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# Pomegranate Fruit and Leaf Disease Prediction using Machine Learning

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**Abstract***: The impact of agricultural plant diseases on farmers' economic losses is significant. These diseases can harm various parts of the plant, including the roots, fruits, leaves, and stems. Early detection of these diseases is crucial for improving agricultural productivity. In traditional agricultural systems, disease recognition relies on the expertise of agricultural professionals and experienced farmers, but this often results in lower accuracy, leading to losses for farmers. To address this issue, numerous researchers have been exploring the use of soft computing and expert systems for more accurate plant disease recognition.*

*Visual identification of plant diseases is less reliable, as some diseases may not exhibit visible symptoms, or their symptoms may only become apparent late in the growing season, near the time of harvest. Fortunately, modern technology has the potential to significantly enhance agricultural production and sustainability. This paper offers a comprehensive review of techniques for detecting diseases in pomegranate plants. The study covers various stages of the disease detection process, including pre-processing, segmentation, feature extraction, and classification. Additionally, the paper provides a comparison of existing methods and highlights their limitations..*

**Keywords:** Pomegranate, Leaf diseases, Fruit diseases, Disease prediction, ML, Disease classification, Segmentation

## I. INTRODUCTION

Agricultural plant diseases have a significant impact on the economic losses experienced by farmers. These diseases can affect various parts of the plant, including the roots, fruits, leaves. Early detection of these diseases is crucial for improving agricultural productivity. In traditional agricultural systems, disease recognition heavily relies on the expertise of agricultural professionals and experienced farmers. However, this manual approach often results in lower accuracy, leading to financial losses for farmers. To address this issue, researchers have been exploring the use of soft computing and expert systems for more accurate plant disease recognition.

Visual identification of plant diseases is less reliable, as some diseases may not exhibit visible symptoms, or their symptoms may only become apparent late in the growing season, near the time of harvest. Fortunately, modern technology has the potential to significantly enhance agricultural production and sustainability. This paper offers a comprehensive review of techniques for detecting diseases in pomegranate plants. The study covers various stages of the disease detection process, including preprocessing, segmentation, feature extraction, and classification. Additionally, the paper provides a comparison of existing methods and highlights their limitations."

Agriculture is the cornerstone of human civilization and has been a pivotal force in its development. Throughout history, various agricultural practices, such as irrigation, crop rotation, fertilizers, and pesticides, have evolved significantly. By the early 19th century, these agricultural techniques had progressed to the point where the yield per unit of land far surpassed that of the Middle Ages. Consequently, effective management of all agricultural inputs is essential for maintaining the sustainability of this intricate system. Regrettably, the exclusive emphasis on improving productivity, often at the expense of ecological concerns, has led to environmental degradation.

Plant diseases stand out as a primary factor that diminishes both the quantity and quality of agricultural products. Diseases and insect pests pose significant threats to pomegranate cultivation, requiring meticulous diagnosis and timely

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intervention to safeguard crops from substantial losses. In pomegranate plants, diseases manifest in various parts, including fruits, stems, and leaves. Prominent diseases affecting pomegranate fruit include Bacterial Blight, Alternaria, and Phomopsis. The initial disease symptoms often appear on the stems, gradually spreading to the leaves and then to the fruits.

On leaves, the disease typically commences with small, irregular, water-soaked spots, measuring 2 to 5 mm in size, with a necrotic center of pinhead size. These spots are translucent when held up to light. As the disease progresses, the spots transition from light to dark brown and are encircled by distinctive water-soaked margins. In severe cases, infected leaves may fall off. High temperatures and elevated relative humidity create favorable conditions for the disease's spread. It can be transmitted to healthy plants through rain splashed by the wind and through infected cuttings when introduced to new areas.

Leaf area is a critical factor in plant growth analysis and photosynthesis. Various methods exist for measuring leaf area, including both destructive and non-destructive approaches. Destructive methods involve removing the leaf from the plant before measurement, while non-destructive methods capture the leaf's dimensions without the need for removal. Farmers can harness technology to assess the condition of leaves, identify potential diseases at an early stage, make informed decisions regarding treatment, and more. A methodology has been developed to determine the specific type of disease affecting a given leaf.

