Journal of Information Systems Engineering and Management
2025, 10(35s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

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

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ARTICLE INFO
Received: 20 Jan 2025
Revised: 15 Feb 2025
Accepted: 25 March 2025

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 color, texture, and shape from fruit images taken with mobile phones or simple cameras. These features are then classified using SVM which gives accuracy result 85% and speed of detection is increased.

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.

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

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 analyzing fruit images and identifying disease patterns based on visual features like texture, shape, and color [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.

Literature Review:

Following Table 1 highlight the contribution or research done by various researcher in the field of pomegranate disease detection.

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Table 1. Literature Study

Title	Authors	Publication (Year)	Method/Algorithm 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 Rathi	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.

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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 techniques	Early study; lacks integration with advanced deep learning models and real-time applications.
Grading & Identification of Disease in Pomegranate Leaf and Fruit	Tejal Deshpande, Sharmila Sengupta, K. S. Raghuvanshi	International Journal of Computer Applications (2014)	Image Processing Techniques	Grading and identification of diseases in pomegranate leaves and fruits	Requires incorporation of machine learning techniques for improved accuracy.
An Effective Pomegranate Fruit Classification Based on CNN-LSTM Deep Learning Models	M. T. Vasumathi, Kamarasan Mari	International Journal of Advanced Computer Science and Applications (2021)	CNN-LSTM	Classification of pomegranate fruit diseases	Needs validation on larger and more diverse datasets.

Objectives of the System

1. **To support farmers in quickly identifying pomegranate fruit diseases** by analyzing 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.

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6. **To create a helpful and affordable tool** that can be used by small-scale farmers, even without technical knowledge or expensive equipment.

System Details

Following Figure 1. A Modified Deep Learning and SVM-Based Model for Accurate Pomegranate Disease Diagnosis shows the details breakdown structure of the system and divided it into number of modules.

