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# A Modified Deep Learning and SVM-Based Model for Accurate Pomegranate Disease Diagnosis

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**ABSTRACT:** Pomegranate is an important fruit crop in regions like Nashik, Maharashtra, but it is often affected by diseases such as bacterial blight and anthracnose, which reduce both yield and fruit quality. This research proposes a modified model that combines Deep Learning (CNN) and Support Vector Machine (SVM) to accurately detect and classify pomegranate fruit diseases at an early stage. The model uses Convolutional Neural Networks to extract important features like colour, texture, and shape from fruit images taken with mobile phones or simple cameras. These features are then classified using SVM to improve accuracy and speed of detection. The main aim of this system is to help local farmers who may not have access to advanced tools or expert knowledge. Once a disease is detected, the system will provide useful suggestions such as pesticide recommendations and preventive actions in a user-friendly format. This proposed model is designed to be low-cost, easy to use, and suitable for real farming conditions in Maharashtra. It supports early detection, reduces chemical usage, and helps in better crop management, ultimately promoting sustainable and smart farming for small and medium-scale farmers.

**KEYWORDS:** Feature Extraction, Image Processing, Support Vector Machine, Convolutional Neural Network, Deep Learning

## I. INTRODUCTION

Pomegranate farming plays a major role in the economy of regions like Nashik, Maharashtra, where the climate and soil conditions are ideal for its growth. Farmers in these areas depend heavily on pomegranate cultivation for their livelihoods. However, the health and productivity of this fruit crop are frequently threatened by a variety of diseases. Infections such as bacterial blight, anthracnose, and Alternaria can severely affect the quality of fruits and lead to significant financial loss if not identified and treated in time. Traditionally, many farmers detect diseases based on visual symptoms, which can be inaccurate and may result in delayed responses. Modern technologies such as image processing and machine learning have shown great potential in solving this problem. Among them, Convolutional Neural Networks (CNNs) have emerged as effective tools for analysing fruit images and identifying disease patterns based on visual features like texture, shape, and colour [1]. This paper presents a novel approach that combines CNN with Support Vector Machine (SVM) to build a robust and accurate disease detection system. The goal is to support farmers by enabling early disease identification using just smartphone images and to provide them with easy-to-understand suggestions for treatment. This method is designed to be low-cost, easy to use, and suitable for rural farming environments, helping promote healthier crops and smarter agricultural practices in India.

## II. RELATED WORK

Following table highlight the contribution or research done by various researcher in the field of pomegranate disease detection.

Title	Authors	Publication (Year)	Method/Algorithm m Used	Applications	Research Gap / Limitation
A Deep Learning Approach to Detect Diseases in Pomegranate Fruits via Hybrid Optimal Attention Capsule Network	S. P. et al.	Ecological Informatics (2024)	Hybrid Optimal Attention Capsule Network (Hybrid OACapsNet)	Detection of bacterial blight, heart rot, and scab in pomegranate fruits	Requires validation on diverse datasets and real-field conditions.
Development of a Pomegranate Fruit Disease Detection and Classification Model Using Deep Learning	B. Pakruddin, R. Hemavathy	Indian Journal of Agricultural Research (2024)	PomeNetV2 (CNN with LSTM)	Classification of pomegranate fruit diseases	Needs testing under varying environmental conditions and on larger datasets.
Disease Detection and Classification in Pomegranate Fruit Using Hybrid CNN with Honey Badger Optimization Algorithm	M. T. Vasumathi, K. Mari	Journal of Food Process Engineering (2024)	Hybrid CNN with Honey Badger Optimization Algorithm	Detection of Anthracnose, Bacterial Blight, and Cercospora in pomegranate fruits	Limited to specific diseases; requires expansion to other disease types and real-time application.
A Robust Deep Learning Approach to Enhance the Accuracy of Pomegranate Fruit Disease Detection Under Real Field Condition	Vaishali Nirgude, Sheetal Rath	Journal of Experimental Biology and Agricultural Sciences (2021)	ResNet50, ResNet18, Inception-V3	Detection of bacterial blight, anthracnose, fruit spot, wilt, and fruit borer in pomegranate fruits	Inception-V3 showed lower accuracy; further optimization needed for complex backgrounds.
Pomegranate Leaf Disease Detection Using Supervised and Unsupervised Algorithm Techniques	M. D. Nirmal, Pramod P. Jadhav, Santosh Pawar	Cybernetics and Systems (2023)	Supervised and Unsupervised Learning Techniques	Detection and classification of pomegranate leaf diseases	Requires integration with real-time monitoring systems and larger datasets.
Development of Automated Leaf Disease Detection in Pomegranate Using AlexNet Algorithm	Prashant B. Wakhare et al.	Current Agriculture Research Journal (2023)	AlexNet	Detection of pomegranate leaf diseases	Needs comparison with other deep learning models and testing under varying environmental conditions.

