



# Automated Cotton Leaf Disease Detection Using Image Processing and Machine Learning in MATLAB

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## ABSTRACT

This paper presents an automated cotton leaf disease detection system using image processing and machine learning techniques implemented in MATLAB. Cotton crops are vulnerable to various leaf diseases that significantly impact yield, and traditional detection methods are manual and time-consuming. The proposed system processes leaf images through preprocessing, segmentation, feature extraction, and classification to identify diseased and healthy leaves. Color, texture, and shape features are extracted and used to train a supervised machine learning model for accurate disease recognition. Experimental results indicate that the system provides a fast, reliable, and efficient solution for early cotton leaf disease diagnosis, supporting improved agricultural management practices.

## KEYWORDS

Cotton Leaf Disease Detection, Image Processing, Machine Learning, MATLAB, Image Segmentation, Feature Extraction, Supervised Classification, Precision Agriculture, Soft Computing, Pattern Recognition.

## 1. Introduction

Agriculture plays a vital role in sustaining the global economy and ensuring food security. Among commercial crops, cotton holds significant economic importance due to its extensive use in the textile industry. However, cotton production is highly affected by leaf diseases that reduce yield, degrade fiber quality, and cause substantial financial losses. Early and accurate identification of these diseases is therefore essential for maintaining crop health and improving productivity.

Conventional disease detection methods primarily depend on manual field inspection and expert observation. Although practical in small farms, these techniques are time-consuming, subjective, and often incapable of identifying infections at an early stage. Delayed diagnosis can lead to rapid disease spread, increased pesticide usage, and reduced overall efficiency. Hence, there is a growing need for automated, reliable, and scalable disease detection systems.

Recent advancements in image processing and machine learning have introduced efficient computational approaches for plant disease diagnosis. Digital image analysis enables the extraction of discriminative features such as color variations, texture irregularities, and morphological distortions associated with infected leaf regions. When integrated with supervised machine learning algorithms, these features can be effectively used to classify healthy and diseased leaves with high accuracy.

In this context, the proposed work focuses on the development of an automated cotton leaf disease detection system using image processing and machine learning techniques implemented in MATLAB. The system follows a structured methodology comprising image acquisition, preprocessing, segmentation, feature extraction, and classification. By leveraging computational intelligence within the MATLAB environment, the proposed framework aims to provide a fast, accurate, and efficient solution for early cotton leaf disease diagnosis. This approach minimizes dependency on manual inspection, reduces time and labor requirements, and supports precision agriculture practices through data-driven crop health monitoring.

## 2. Methodology

The proposed methodology for Automated Cotton Leaf Disease Detection Using Image Processing and

Machine Learning in MATLAB follows a systematic computational framework comprising data acquisition, preprocessing, segmentation, feature extraction, and classification. All stages are implemented in MATLAB to ensure accuracy, repeatability, and efficient model development.

### 1. Data Collection

A dataset of cotton leaf images was prepared for training and testing the machine learning model. Images of both healthy and diseased leaves (including common infections such as bacterial blight, powdery mildew, and target spot) were collected through:

- Manual image acquisition using digital cameras and smartphones under controlled lighting conditions.
- Publicly available agricultural image datasets for cotton disease classification.

The collected images were labeled according to disease categories to facilitate supervised learning.

### 2. Image Preprocessing

Raw images often contain noise, background variations, and illumination inconsistencies. To standardize the dataset and enhance feature visibility, preprocessing operations were performed, including:

- Image resizing to a uniform resolution
- Noise removal using filtering techniques
- Contrast enhancement
- Conversion to grayscale (where required)

These steps improve image quality and ensure consistency for subsequent analysis.

### 3. Image Segmentation

Segmentation is performed to isolate the cotton leaf and infected regions from the background. In this work, threshold-based segmentation techniques are applied to convert the enhanced image into a binary format. This process separates the region of interest (leaf area) and highlights diseased spots, thereby reducing computational complexity and improving feature extraction accuracy.