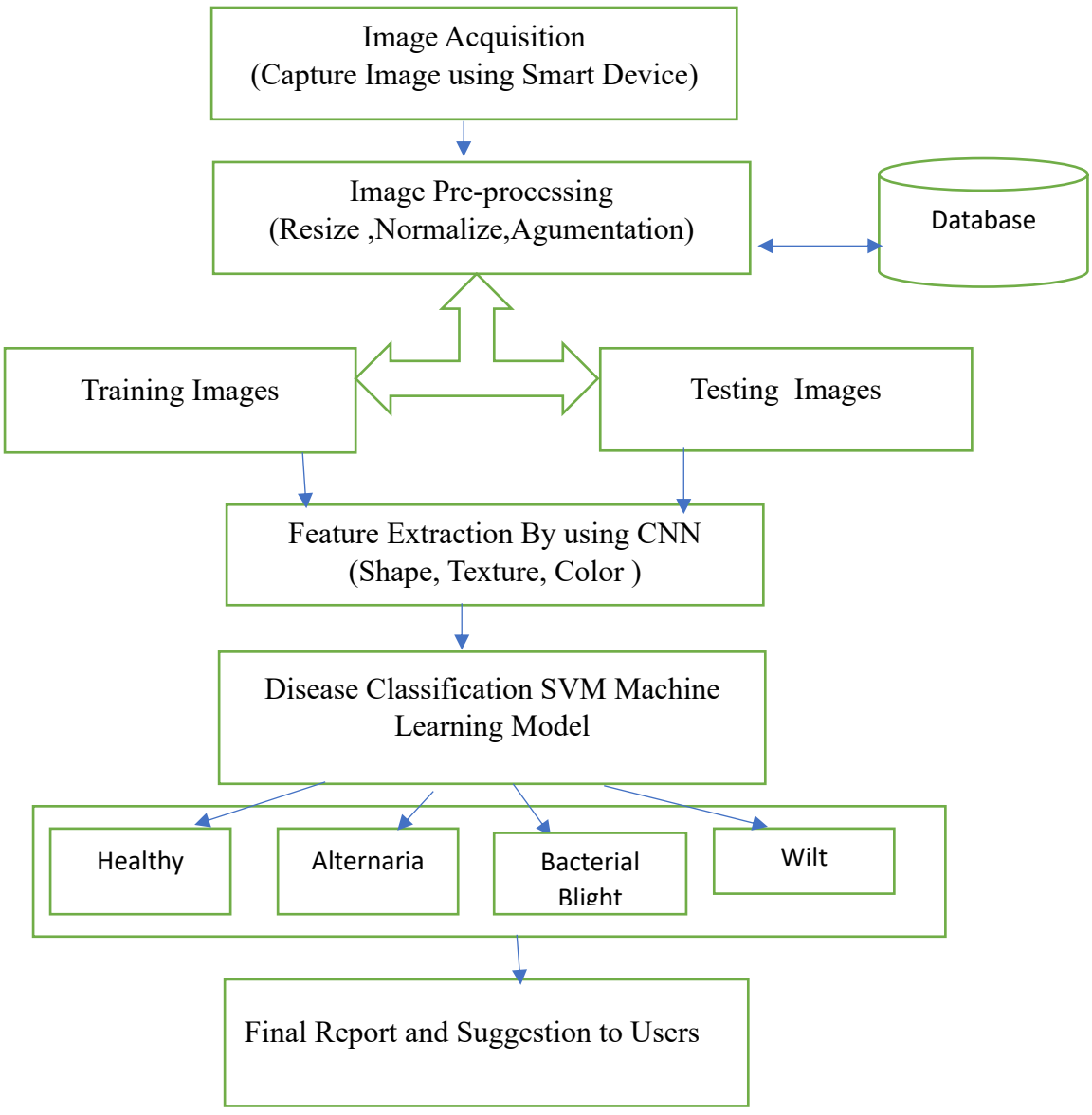

Figure.1 A Modified Deep Learning and SVM-Based Model for Accurate Pomegranate Disease Diagnosis

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:

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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 Color 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.

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 color value. Now save the extracted features vectors (Shape ,Texture and Color).
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 a 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.Simillar 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 its classify 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 consist of more than 5000 images.

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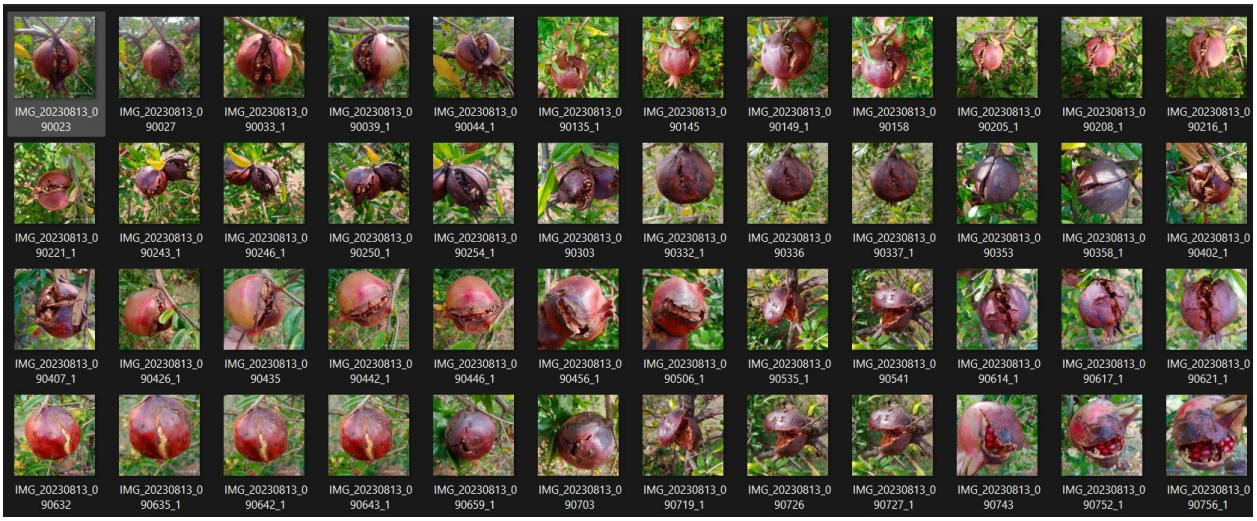

Result and Discussion

In this study to optimize the performance of the system features of the images are extracted by using Convolutional Neural Networks and those extracted features are classified into disease by using SVM model. The proposed model achieved an overall accuracy of 85% across four classes on a dataset as shown in Table 2. The model demonstrates the strong performance for healthy class but varying the performance in other classes.