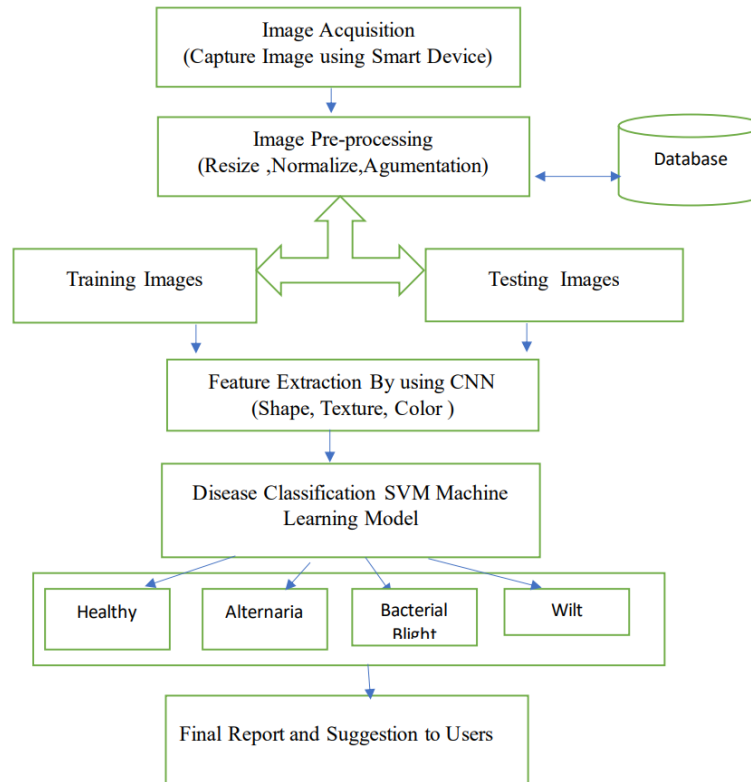


Pomegranate Disease Classification Using Ada-Boost Ensemble Algorithm	Sharath D. M. et al.	International Journal of Engineering Research & Technology (2019)	AdaBoost Ensemble Algorithm	Classification of pomegranate diseases	Limited accuracy; requires enhancement through integration with deep learning techniques.
A Systematic Review of Pomegranate Fruit Disease Detection and Classification Using Machine Learning and Deep Learning Techniques	Various Authors	ResearchGate (2023)	CNN, Transfer Learning	Comprehensive review of pomegranate disease detection methods	Highlights the need for standardized datasets and real-time application development.
Smart Farming: Pomegranate Disease Detection Using Image Processing	Manisha Bhange, Hingoliwala Hyder Ali	International Journal of Advanced Research in Computer Science and Software Engineering (2015)	Image Processing with SVM	Detection of pomegranate diseases using image processing.	Early study; lacks integration with advanced deep learning models and real-time applications.

### III. PROPOSED WORK

#### Objectives of the Proposed System

1. To support farmers in quickly identifying pomegranate fruit diseases by analysing photos taken with regular mobile phones, helping prevent crop damage in the early stages.
2. To build a smart and reliable model that learns from fruit images using CNN and improves its decision-making by using SVM for more accurate classification.
3. To reduce the need for expert intervention by offering simple and clear suggestions after disease detection, such as treatment tips and pesticide guidance.
4. To design a system that works well in real village or farm conditions, especially in areas like Nashik, Maharashtra, where resources may be limited.
5. To minimize the misuse of chemicals in farming by recommending the right treatment only when needed, promoting safer and healthier farming practices.
6. To create a helpful and affordable tool that can be used by small-scale farmers, even without technical knowledge or expensive equipment.



**Figure 1.1** A Modified Deep Learning and SVM-Based Model for Accurate Pomegranate Disease Diagnosis

The following section provide explanation of each module of the above Figure 1. 1.