### 4. Feature Extraction

Feature extraction involves deriving meaningful and discriminative parameters from the segmented images. The extracted features include:

- Color features (e.g., intensity variations, RGB components)
- Texture features (e.g., statistical texture measures)
- Shape and morphological features (e.g., area and spot distribution)

These features form the input vector for the machine learning classifier and enable differentiation between healthy and diseased leaves.

### 5. Image Classification

The extracted feature set is used to train a supervised machine learning model within the MATLAB environment. The trained classifier categorizes leaf images into predefined classes such as healthy or specific disease types. Model performance is evaluated using training and testing datasets to determine classification accuracy and reliability. This structured methodology ensures automated, accurate, and efficient cotton leaf disease detection, reducing reliance on annual inspection and supporting precision agricultural practices.

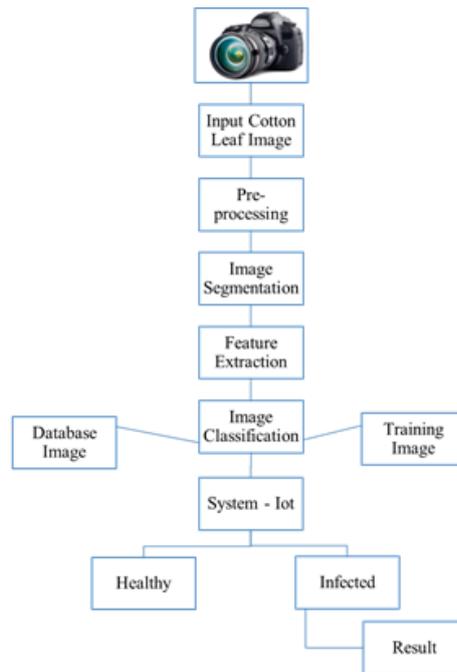


Fig: 1 Basic Flow of Infected Image Detection Algorithm

### 3. Dataset of Leaf

The dataset was collected from multiple sources, including agricultural databases, local farms, and research institutions. Data on cotton diseases were labelled based on expert agricultural knowledge. Appropriate datasets are required for all phases of object recognition research, from algorithm training to final testing and evaluation. The data collected from online databases were sourced by searching for disease and plant names across various public and academic repositories. The dataset was then classified into two primary categories: diseased leaves and healthy leaves and we are focused on spot which on leafed.

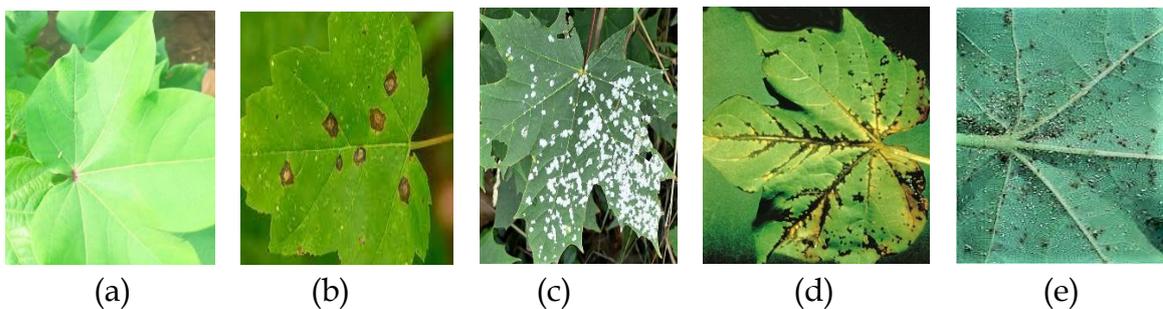


Fig: 2 (a) Healthy Leaf, (b) Target Spot (c) Powdery Mildew (d) Bacterial Blight (e) Aphids

Flow of testing Spot Cotton Leaves

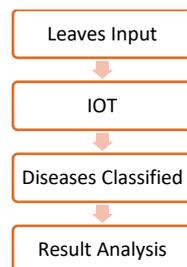


Fig: 3 Flow of Testing Spot Cotton Leaves

Cotton Spot Leaves Input

Flowing are data Set of Spot Leaves are given,



a) Data Set 1



b) Data Set 2,



c) Data Set 3



d) Data Set 4

#### 4. Training and Testing Procedure Accuracy of Testing Result With Images

Results with applied input and Spot Identification with Real Image are shown below.

