases presents unique challenges. This is due to the wide range of morphological variations in tomato leaf images, which are influenced by environmental factors, background conditions, and image quality. These factors make precise segmentation and monitoring of plant health particularly difficult. This chapter discusses the method of segmenting tomato leaf images and linking imaging data with measurements of leaf area, a step towards a brighter future in disease detection and crop management.

3.2 IMAGE CLASSIFICATION METHOD

Various methods have been explored in disease detection, particularly in image classification. Image classification involves traditional machine and deep learning methods, some of which are depicted in Figure 3.1.

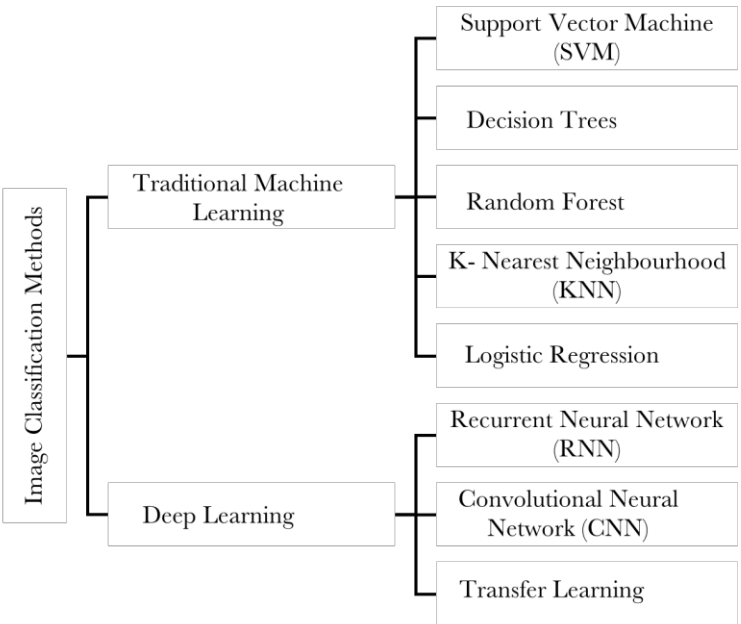

Figure 3.1 Image classification methods

Traditional and supervised machine-learning methods, often called "old school" methods, have stood the test of time and are effective in disease classification. For instance, the Decision Tree algorithm achieved an impressive accuracy of approximately 98% in classifying three distinct classes into bacterial blight, brown spot, and leaf smut (Ahmed et al., 2019). Other effective methods include support vector machines

(SVM) such as linear and radial basis function (RBF) SVMs, k-nearest Neighbours (k-NN), random forest (RF), and logistic regression. While these methods have demonstrated strengths in various applications, they also have limitations. Some challenges include sensitivity to outliers and noisy data (k-NN and SVM), computational complexity and longer training times (SVM and RF), susceptibility to overfitting (decision trees and RF), and reduced interpretability.

Deep learning is a machine learning subfield that uses artificial neural networks to process complex computations on extensive datasets. One of the critical components of deep learning is convolutional neural networks (CNNs), which have shown exceptional performance in tasks related to image classification. CNNs are adept at identifying critical features and interpreting patterns within images, drawing inspiration from the functioning of the human visual system as conceived by Yann LeCun and Yoshua Bengio (1995). Their proficiency has been demonstrated in optical character recognition and image classification, notably during the 2012 ImageNet Large Scale Visual Recognition Challenge (Deng et al., 2009). The winning solution, developed by Krizhevsky et al. (2016), underscored the immense potential and effectiveness of deep CNNs. In addition to CNNs, recent methods like transfer learning have gained popularity, utilising pre-trained models such as EfficientNetV2 and MobileNets, which have shown strong performance and accelerated training in image classification tasks. However, recurrent neural networks (RNNs) are not commonly used directly for image classification due to their sequential nature. They are better suited for tasks involving sequential information within images or video frames.

3.3 LEAF IMAGE SEGMENTATION MODEL

Initially, the focus of leaf segmentation has been on developing techniques to segment leaves accurately. This involves investigating various methods, such as using thresholding algorithms to separate individual leaves and employing edge detection techniques to identify