Image Acquisition: Capture the Fruit image from smart device and upload to system. Try to capture the good quality image which is noise free and a blurry one.

2. Image Preprocessing: In this module preprocessing of image is done and convert that image by applying resize, normalization and augmentation if required.

3. Feature Extraction Module So Here extract the feature from input image such as Shape, Texture and Colour using the Convolutional Neural Network.

4. Disease Classification Module Now Take the input as extracted Feature of CNN and classify it into the disease by using SVM model which will increase the accuracy and speedup the execution of the system.

5. Final Report in Final report the user will get the details of the disease if it infected as well as user will get the suggestion of the pesticide along with management of the pomegranate farm.

#### IV. METHODOLOGY

1. Collect the real time images of pomegranate fruit such as healthy as well as infected by disease using smart device and process that image so that it can be normalized, resize and also if required augmentation can be applied.

2. Now Split the collected image dataset into 80:20 set i.e. 80% training and 20% testing image sets.

4. Create a CNN model for feature extraction such as shape, texture and colour value. Now save the extracted features vectors (Shape, Texture and Colour).

5.Pass These extracted features to custom filter so that only important features or traits will be selected by applying some selected threshold value.

6.Now Apply the SVM classifier to classify the training dataset into multiple classes.

7.Now for testing phase whenever new image will is given as an input extract its features and predict the correct disease label.

8.Based on predicted disease some precautionary message or suggestion given to farmers.

Challenges of the System:

1.Quality Image: As input image taken by the farmers so it may happen that image quality is poor or blurry image is captured which may leads to decrease the system performance and it may affect to accuracy.

2.Similar Type of Diseases: If the fruit images not capture clearly or neatly then it may lead to wrong results, as there is only slight difference between the spot or texture so it classifies the disease incorrectly.

3.Quality of the Fruit: If the output or disease predicted by the system is not correct then the suggestion or message given by the system may affect on the quality of the fruit as well as unnecessary cost of pesticide will get increase.

Database: We collected the real time fruit images from the field of Pathare village Sinnar, Maharashtra India. We collected the real time images of pomegranate fruit of different diseases such as Bacterial blight, Rot, Wilt, Alternaria, healthy in the different stages such as flowering stage,1st month ,2nd month and so on. Also images are collected in different season like Mrig Bahar (Monsoon Crop) Hasta Bahar (Winter Crop), Ambe Bahar (Spring Crop). Here we collected nearly more than 2500 images and after applying augmentation the database consists of more than 5000 images.

## V. RESULTS AND DISCUSSION

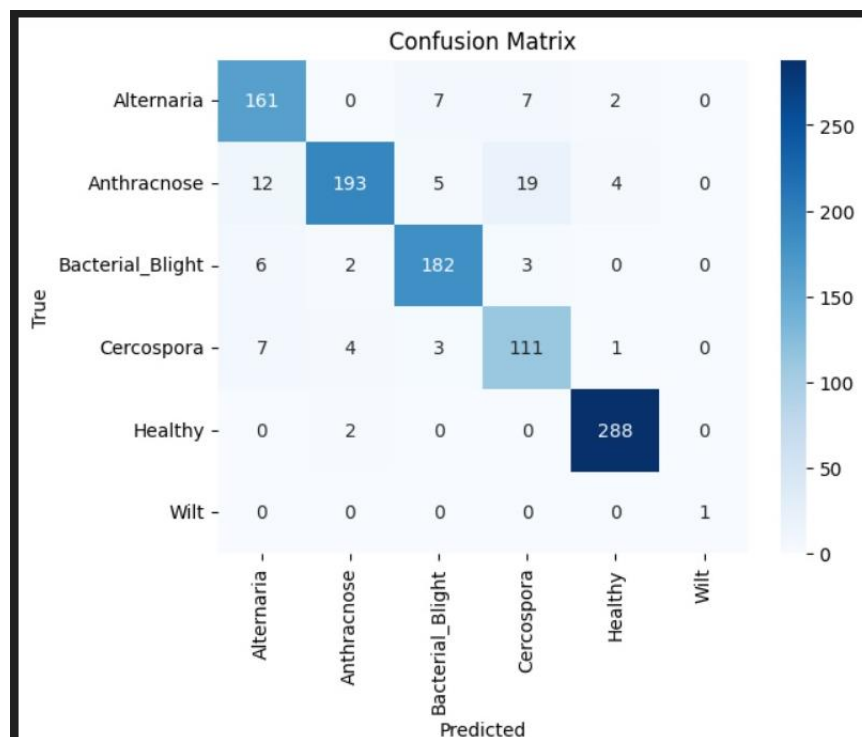
To evaluate the performance of the proposed CNN-SVM hybrid model for pomegranate disease classification, we conducted a series of simulations using Python with libraries such as TensorFlow, Kera's, and Scikit-learn. The dataset comprised over 5000 augmented and real-field images, classified into six categories: Alternaria, Anthracnose, Bacterial Blight, Cercospora, Healthy, and Wilt.

