International Journal of Advanced Multidisciplinary Research and Educational Development
Volume 2, Issue 2 | March – April 2026 | www.ijamred.com
ISSN: 3107-6513

Leaf Disease Detection Using Image Processing

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ABSTRACT

Detecting plant diseases is a difficult task in agriculture. If diseases are not identified correctly, farmers may face heavy crop losses, which also reduces the market value of their produce. Traditionally, checking leaf diseases requires a lot of manual work, specialized knowledge in plant pathology, and takes considerable time. To make this process faster and more reliable, image processing methods can be used in MATLAB for automatic leaf disease detection.
The workflow generally includes several steps:

- Capturing the leaf image (image acquisition)
- Improving image clarity (contrast enhancement)
- Converting the image from RGB format to the HSI color model
- Extracting important features from the image
- Classifying the disease using Support Vector Machine (SVM)

Keywords: Contrast enhancement, HSI, SVM, RGB

INTRODUCTION

India is a fast-growing country where agriculture has long been the backbone of its economy, especially in the early stages of development. Over time, industrialization and globalization have created new challenges for the farming sector. At the same time, it has become important to educate younger generations about the value of agriculture and cultivation practices.

Even though modern technology has transformed many industries, farming still depends heavily on traditional methods. One major issue is the incorrect identification of plant diseases, which can cause serious losses in crop yield, money, time, and product quality. Monitoring plant health is therefore essential for successful farming.

In the past, disease detection was mainly done manually by skilled farmers and experts. However, changing weather patterns and environmental conditions have made accurate manual diagnosis more difficult. To address this, image processing techniques provide a reliable way to automatically detect plant diseases. Since symptoms usually appear on leaves, stems, or flowers, this study focuses on analyzing leaf images to identify diseased plants.

LITERATURE SURVEY

 ISSN: 3107-6513

Researchers have explored many approaches for analyzing plant leaf images, often using color models such as RGB, HSV, YIQ, and dithered formats. Among these, RGB-based feature extraction has been widely used in proposed systems. Automated methods for segmenting diseased regions from digital leaf images have also been developed, with classification performed for selected disease categories across different plant species. The main goal of these studies is accurate disease recognition through leaf image analysis.

One notable study examined cotton leaf disease detection using image processing. Here, **K-means clustering** was applied to divide leaf images into distinct clusters, helping to separate healthy and diseased regions. This method has been integrated into several systems and compared with other detection techniques. Both **Support Vector Machine (SVM)** and K-means clustering have been commonly used for classification due to their effectiveness
More recently, machine learning and data mining techniques have been applied to detect multiple leaf diseases across different crops. While classification has often been limited to a few disease types, **SVM has consistently proven to be a strong classifier**, capable of handling complex data patterns and improving accuracy in disease detection.

PROPOSED METHODOLOGY

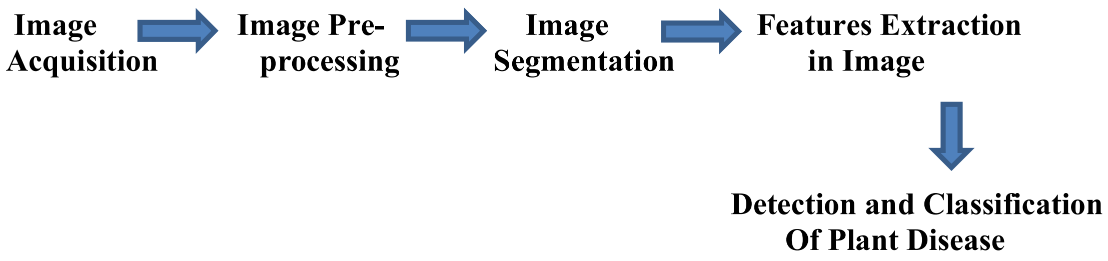

Figure 1: Flow chart for disease detection

Image Acquisition

The process starts by choosing a plant that shows disease symptoms and taking a sample of its leaf. A photo of the leaf is then captured with a camera and uploaded into the system for further analysis.

Segmentation

Segmentation is the step where an image is broken down into smaller, meaningful parts to make analysis easier. At this stage, the digital leaf image is divided into several segments, often called super-pixels, which make it possible to separate the diseased portions of the leaf from the healthy ones.

