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Fruit Disease Identification and Analysis using Image Processing-A Review

Jagadeesha B G[1] Dr. Ramesh Hegde[2]
[1]*Department of Computer Science The Natioanal College, Basavanagudi, Bangalore-560004*
[2]*Department of Physics, Acharya Institute of Technology Soladevanhalli, Bangalore-560107*

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ABSTRACT: Agriculture is the backbone of the Indian ecosystem. Over 58% of the Indian population is heavily dependent on agricultural income for their daily living. Nourishment crops, cash crops, farmstead crops, and viniculture crops. Agriculturalist's basic needs are territory specialists for guiding and observing the weekly development of cultivated harvests. Therefore, it is crucial to develop an efficient automation method to support assistance for getting healthier crops and revenue per hectare of their land. Through this article, we would like to elaborate on a few important procedures and practices established by numerous examiners for uncovering syndromes in fruits, using image processing techniques. It comprises the investigation in disease identification mechanism and cataloging of fruits like citrus, apple, pomegranate and grapes.
Keywords: Agriculture, Disease, Feature extraction, Segmentation, Classification

I. INTRODUCTION

India's climate supports to grow different types of fruits and vegetables. After China, India is in the second position in fruits and vegetable production in the world. As published by the National Horticulture Board's National Horticulture Database, 90.2 million metric tons of fruit produced by India in 2015-16 [18]. The top five fruits producing states are Uttar Pradesh, Andra Pradesh, Maharashtra, Gujarat, and Karnataka. Fruits such as apple, banana, grape, citrus, mango, guava, and papaya are cultivated in India. India ranks first[19] in the production of fruits like bananas (25.7 percent), papayas (43.6 percent), and also mangoes (40.4 percent). About 20% of the nation's growth comes from fruit production. Because of inappropriate farming of fruits and physical examination, there has been a decline in quality fruit production. It is therefore very important that fruit diseases are automatically detected using image processing.

II. FRUIT DISEASES

Fruits are affected by different types of diseases. Most of the diseases caused by bacteria and fungus. Apple scab, apple rot, and also apple blotch are some of the frequently appearing apple fruit diseases which are well addressed in[1]. Apple scabs are caused by a fungus, which appears in the form of brown or gray cork-like spots. Apple rot infections create a little depressed, spherical black or brown acne that could be surrounded via a red colour circle. Apple blotch spot is caused by a fungus which occurs as a dark spot, rough or lobed boundaries on the surface of the fruit. Pomegranate fruit diseases are Cercospora, Fruit rot, Alternaria fruit and Bacterial blight. Symptoms of the disease can initially be detected on the portion of the stem that slowly penetrates into the fruit. [2].

Grapes are affected by block rot, powdery mildew and downy mildew[3].Black rot disease is widespread and serious disease for grapes.Powdery mildew produced by Uncinulanecator fungus; it is also referred to as Oidium. This fungus affects only grapes and a few other associated plants.Downy is extremely destructive grapevine infection. In the grape cultivation areas around the world, silky mildew happens during flowering, autumn, rainy season and if temperature attains toa level of 10˚C (50˚F)[3].Diseases such as black spot, canker, greening and scab are affecting citrus fruit.

III. LITERATURE SURVEY

Many attempts have been made on the identification and analysis of plant diseases using the techniques of image processing. An explanation for the identification and classifying the apple fruit diseases was suggested by Dubey and Jalal [1] and experimentally authenticated. The technique detects diseases of apples such as apple rot, apple blotch, and apple scab. Segmentation of images is conducted by cluster technique. Hue histogram, complete local binary patterns are used for extracting image features. Detection and categorization of the disease are done with a multiclass support vector machine.

But, they are not combined with more than one type of feature. The automated grading system used to grade pomegranate leaf diseases, such as bacterial blight, was proposed by Deshpande et al.[4] in 2014.. Segmentation is done using k-means clustering. Edge Detection algorithms have been used along with black spot detection algorithm. Jagadeesh D Pujari et al. [5] presented a solution using image processing methods to recognize and classify symptoms of the fungal disease for various crops in agriculture/horticulture. The affected images of fruit crops are collected using various symptoms of fungal disease and then are graded. Using the nearest neighbor (NN) classifier, the images are classified into normal, partially affected, seriously affected, and moderately affected. The proposed method is found to be applicable for fungal diseases only.

In 2015, Bhavini and Sheshang[6] surveyed the techniques used to identify diseases in apple fruit. Bhange and Hingoliwala[7] proposed internet based technique for detecting disease of the pomegranate fruit. In the suggested approach CCV and color, morphology feature vectors are used for extracting the features. Support vector machine (SVM) algorithm is used for training the images and also for classification. It is observed that the proposed web-based method only works for the Bacterial Blight ("Telya") disease of the pomegranate fruit. The overall precision of the system is calculated to be 82 percent using fewer datasets. Ashwini Awate et al.