**PROBLEM STATEMENT**

When pomegranate plants become infected or attacked by diseases, there is a risk of the disease spreading to other areas of the plant. This not only results in a decrease in pomegranate yield but also leads to a reduction in the income of the farmers. Presently, pomegranate farmers rely on manual methods to determine the type of disease affecting their crops. However, this manual approach is prone to errors, and it is time-consuming for the farmers. Moreover, since pomegranate fields often cover extensive areas, the process of manually inspecting the entire field for disease detection can be quite time-consuming.

**OBJECTIVE**

- Generating a custom dataset of leaf & Fruit images.
- Investigating various segmentation techniques to optimize classification accuracy.
- Identifying the specific disease affecting the fruit & leaves.

## II. LITERATURE SURVEY

In light of the preceding survey, we will conduct a comparative analysis of various mechanisms employed for the assessment of fruit quality and the detection of diseases. Our approach will leverage deep learning techniques, specifically the Convolutional Neural Network (CNN) algorithm, to construct a robust training model. This model will be developed using an existing dataset tailored for pomegranate crops, allowing us to achieve precise and reliable detection of both fruit quality and diseases. CNN, as a class of deep learning neural networks, plays a pivotal role in our methodology. In essence, CNN acts as a machine learning algorithm adept at processing input images, discerning and assigning significance to different elements within those images. This proficiency enables CNN to differentially identify various aspects or objects in the image with remarkable accuracy.

| Paper Title | Mechanism | Advantages |
|---|---|---|
| 1. Research on Detection Technology of Various Fruit Disease Spots Based on Mask R-CNN | Mask R-CNN, improved target detection algorithm based on Faster RCNN, instance segmentation. | - Enhanced multiscale feature fusion. - Effective for large-scale targets in lesion detection. |
| 2. Detection of Quality in Orange Fruit Image using SVM Classifier | Support Vector Machine (SVM) for classification, Artificial Neural Network (ANN) modeling. | - SVM is an accurate classifier. - SVM is suitable for multi-class classification. |
| 3. A Deep Neural Network-based | Deep Learning (DL) with CNN, | - Effective in detecting defects in |

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|---|---|---|
| disease detection scheme for Citrus fruits | data augmentation. | citrus fruits. - Works well with a wide collection of data. - Data augmentation enhances the model's performance. |
| 4. Image-based Plant Disease Detection in Pomegranate Plant for Bacterial Blight | Thresholding segmentation, Local Binary Pattern feature extraction, Feed Forward Neural Network. | - Achieved greater accuracy in disease type detection. |
| 5. Fruit Quality Evaluation using Machine Learning: A Review | K-Nearest Neighbors (KNN), Support Vector Machine (SVM), Artificial Neural Network (ANN). | - SVM works well when there is a clear margin of separation between classes. - SVM is relatively memory-efficient. |
| 6. Fruit Disease Classification and Identification using Image Processing | K-means clustering for segmentation, multi-class support vector machine (SVM) for classification, GLCM for texture features representation. | - Achieves greater accuracy using GLCM, ISADH, CLBP, and ZM. |
| 7. Detection and Classification of Fruit Diseases using Image Processing & Cloud Computing | MATLAB for image processing, classification based on K-Means, Neural Network, and SVM techniques. | - Computation can be done with ease. |
| 9. A Review on Pomegranate Disease Classification Using Machine Learning and Image Segmentation Techniques | Pre-processing, features extraction using k-means clustering, Particle Swarm Optimization (PSO) technique for feature optimization, and machine learning. | - Machine learning algorithms provide good outcomes for disease detection and identification. |
| 10. Detection of Banana Leaf and Fruit Diseases Using Neural Networks | Image acquisition, image preprocessing, classification using ANN algorithm. | - Higher accuracy achieved with maximum threshold values in histogram results. |

## III. EXISTING SYSTEM

The rise and dissemination of diseases have become increasingly prevalent, largely attributed to climate and environmental factors. Traditionally, naked-eye observations have been the primary method employed for disease detection. However, due to variables such as varying working conditions, individual judgment, and levels of fatigue, the grading results frequently exhibit inconsistencies among different inspectors. It is evident that certain approaches have proven to be less accurate, mainly due to the presence of noise in the input images. In pursuit of more reliable disease detection methods.