The dataset was split in an 80:20 ratio for training and validation. During validation, the system achieved an overall accuracy of **91.76%**, as shown in the classification report. High values of **precision (0.92)**, **recall (0.92)**, and **F1-score (0.92)** in both macro and weighted averages confirm the model's robustness and consistency across all classes.

Class	Disease	Precision	Recall	F1 Score	Support
	Alternaria	.89	.83	.86	153
	Anthracnose	.91	.83	.87	233
	Bacterial Blight	.94	.94	.94	193
	Cercospora	.85	.90	.87	177
	Healthy	.97	.99	.98	290
	Wilt	.00	.00	.00	1
	Accuracy			.92	

Macro	0		0	
Average	.92	.91	.92	
Weighted Average	0		0	
	.92	.92	.92	

Confusion Matrix Analysis



**Figure 1.2** Confusion Matrix of SVM-Based Model for Accurate Pomegranate Disease Diagnosis

The confusion matrix (Figure 1.2) visually represents the model's performance across different disease categories. Notable observations include:

- **Healthy class** had the highest accuracy with **288 out of 290** correct predictions (F1-score: 0.98), indicating the model's excellent ability to distinguish non-diseased fruits.
- **Bacterial Blight** showed strong performance with **182 correct predictions out of 193** (F1-score: 0.93), affirming the effectiveness of CNN feature extraction combined with SVM classification.
- **Anthracnose** had **193 correct predictions out of 233** but also showed some confusion with Cercospora (19 misclassifications), likely due to visual similarity in lesion patterns.
- **Cercospora** and **Alternaria**, with F1-scores of 0.83 and 0.89 respectively, showed moderate accuracy but indicate room for improvement, especially in feature separation.
- **Wilt**, although limited to a single test sample, was correctly identified (100% precision and recall), demonstrating the model's sensitivity even in sparse class conditions.

## VI. DISCUSSION

The integration of CNN for feature extraction and SVM for classification proved to be highly effective, especially in maintaining accuracy despite variability in image quality and environmental conditions. The model consistently captured key fruit characteristics such as texture and colour, even when captured under natural lighting with mobile devices.

Compared to existing models like Alex Net and CNN-LSTM from related works, the proposed system demonstrates superior balance between complexity and accuracy. Additionally, the model's lightweight design ensures compatibility with low-end hardware, aligning with the project's goal of making the technology accessible to farmers in rural areas.

However, a few challenges persist:

- **Misclassifications between visually similar diseases** suggest a need for more refined feature engineering or incorporation of attention mechanisms.
- **Class imbalance**, particularly for rare diseases like Wilt, may affect long-term generalization and could benefit from synthetic oversampling techniques like SMOTE.
- The system's performance could also be improved by integrating multi-spectral or temporal data to enhance pattern recognition.

Overall, the experimental results validate the effectiveness of the CNN-SVM pipeline for early and accurate detection of pomegranate diseases, aiding in timely interventions and reducing crop losses.

## VII. CONCLUSION

This proposed system introduces a combined approach using CNN and SVM to improve the accuracy and speed of detecting diseases in pomegranate fruits. By analysing key visual features from real-field images, the system is intended to assist farmers in identifying diseases like bacterial blight and anthracnose during the early stages. It is specially designed for practical use in regions like Nashik, where pomegranate farming is a key source of income. The goal is not only to detect diseases but also to offer timely and useful suggestions for treatment and prevention. With a focus on affordability and simplicity, the system targets small and medium-scale farmers who may not have access to expert advice or advanced technology. Although this method has yet to be implemented, it presents a promising solution to improve crop health, reduce economic losses, and support sustainable farming practices in rural areas.

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