 ISSN: 3107-6513

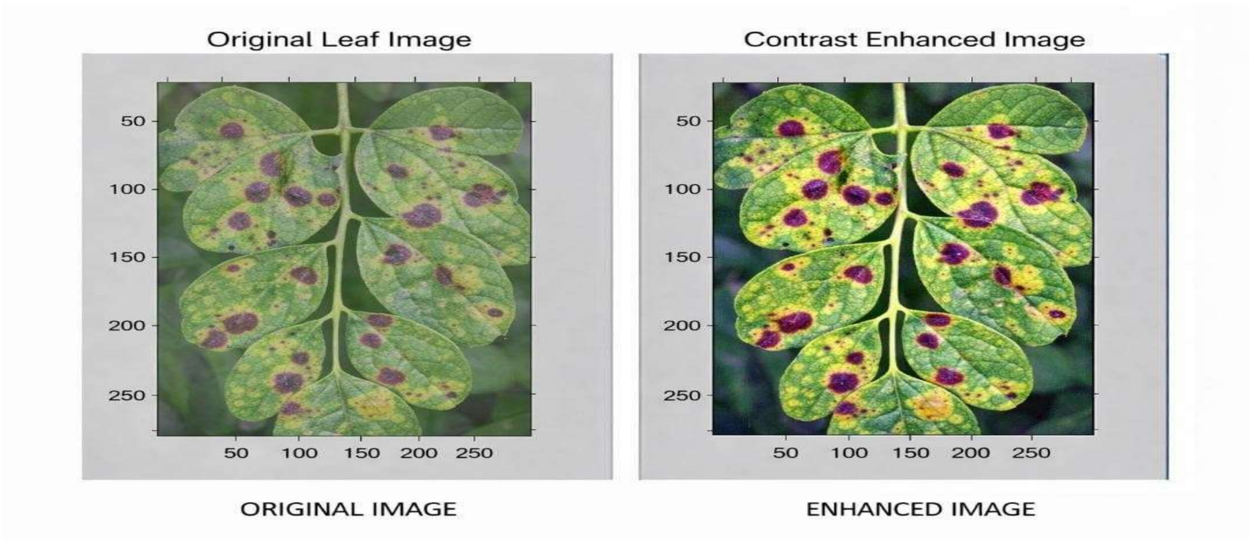

Figure.2.Enhanced Image Low

Contrast:

Contrast describes a situation where the brightness levels (pixel intensities) in an image fall within a narrow range. When this happens, the differences between various regions of the image become less noticeable, making it harder to distinguish details.

Contrast Enhancement:

As illustrated in Figure 2, the system first takes the original image as input. Once contrast enhancement is applied, the output is a clearer image where sudden changes in brightness and overly sharp edges are minimized, resulting in improved overall visibility and detail.

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Conversion from RGB to HSI:

An RGB image is defined with dimensions M × N × 3, where the three channels represent the red, green, and blue color values. If all three values are the same, the hue cannot be determined during conversion. In RGB format, pixel intensity values usually range from 0 to 255, while in the HSI model they are normalized between 0 and 1. Converting an image from RGB to HSI involves calculating three components: Hue, Saturation, and Intensity.

HUE:

□□□□□□□□□□ = ½[(□ – □) + (□ + □)]

□□□□□□□□□□□□ = ((□ – □)2 + ((□ – □) □ (□ – □)))^0.5

Now find theta value for

□ = □□□□□(□□□□□□□□□□/□□□□□□□□□□□□) Saturation:

□ [□, □, □]

Intensity

□ =

Then combine the three results into one single value then the HIS image is formed.

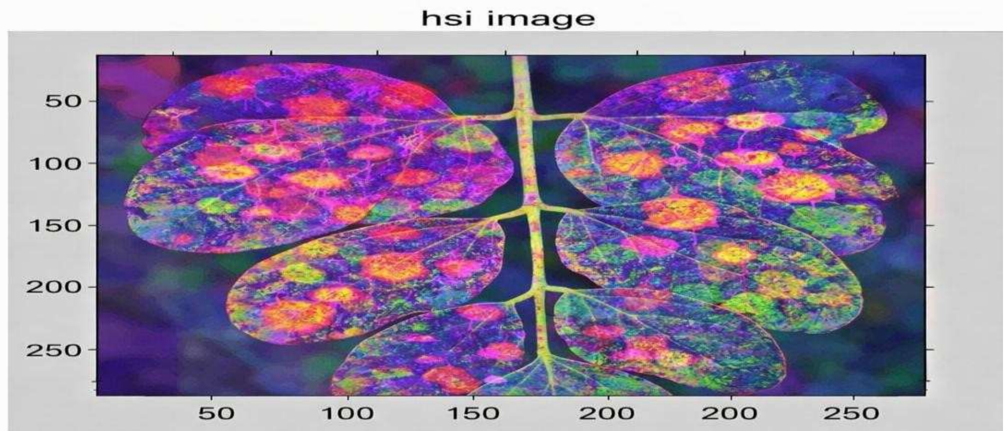

Figure.4.HSI image

K-means Clustering Algorithm:

K-means clustering is used to divide the leaf image into *k* separate groups based on its extracted features. The algorithm compares data points using Euclidean distance, which helps in identifying similarities and separating diseased regions from healthy ones.