## PROPOSED SYSTEM

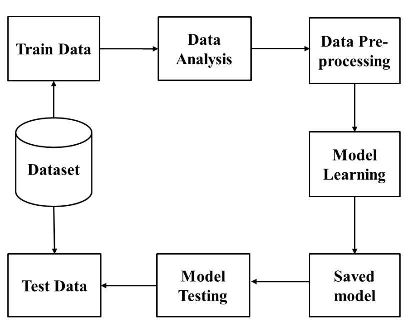


Fig.1 System Architecture

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A proposed system for the recognition and classification of fruit diseases employs various image processing techniques. This work is structured into four main stages: image acquisition, image preprocessing, image descriptor extraction, and disease classification and identification [10]. The diagram in Figure 1 outlines this approach, consisting of two primary phases: the training stage and the testing stage.

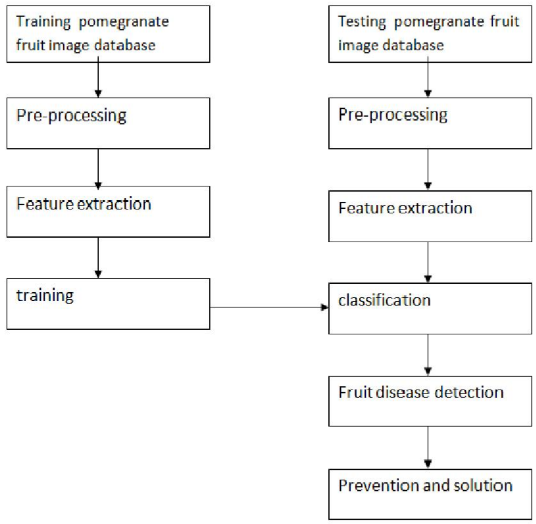


Fig.2 Proposed Framework

**A. Image Acquisition:** Images of both healthy and diseased pomegranate fruits are collected from six different pomegranate varieties. These images are captured using a digital camera and are saved in JPEG format.

**B. Image Preprocessing**: Initially, the captured images are resized to a standard resolution to enhance computational efficiency and improve performance. Various image processing techniques are employed to remove noise. This includes using a Gaussian low-pass filter on the resized images to reduce high-edge artifacts [8]. A color-based image segmentation using k-means clustering is utilized to separate the affected area from the healthy part.

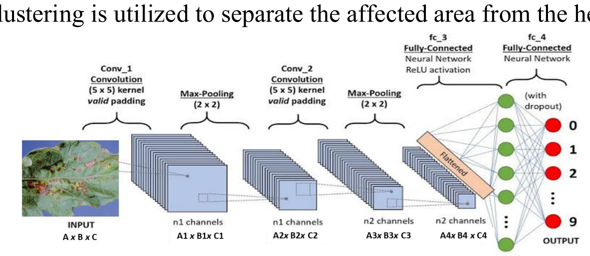


Fig. 3 Image Preprocessing

**C. Feature Extraction:** In this step, significant information known as image descriptors or features is extracted from the image to reduce dimensionality.

**D. Categorization of Diseases:** The presented work involves the creation of a Probabilistic Neural Network (PNN) classifier that identifies the type of diseases based on color and texture features extracted from the image. This classifier is developed in four stages: a system object is created from the image descriptor database, a testing dataset is randomly selected, a training dataset is compiled, and the network is trained using backpropagation with a two-layer feedforward neural network containing 20 neurons in the hidden layer. The system is trained until the mean square error (MSE) is minimized. After training, the system acts as a classifier, taking the features of the query image as input and producing the desired output, classifying it as Bacterial Blight or Wilt complex. Additionally, Support Vector Machine (SVM) and K-Nearest Neighbors (KNN) classifiers are used for disease categorization.