[3] introduced a tool to diagnose and categorize external disease ins ide fruits. Images are cataloged and mapped on the basis of four feature vectors of color, morphology, texture, and hole structure on the fruit according to their respective disease categories. The artificial neural network (ANN) is used for pattern matching and disease classification. For the identification of grape, apple, and pomegranate fruit diseases, the suggested approach is used

In 2016, Gaikwad and Karnade [2] suggested a novel method to automatically identify and grade the pomegranate fruit disease. A system for the classification of apple disease using color, texture, and shape-dependent characteristics was proposed by Dubey and Jalal [8]. The identification of infected fruit components is carried out using the k-means clustering method and for segmentation multicast support vector machine (MSVM) is used. To shape the more distinctive characteristic, the various types of features are combined. A hybrid method was proposed by Bhavini J. and Sheshang D[9] for the identification and classification of apple fruit diseases using the Random Forest Classifier. Segmentation is performed using the k-means method. The accuracy of classification is enhanced by combining different color and texture characteristics such as CCV, LTP, CLBP GCH, LBP, Gabor. Random forest classifier takes more time for training. Ranjith K N et al.[10]experimentally validated a method of identification and categorization of fruit diseases. Segmentation is done using c-means and k-means clustering algorithms. Segmentation algorithm performance assessment is done by calculating parameters such as Under-segmentation Measure (MUS), Over-segmentation Measure (MOS), Dice Similarity Measure (DSM), Error Rate (ERR). To identify the diseases in fruits, the k-Nearest Neighbours algorithm classifier is used. Data sets with less number of images are taken for the experiment.

In 2017, Gaikwad et al.[11] anticipated a solution for fruit disease detection and classification. For image segmentation, the k-means clustering approach is used and the classification is done by SVM classifier. SVM algorithm is not suitable for large data sets. Bharate and shirodkar[12] reviewed different techniques for the recognition of diseases in plants. This includes studies on the identification of diseases in plants such as peppers, pomegranates, apples, grapes tomatoes, etc.

In 2018,Shafi et al. [13] suggested a technique for identification of fruit disease using a supervised learning technique for classifying images. Global Thresholding is used to segment the infected portionof the input images. Various features are extracted and multiclass supportvector machine (MSVM) method is used for classification. In the proposed work one type of fruit disease be able to detected from a single image and classification result affected by the different background color of the image.

In 2019, Behera et al.[14]suggested a technique for fruit identification and disease investigation by machine-learning techniques. The fruit identification and quality assessment are based on various features, such as the texture, color, and appearance of defects. Features are extracted by using Gray-Level Co-Occurrence Matrix (GLCM). Clustering is done using the k-means algorithm and classification is done by using the Multiclass Support Vector Machine (MSVM) classifier. In the classification of healthy and defected fruit, the suggested technique achieved 100% accuracy. Fuzzy logic was also used to assess the severity of illnesses. S. Abirami and M. Thilagavathi[15] worked on fruit disease classification. Thresholding is used for segmentation and the Local Binary Pattern (LBP) method is used for feature extraction. Classification of fungal and bacterial fruit diseases is done by Feed forward back propagation neural network. In 2020, Saha and Neware[16] proposed a method for orange

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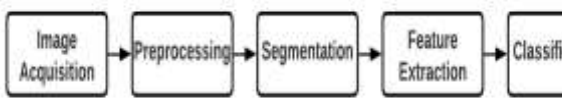
fruit disease classification using deep learning approach., They have used color and texture features to obtain efficient and accurate results. The classifier convolution neural network (CNN) is used for identifying orange fruit disease.

IV. GENERAL METHODOLOGY

The general methodology of fruit disease identification and classification is demonstrated in the following figure.



A. Image Acquisition

Image acquisition is defined as "the creation of a representation of the visual characteristics of an object" [20]. It is the first step of any image processing. Image acquisition is done through a digital camera or cell phone camera.

B. Preprocessing

Image processing means operation like image resizing. Acquired images may be converted to uniform size for example 240*240. Other preprocessing activities may be converting color to gray scale or geometric and color transformation and many more.

C. Segmentation

The method of dividing digital images into multiple segments is called image segmentation. Image segmentation is commonly used in images to find objects and boundaries (lines, curves, etc.). Different segmentation methods are Region based approaches, Histogram Matching, clustering based approaches and Edge detection approaches.

D. Feature Extraction

The classification of fruit diseases is carried out based on the features of the fruits like color of fruit, texture and shape. Some of the color feature extraction methods are L*a*b, HSV histogram, RGB, YUV, Color coherence vector and Global Color Histogram. Different texture feature extraction methods are Local Binary Pattern, Complete Local Binary Pattern, Gray Level Co-occurrence Matrices,Gabor filter, Wavelets Transform etc.