K-means Algorithm Steps:

- **Initialization:** The user sets the value of *k*, which indicates how many clusters the image will be divided into.

 ISSN: 3107-6513

- **Pixel Assignment:** Each pixel is placed into the cluster whose centroid is closest, based on the minimum distance rule.
- **Centroid Update:** The centroid positions are recalculated by averaging the pixels in each cluster, shifting them toward the center of their groups.
- **Cluster Selection:** From the clusters formed, the one representing the diseased portion of the leaf is chosen for further classification

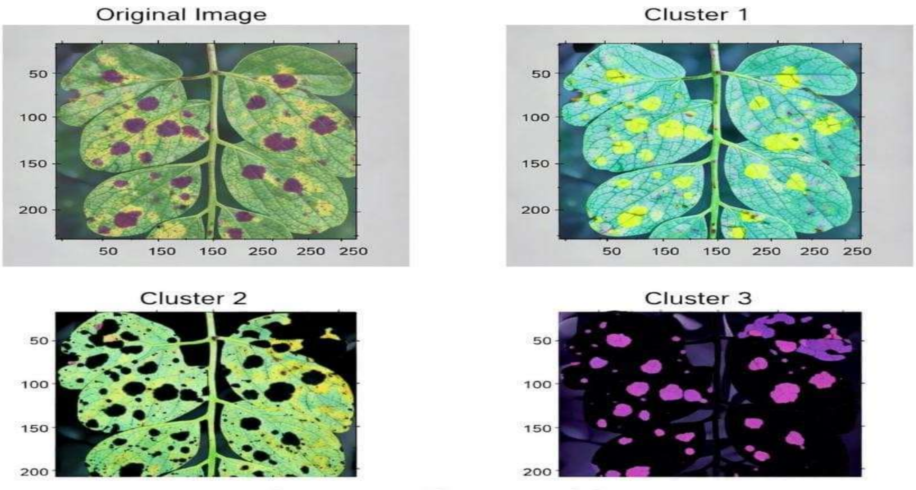

Figure.5.Clustered Image Support
Vector Machine (SVM):

Support Vector Machine (SVM) is a classification method that comes from statistical learning theory. Since statistics is concerned with handling uncertainty, it helps in finding useful patterns, making predictions, and guiding decisions based on the data available.

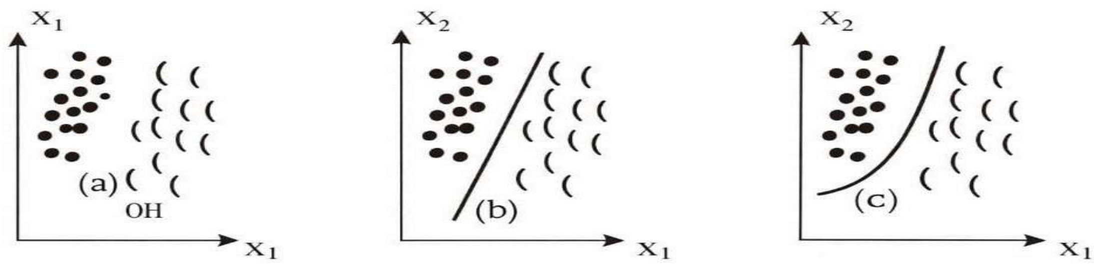

Figure 6: SVM

The figure demonstrates a simple classification problem in a two-dimensional feature space. Two distinct categories of patterns are illustrated: one crescent-shaped and the other oval-shaped. Multiple separating lines can be drawn to distinguish between these two classes. Among them, the boundary in Figure (b) achieves better separation than Figure (a), as it reduces the number of misclassified samples. Figure (c), however, shows the most effective boundary. As the dimensionality increases—moving from two features to three—the separating line becomes a plane, and with more than three features, it generalizes into a hyperplane. The boundary depicted in Figure (c) is known as the **optimal hyperplane**, or more specifically, the **maximum margin hyperplane**

 ISSN: 3107-6513

CONCLUSION

This study emphasizes the application of two fundamental image processing techniques—**K-means clustering** and **Support Vector Machine (SVM)**—to identify diseases in plant leaves. The proposed framework ensures reliable and precise detection of leaf infections. The overall process is organized into five major stages: **image acquisition, preprocessing, segmentation, feature extraction, and classification**. By estimating the severity of infection on a leaf, farmers can apply pesticides in appropriate amounts, leading to more effective pest management and improved crop productivity

In addition, the system can be further refined by integrating alternative segmentation and classification algorithms to enhance accuracy. This approach is adaptable to different leaf types, allowing the infected region to be measured as a percentage of the total leaf area. Accurate identification of plant diseases enables farmers and agricultural practitioners to respond efficiently, thereby minimizing both cost and effort

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