SSRG International Journal of Electronics and Communication Engineering
ISSN: 2348 – 8549 / https://doi.org/10.14445/23488549/IJECE-V9I4P102

Volume 9 Issue 4, 10-14, April 2022
©2022 Seventh Sense Research Group®

Review Article

Detection of Fruit Diseases using Image Processing Techniques: A Review

Fouqiya Badar[1], Ayesha Naaz[2]

[1,2] *Department of Electronics and Communication, Osmania University, Telangana, India.*

Received : 01 March 2022 Revised : 10 April 2022 Accepted : 21 April 2022 Published : 30 April 2022

Abstract *- The production of fruit crops is necessary for India. It is important in terms of economy and nutritional value and feeds humans and other living beings. The trees provide shelter to living beings. Also, it absorbs many harmful gases and gives us pure and free oxygen. Fruits are a lot better than junk food, which has become the cause of many diseases today. Keeping these aspects in mind, the fruits must be prevented from getting infected with diseases at an early stage itself. This paper reviews the various image processing methods that can be used to detect diseases in fruits based on symptoms. Then the research gaps for every paper have been highlighted. This paper aims to help other researchers get to know the various methods that can be used in fruit disease detection.*

Keywords *- Image Processing, k-means clustering, Object tracking, Deep learning, Disease.*

1. Introduction

Fruit harvesting is an occupation with roots dating from ancient times. The livelihood of the farmers depends on this profession. Fruit production creates employment opportunities; it provides energy and shelter to human beings and animals. This occupation can overcome poverty. The economic growth of any country depends upon the production of fruits. Besides this, many industries use fruits to fetch profit for their businesses. Also, fruits are very healthy and have low cholesterol, and when consumed, it gives us numerous benefits at a cheap rate. Hence, if the fruits' diseases are not treated early, we may lose many benefits of this trade, and a particular fruit may enter into extinction. Future generations will not know whether such a fruit had even existed earlier.

2. Abbreviations

ANN	Artificial Neural Network
CNN	Convolutional Neural Network
DE	Delta E
ExG	Excess Green
ExGR	Excess Green Red
ExR	Excess Red
HAAR	HAAR Wavelet Transform
HUE	HUE Color Component
LVQNN	Learn Vector Quantization Neural Network
NN	Neural Network
RGB	Red Green Blue
ROI	Region of Interest
SVM	Support Vector Machine
UAV	Unmanned Aerial Vehicles
YUV	YUV Color space

3. Literature Review

As per a research paper [1], manual detection of diseased fruit is difficult and time-consuming; the authors have proposed a web-based system through which even the non-experts can identify the Disease through symptoms. The authors have considered three apple disease types: Apple Blotch, Apple Rot, and Apple Scab. They have suggested a solution that has three steps. The first step involves the K-means algorithm for segmentation, and the second step consists of feature extraction of the segmented image. In the third step, images are classified using LVQNN. The proposed algorithm has achieved an accuracy of 95%, proving that the LVQNN could effectively recognize the mentioned apple diseases.

Authors in [2] used a k-means clustering algorithm to identify fruit diseases. Apple was taken as a case study in this. The authors have used color images for defect segmentation. It consists of 3 clusters. The first step transformed the colour image into lab color space from RGB. In the second step, clustering was performed by taking the absolute difference between each pixel and the clustering center in color space. This algorithm achieved 95% segmentation accuracy for 3 common diseases in apple.

In paper [3], the authors proposed a technique to detect and classify major citrus diseases. They have taken Kinnow mandarin citrus fruit as a case study. The authors used the DEDE color difference algorithm to separate the Disease affected area, and color histogram and textural features were used to classify the diseases. The overall classification results show 99% accuracy, 1.0 area under the curve, and 99.7% sensitivity. Principle components analysis was

This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

applied for the feature set dimension reduction, and these reduced features were tested using state-of-the-art classifiers.

In paper [4], the authors have developed the previous detection algorithm through object tracking for robustness in the crop detection system. the previous detection algorithm consisted of color space and shape analysis. The performance of the previous algorithm in sunny conditions was not robust. The authors have taken cauliflower as a case study in this paper. First, Kalman filtering was done to predict the new position of cauliflower in video sequences. Then they applied data association (Hungarian algorithm) to assign each detected crop that appears in each image to the correct crop trajectory. The recall matrix was used for detection and tracking. The detection failures were reduced specifically in sunny conditions by tracking the algorithm. The overall detection performance raised from 97.28 to 99.3404%.