E. Classification

Image classification is "the process of categorizing and labeling groups of pixels or vectors within an image based on specific rules". There are many classifiers are available. Some of the classifiers are Support Vector Machine (SVM), k- Nearest Neighbors (k-NN), Random Forest Tree Classifier and Artificial Neural Network (ANN).

V. SUMMARY OF THE DIFFERENT METHODS USED IN FRUIT DISEASE ANALYSIS DETECTION AND CLASSIFICATION.

Fruit	Diseases	Segmentation Methods	Feature Extraction Methods	Training and Classification Techniques	Results	Ref
Apple	Apple scab, Apple rot and Apple blotch	k-means clustering	Used Global Colour Histogram, Color Coherence Vector, Local Binary Pattern And Complete Local Binary Pattern (CLBP)	Multi-class Support Vector Machine (MSVM)	The CLBP feature extraction method gave accurate results up to 93% for the classification of apple fruit diseases	[1]

Pomegranate	Bacterial blight	Not used	Color, morphology and CCV feature vectors	Support Vector Machine (SVM) algorithm	The overall performance accuracy achieved is 82%.	[7]
Grapes	Block rot, Powdery mildew and Downy mildew	k-means Clustering	Color, texture, morphology and Structure of hole of the fruits	Artificial Neural Network (ANN)	No appreciable result is observed	[3]
Apple	Apple scab,Apple blotch, and Apple rot.	k-means Clustering	texture based - Local Binary Pattern (LBP) and Completed Local Binary Pattern (CLBP), and shape based - Zernike Moments (ZM).	Multi- class Support Vector Machine (MSVM)	Accuracy of about 95% is achieved by combining different features.	[8]
Apple, banana, citrus, grape, guava, mango, papaya, peach, pomegranate, watermelon	Bitter rot,Anthracnose And other diseases	k-means and c-Means Clustering	GLCM	k Nearest Neighbors Algorithm	Using k-means, the result of classification has out to be relatively greater precision than C-means clustering algorithm.	[10]
Apple	Apple scab, apple rot and apple blotch	K-means clustering	Color Features: Global Color Histogram, Color Coherence Vector. Texture Features: local binary pattern, complete local binary pattern, and	Random forest classifier	Suggested that the result may Improve if we combine two or more than two color and texture features like	[9]

			local ternary pattern.		GCH, LBP, CCV, LTP, CLBP, gabor.	
Apple	Apple scab, apple rot and apple blotch	Global Thresholding	Gray Level Co-occurrence Matrix (GLCM), Entropy,Global Color Histogram (GCH) and Local Binary Pattern (LBP)	Multiclass Support Vector Machine (MSVM)	Demonstrated the accuracy of the classification, up to 94% using several features. .	[13]
Apple, Mango, Orange, Tomato and Pomegranate	Anthracnose, Fruit Rot	K-means clustering	Gray-Level Co-Occurrence Matrix (GLCM)	Multi class Support Vector Machine (MSVM) classifier	92.17% accuracy is achieved in disease detection. Fuzzy logic was applied to measure the severity of disease.	[14]
Different Fruits.	Bacterial and fungal disease	Thresholding	Local Binary Pattern (LBP) method.	Feed forward back propagation neural network	About 86% accuracy achieved for fungal diseases and 92% for bacterial disease byusing 10 hidden layers..	[15]
Orange	Brown rot, Citrus Canker, Melanose	Color Threshold	Vegetation index , Normalized difference water index , Normalized difference vegetation index,Green difference	Convolution Neural Network (CNN)	The system classified the diseases of orange fruit and healthy oranges with the	[16]

			vegetation index, Enhanced vegetation index ,Difference vegetation index , Infrared percentage vegetation index and Chlorophyll index		accuracy of 88.89% for the Brown rot, 84.21% for the Citrus Canker, 100% for the Melanose , 100% for the Healthy Oranges.	
Papaya	Powdery mildew,Black spot, Bhytophthora blight, and Anthracnose.	k-means Clustering	1. Co-occurrence Matrix Features 2. Statistical Features	Support Vector Machine (SVM)	The classification accuracy has been achieved is more than 90%	[17]

VI. CONCLUSION

We have presented a review on the identification and analysis of disease in different fruits in this paper. According to our literature survey, texture, color, and morphological features are most important for the identification and classification of fruit diseases. Segmentation techniques such as the k-means clustering technique, artificial neural networks (ANN), support vector machine (SVM), and multiclass support vector machine (MSVM) are the most widely used classification techniques for classifying fruit diseases. Automation of fruit disease detection would resolve the problem of farmers. Identification of fruit diseases in the initial stage will help the farmers to increase the yield of crops, which in turn improves the Indian economy and also leads to AatmaNirbar Bharat.

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Email id: ijaem.paper@gmail.com