Table 2.Classification Report

Disease Class	Precision	Recall	F1 -Score	Support
Healthy	0.99	0.99	0.99	266
Alternaria	0.82	0.80	0.81	223
Bacterial Blight	0.75	0.72	0.73	198
Wilt	0.90	0.67	0.77	3
Overall Accuracy=85%				690

Additionally, the confusion matrix of the model with Figure 2(a) shows the classification results for each class. Each cell in the matrix represents the model's prediction accuracy for a given true label and predicted label. Figure 2(b) shows the bar-chart representation of classification metrics by class.

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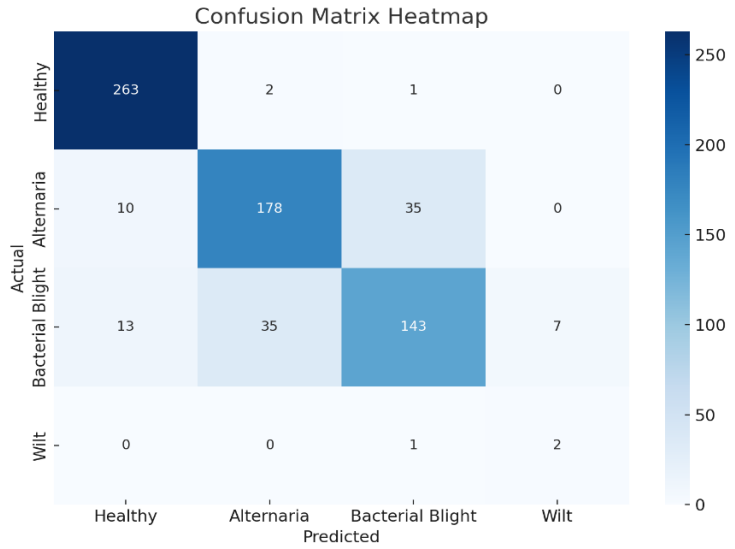

Figure 2(a)Confusion Matrix

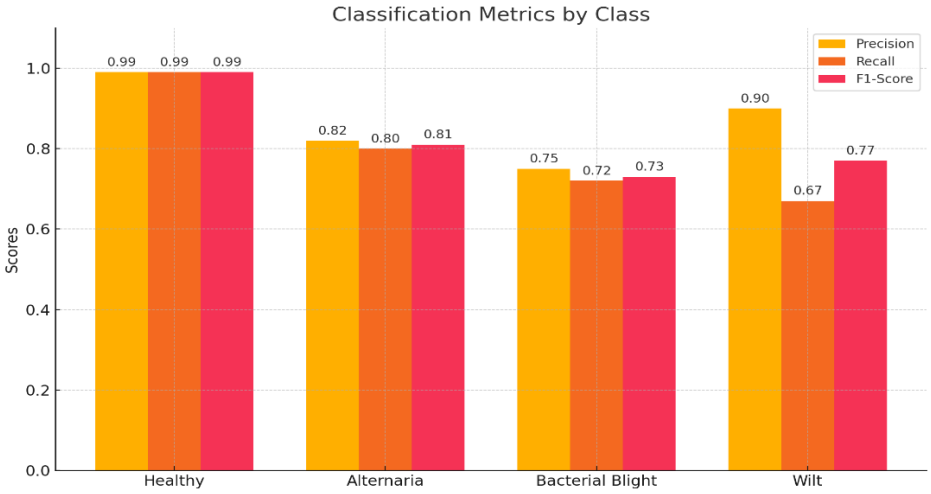

Figure 2(b). Classification Metrics by Class

Conclusion

The system introduced a combined approach using CNN and SVM to improve the accuracy and speed of detecting diseases in pomegranate fruits. By analyzing 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. In this system features of the images are extracted using CNN and classified by using SVM model. The system gives the accuracy result is 85%.

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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