In another paper [5], the authors discussed the problem of identifying the infected areas of grapevines using UAV images in the visible domain. Authors have proposed a method based on CNN and color information to detect symptoms in vineyards. Authors have studied and compared the performances of CNNs using different color spaces, vegetation indices, and a combination of information. The results showed that CNNs with YUV color space combined with the ExGR vegetation index and CNNs with ExG, ExR, and ExGR vegetation indices yielded the best results with more than 95.8% accuracy.

Authors in the paper [6] have used Otsu's algorithm in which the ROI was segmented by taking only the HUE component. A total of 36 statistical and textural features were extracted using HAAR wavelet transformation. Then extracted features were given to SVM classifier as inputs to classify the test images as bananas and apples. 140 sample images of apples and bananas were used for training, and 25 images of bananas and 25 images of apples were used for testing Otsu's algorithm. This algorithm gave a 100% accuracy rate.

In the paper [7], the authors have used an open dataset of 5000 pictures of unhealthy and solid plants. In this dataset, they have applied a Convolutional system and semi-supervised techniques to characterize crop species and detect sickness of 4 different classes. CNN was used to detect and classify plant diseases. It achieved 99.32% accuracy in classification. Image classification, Image Categorization, Feature Extraction, and Data Training were then performed. The entire algorithm was done in python using several toolboxes like statistics and machine learning, NN, and image processing. The authors have compared the test input image with the trained data for detection and prediction analysis.

In the paper [8], the authors have explained four features, i.e., feature shape, size, color, and texture-based feature selection. They have also observed that the SVM classification result changes when the training/testing ratio changes. So, they have used making ratio for combining features and color and cluster-based methods for actual part segmentation.

The authors in the paper [9] have developed a probabilistic programming approach for plant disease detection using state-of-the-art Bayesian deep learning techniques and uncertainty as a miss-classification measurement to reduce the uncertainties in selecting the samples. The results showed that classification performance was better than standard optimization procedures for fine-tuning deep learning models.

In the paper [10], the authors have proposed a plant disease detection model using NNNN. First, they applied augmentation to the dataset to increase the sample size, and then they used CNN multiple convolutions and pooling layers. The authors have used the plant village dataset to train the model. After training the model, they tested for the results. They have performed several experiments using this model. 15% of data from plant village data was used for testing. The dataset contained both healthy as well as diseased plant images. The proposed model has achieved a testing accuracy of 98.3%.

In the paper [11], the authors have considered citrus fruit diseases. They first collected the healthy and damaged citrus fruits images. Originally, they took 150 images, but these images were increased to 1200 images with nine features by data augmentation. Then they performed preprocessing, which improved the image quality and rescaling to avoid delays. Authors have performed this classification algorithm and compared the results with the same CNN model without applying data augmentation and preprocessing. The results conveyed that the data augmentation and preprocessing techniques improved classification accuracy, and the loss obtained was less. An accuracy of 89.1% on the citrus fruit dataset was achieved.

In another paper [12], the authors have proposed an automatic grading system that requires less time for arranging agricultural products. The proposed algorithm was able to classify diseased vegetables. Vegetables were recognized based on their features, such as color, shape, size, and textures. They have extracted the features using the algorithms to differentiate the vegetables. The authors have used the K-means algorithm to detect the infected vegetables based on their features. The algorithm included three steps, i.e., enhancement, segmentation, and classification. The authors have gathered the vegetable image samples, and data acquisition was made to prepare the dataset. Image segmentation was performed using a k-means clustering algorithm, and image classification was based on SVM.

Authors in the paper [13] have undertaken an approach to detect the Disease and identify some kinds of diseases that target fruits by making some comparisons. The approach they have used is CNN, a deep learning algorithm. In this algorithm, authors have taken images as inputs, and the inputs were differentiated based on different points. These inputs were applied to analyzing visual imagery. In this approach, the authors have used python language. This algorithm has fetched them an accuracy of 97%.