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**E. Disease Detection:**

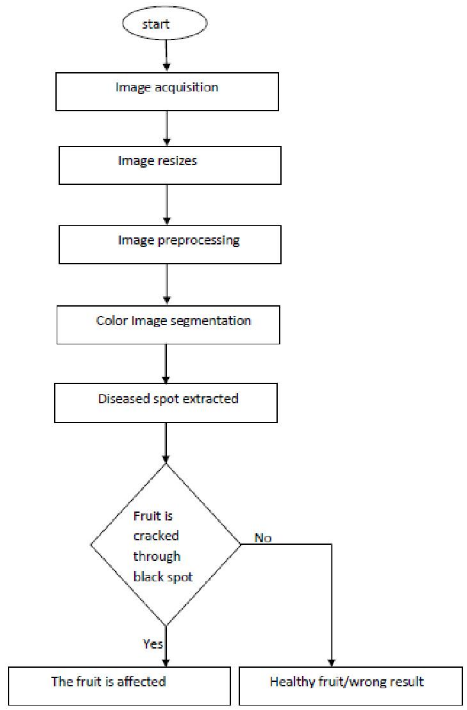


Fig.4 Disease detection Process

Image preprocessing is conducted on the captured image, and algorithms are employed to remove shadows present during disease detection. Image correction algorithms are also applied. To eliminate shadows, morphology operations such as erosion and dilation are used. In the image post-processing phase, the affected part is extracted using the k-means clustering technique, and its features are analyzed. The pomegranate fruit is categorized based on the characteristics observed. For instance, the presence of dark spots, surrounded by a yellow edge, indicates Bacterial Blight. Large patches may signify scab, while fruit splits may be attributed to anthracnose. The combination of the observed features leads to the accurate identification of pomegranate fruit diseases.

## V. DISCUSSION AND SUMMARY

Several points for future research are outlined to advance the current state of the art:

- Most disease detection research has relied on manually collected databases. The lack of accessible and comprehensive datasets poses a major challenge for vision-based plant disease detection. Developing standard datasets for Pomegranate disease detection is essential.
- Addressing cases where two diseases are present on the same fruit or different disorders exhibit similar symptoms is a challenging research area. Investigating accurate methods for identifying and differentiating multiple diseases in the same fruit, including disease stages, is crucial.
- Existing research primarily focuses on a limited number of diseases. There is a need to develop techniques capable of identifying and classifying a broader range of pomegranate fruit diseases, including recent ones.
- Some systems rely on manual datasets, where each disease may have different stages with varying symptoms. A significant gap exists in the detection of different disease stages and providing precise solutions for these diseases.
- Many existing systems are semi-automatic. Collaborations with agricultural universities and research centers are required to develop fully automated systems that can handle new diseases and enhance disease detection accuracy.

- A real-time system for pomegranate plant disease detection has not been proposed in existing literature. There is a need to explore algorithms for image segmentation, fusion of disease features, and selection methods to improve the output of such a system.
- Developing a decision support system or application that is easily accessible to farmers is essential. Such a system could allow farmers to capture plant images using sensor devices and send them to the decision support system. The system would then detect plant diseases at their initial stages and provide treatment recommendations.
- Existing plant disease detection systems have limitations concerning techniques, database size, image quality, and variations in disease symptoms based on pomegranate plant varieties.

## VI. ADVANTAGES

- Continuous expert monitoring is necessary, which can be prohibitively expensive for extensive farms.
- The cost can be high, depending on the system employed and the number of detectors acquired.

## VII. FUTURE SCOPE

The current study's scope can be expanded to encompass the detection and classification of various diseases not only in fruits but also in leaves and flower images. Furthermore, this research can be extended to incorporate the use of three-dimensional (3-D) images. Such a system has the potential to find applications in solar greenhouses. Additionally, it can be broadened to encompass the identification, detection, and classification of different plants across a wide range of agricultural products. Moreover, this work can be further extended to provide online resources and information regarding various plants to both biological experts and farmers, thereby assisting them in their research and agricultural endeavors.

## VIII. CONCLUSION

The primary objective of this research paper is to enhance overall efficiency and effectiveness through the proposed system, addressing the limitations of manual fruit disease detection processes. The field of fruit disease detection is of significant importance and efficiency. The core aim is to provide an overview of established methods for detecting and classifying fruit diseases, highlighting recent advancements in the field. The proposed techniques enable the effective analysis of both healthy and diseased fruits, with a specific focus on identifying Bacterial Blight disease in pomegranate fruit. Once a disease is identified, appropriate treatment measures are recommended based on expert guidance from agricultural professionals to mitigate further losses.

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