Chapter 13
Apple Leaf Disease Identification and Segmentation Using Enhanced Learning-Driven Feature Representation Model

Harsha Raju
https://orcid.org/0000-0003-0159-8342
Reva University, India

Veena Kalludi Narasimhaiah
Reva University, India

Mukil Alagirisamy
https://orcid.org/0000-0003-1623-1914
Asia Pacific University, Malaysia

ABSTRACT

The field of automatic segmentation and identification of plant diseases from leaf images has become increasingly significant in recent years. There are a number of fungal diseases that affect apple quality and yield, including apple scab, cedar rust, and black rot. In order to prevent crop losses, it is essential to identify these diseases quickly as possible. Despite many approaches being discussed, segmenting the diseased part of leaves with high accuracy and low false positive rates remains a challenging task. This study suggests that by isolating the color background and highlighting the area of interest, a substantial feature set can be constructed to enhance deep learning generalization capability for disease classification. An algorithm for fitness function is developed to represent the features that are relevant to disease classes and optimally adjusts the weights and biases in the training phase. Based on visual outcome and comparative analysis in terms of precision, recall rate, and F1-scores, the efficacy of the proposed work is justified.

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1. INTRODUCTION

Apple plant diseases can have a significant impact on the productivity and profitability of fruit, and accurate identification and diagnosis of plant diseases is essential for disease management and crop protection. Traditional methods for plant disease diagnosis, such as expert manual examination, can be time-consuming, subjective, and prone to human error. The use of image processing applications and machine learning methods for plant disease classification has the potential to provide a faster, more accurate, and more objective method of disease diagnosis. The proposed research focuses on developing an automated and synchronized framework that can accelerate plant leaf disease detection and help farmers prevent diseases from spreading at early stage. The proposed system is evaluated through experiments on an apple leaf dataset to assess its accuracy and performance.

1.1 Background

Agriculture is a major contributor to the economies of many countries. The export and import of fruit varieties is also common, especially apple fruit, which is in high demand worldwide (Liu, J., and Wang, X,2021). Apple trees are a crucial source of food and income for many regions around the world. However, apple trees are susceptible to various diseases that can reduce their productivity and ultimately result in crop loss. There are many diseases that attack apple trees in crop fields due to their unavoidable presence in agriculture. However, apple rust and cider rust and scab are three of the most common fungal diseases that heavily impact apple crop yields and economic values (Orchi, H., Sadik, M. and Khaldoun, M., 2021.), (Ganatra, Nilay & Patel, Atul. (2018). According to estimates, diseases to plants result in a loss of 35-40% of crop yields in agriculture(Savary, Serge & Ficke, Andrea & Aubertot, Jean-Noël & Hollier, Clayton. (2012)). Due to lack of facilities and awareness, most farmers have no idea what type of disease they are dealing with. In these situations, they often use fungicides and insecticides to prevent yield loss due to fungi and pests(Nicolopoulou-Stamati, Polyxeni, Sotirios Maipas, Chrysanthi Kotampasi, Panagiotis Stamatis, and Luc Hens.). However, this practice often involves the excessive use of chemicals, which raises significant concerns over health and environmental issues, as it can be toxic to birds and many other organisms, including environmentally friendly insects (Yoon, M.Y., Cha, B. and Kim, J.C., 2013.). In addition, manual and tedious processes result in high operating costs for farmers. An appropriate remedial action can be planned to prevent fungal infections in apple plants, reduce chemical use, and ensure sustainable crop maintenance practices if diseases can be diagnosed and detected early (Vasavi, P., Punitha, A. and Rao, T.V.N., 2022). Thus, it is extremely important to develop an automated and affordable method for identifying and classifying diseases, so that farmers and agriculture experts can take effective measures.

1.2 Digital Image Processing

Digital Image Processing is a field of study that deals with the acquisition, representation, analysis, and interpretation of images to extract meaningful information. It utilizes mathematical and computational methods to manipulate images and extract features that are relevant to the task at hand. A typical architecture of plant disease detection using application of image processing and AI is shown in Figure 1.

In the context of plant leaf disease detection, digital image processing can help by automating the analysis of leaf images to identify and diagnose various diseases. For example, the preprocessing tech-