In the paper [14], the authors have proposed a deep learning-enabled object detection model based on a state-of-the-art computer vision algorithm. It was applied to multiple class plant diseases. This model addresses the accurate detection of fine-grained, multi-scale early disease detection. The proposed model was improved to optimize detection speed and accuracy and applied to multi-class apple plant disease detection. The results showed that this model outperformed the state-of-the-art detection model with a 9.05% increase in precision and a 7.6% increase in the F1 score.

In another paper [15], authors have developed grading and sorting techniques for dragon fruit using machine learning algorithms, i.e., CNN, ANN, and SVM. the working of these algorithms was based on features such as shape, color, weight, size, and diseases of dragon fruits. Using machine learning algorithms, Raspberry functionality was used to count the total number of fruits in a fruit bucket and separate them based on their maturity level. The ANN uses a backpropagation algorithm to reduce the errors, and the output neurons generate the output.

Table 1. Research Gap Table

Paper ID	Findings	Research Gaps
1	95% accuracy was achieved.	It can be tested on other apple diseases as well
2	Able to accurately segment defective areas of fruit present in the database.	It can be applied to other fruits as well.
3	Classification results showed 99% accuracy, 1.0 area under the curve, and 99.7% sensitivity.	Mobile Applications based on this model can be developed; there's a need for standard publicly available datasets to improve the overall performance of such systems
4	the performance raised from 97.28 to 99.34%	It can be applied to other fruits and vegetables.
5	an accuracy of more than 95% was obtained.	It can be applied to other fruit diseases as well.
6	This algorithm gave a 100% accuracy rate.	Otsu's algorithm can be tested on other fruits and vegetables.
7	Provides reliable results K-Means clustering and moisture content along with predicting of withstanding	Dataset images can be increased for better accuracy.
8	This system is better for orange fruit defect classification.	It can be applied to other fruits as well.
9	Classification performance was better compared to other deep learning models.	An accurate model can be developed.
10	the proposed model has achieved 98.3% testing accuracy.	This model can be integrated with a drone or another system to detect live diseases and report them to people.
11	An accuracy of 89.1% on the citrus fruit dataset was achieved.	It can also be applied to other fruits; the dataset can be increased to increase accuracy.
12	an accuracy of 97% was obtained	This algorithm can be used for different diseases.
13	High accuracy was obtained, and less time was consumed.	The database can be increased for disease identification, and the algorithm can be used for fruit disease detection.
14	the proposed model can be employed as an effective and efficient method to detect different apple plant diseases under complex orchard scenarios.	It can be extended to different fruits and crops.
15	CNN increases the speed of operation and produces effective output compared to ANN and SVM	It can be applied to other fruits as well
16	an accuracy of 89.07% and a loss value was 0.71.	It can be applied to other fruits and vegetables
17	An accuracy of 97.56% using the majority voting ensemble model was achieved.	Models based on different machine learning classifiers and deep learning networks can be developed.

Authors in the paper [16] have used CNN for feature extraction and classification, which is less costly. They have made use of deep learning to obtain more accuracy. They have taken apple fruit as a case study. The authors have presented creative methods to detect diseases in fruits and are a prototype for implementing modern technology in agriculture. This algorithm detected the Disease in a very cheap and fast way. The number of stages used was 30. the authors have achieved an accuracy of 89.70%, and the loss value was 0.71.

In the paper [17], the authors have proposed two classification models based on deep feature extraction from pre-trained convolutional neural networks. The proposed models fine-tuned and combined six state-of-the-art convolutional neural networks and evaluated them on the given problem individually and as a group. Finally, the performances of different combinations based on the proposed models were calculated using an SVM classifier. The authors have collected a Turkey Plant dataset consisting of unconstrained photographs of 15 kinds of diseases and pests images observed in Turkey to verify the validity. An accuracy of 97.56% using the majority voting ensemble model was achieved, whereas 96.83% accuracy was obtained using the early fusion ensemble model.

4. Conclusion

One of the biggest concerns for farmers is the diseases in the plants. The advancement in digital techniques is, to some extent, reducing the farmers' worries. In this paper, we have discussed the different image processing techniques such as Neural Networks, object tracking, k- means clustering, and many other techniques that can be used to detect infected fruits at a preliminary stage, thereby reducing many losses incurred by agriculture, economy and as well environment. This paper serves to help the researchers that wish to do their research in this area.