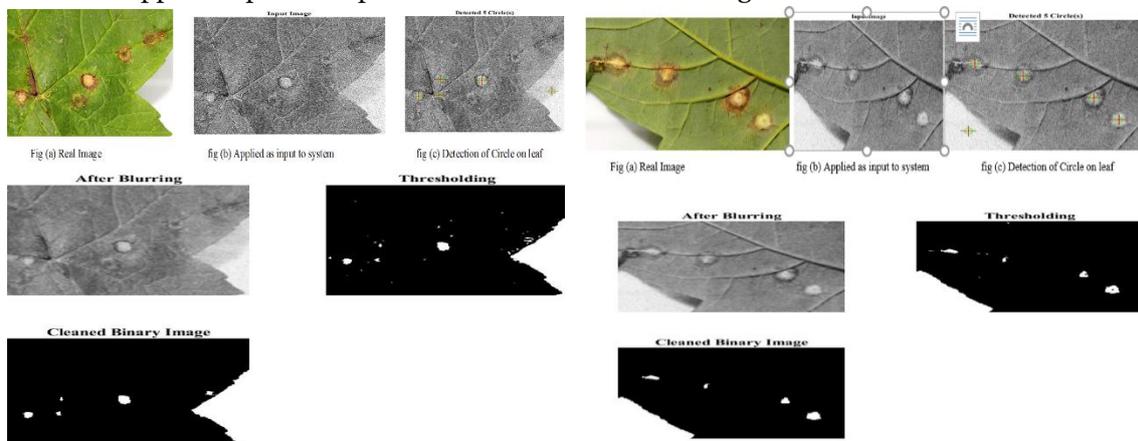


Fig (d) After Blurring, Thresholding and Cleaned Binary Image

Fig (d) After Blurring, Thresholding and Cleaned Binary Image

Result (a)

Result (b)

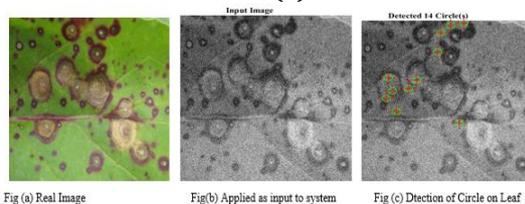


Fig (a) Real Image

Fig(b) Applied as input to system

Fig (c) Dtection of Circle on Leaf

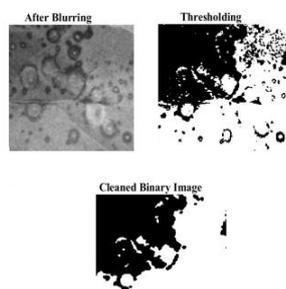


Fig (d) After Blurring, Thresholding and Cleaned Binary Image.

Result (c)



Fig (a) Real Image

Fig(b) Applied as input to system

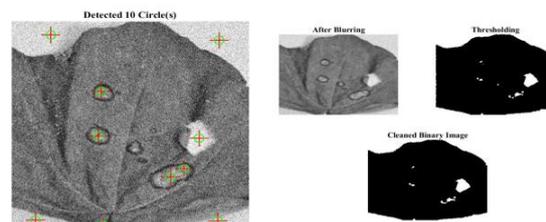


Fig (c) Dtection of Circle on Leaf

Fig (d) After Blurring, Thresholding and Cleaned Binary Image.

Result (d)

From the results above, it has correctly identified the spots on the leaf in all four cases with good .

#### 5. Conclusion

This paper presents a novel soft computing approach for the automated interpretation and prognosis of diseases in cotton crops. The work demonstrates how IoT technology can be effectively harnessed for early plant disease detection and real-time health monitoring. By integrating an IOT with environmental sensors, the system continuously tracks critical parameters that influence plant growth

and disease proliferation. The proposed solution provides farmers with convenient, user friendly access to live data, alerts, and actionable plant health information. The accuracy achieved in leaf disease classification is promising, indicating strong potential for real-world application

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