References

[1] Abhijeet V. Jamdar, and A. P. Patil, "Detection and Classification of Apple Fruit Diseases Using K-Means Clustering and Learning Vector Quantization Neural Network," *International Journal of Scientific Development and Research,* vol. 2, no. 6, pp. 423-429, 2017.

[2] Abhijeet V. Jamdar, and A. P. Patil, "Apple Fruit Disease Detection Using Image Segmentation Algorithm," *International Journal for Research Trends and Innovation,* vol. 2, no. 6, pp. 221-225, 2017.

[3] H. Ali et al., "Symptom-Based Automated Detection of Citrus Diseases Using Color Histogram and Textural Descriptors," *Computers, and Electronics in Agriculture,* vol. 138, pp. 92-104, 2017. *Crossref,* https://doi.org/10.1016/j.compag.2017.04.008

[4] Esmael Hamuda et al., "Improved Image Processing-Based Crop Detection Using Kalman Filtering and the Hungarian Algorithm," *Computers, and Electronics in Agriculture,* vol. 148, pp. 37-44, 2018. *Crossref,* https://doi.org/10.1016/j.compag.2018.02.027

[5] Mohamed Kerkech, Adel Hafiane, and Raphael Canals, "Deep Leaning Approach with Colorimetric Spaces and Vegetation Indices for Vine Diseases Detection in UAV Images," *Computers, and Electronics in Agriculture,* vol. 155, pp. 237-243, 2018. *Crossref,* https://doi.org/10.1016/j.compag.2018.10.006

[6] PL. Chithra, and M. Henila, "Fruits Classification using Image Processing Techniques," *International Journal of Computer Sciences and Engineering,* vol. 7, no. 5, 2019. *Crossref,* https://doi.org/10.26438/ijcse/v7si5.131135

[7] Suma V et al., "CNN-Based Leaf Disease Identification and Remedy Recommendation System," *International Conference on Electronics Communication and Aerospace Technology,* pp. 395-399, 2019. *Crossref,* https://doi.org/10.1109/ICECA.2019.8821872

[8] Hardik Patel, Rashmin Prajapati, and Milin Patel, "Detection of Quality in Orange Fruit Image Using SVM Classifier," *Proceedings of the Third International Conference on Trends in Electronics and Informatics (ICOEI),* pp. 74-78, 2019. *Crossref,* https://doi.org/10.1109/ICOEI.2019.8862758

[9] S. Hernandez, and Juan L.López, "Uncertainty Quantification for Plant Disease Detection Using Bayesian Deep Learning," *Applied Soft Computing,* vol. 96, 2020. *Crossref,* https://doi.org/10.1016/j.asoc.2020.106597

[10] Murk Chohan et al., "Plant Disease Detection Using Deep Learning," *International Journal of Recent Technology and Engineering,* vol. 9, no. 1, pp. 909-914, 2020. *Crossref,* https://doi.org/10.35940/ijrte.A2139.059120

[11] Vinay Kukreja, and Poonam Dhiman, "A Deep Neural Network-Based Disease Detection Scheme for Citrus Fruits," *Proceedings of the International Conference on Smart Electronics and Communication (ICOSEC),* pp. 97-101, 2020. *Crossref,* https://doi.org/10.1109/ICOSEC49089.2020.9215359

[12] Rahamathunnisa U et al., "Vegetable Disease Detection Using K-Means Clustering and SVM," *6th International Conference on Advanced Computing and Communication Systems,* pp. 1308-1311, 2020. *Crossref,* https://doi.org/10.1109/ICACCS48705.2020.9074434

[13] Malathy. S et al., "Disease Detection in Fruits Using Image Processing," *Proceedings of the Sixth International Conference on Inventive Computation Technologies (ICICT),* pp. 747-752, 2021. *Crossref,* https://doi.org/10.1109/ICICT50816.2021.9358541

[14] Arunabha M. Roy, and Jayabrata Bhaduri, "A Deep Learning Enabled Multi-Class Plant Disease Detection Model Based on Computer Vision," *Artificial Intelligence,* vol. 2, no. 3, pp. 413-428, 2021. *Crossref,* https://doi.org/10.3390/ai2030026

[15] Pallavi U. Patil et al., "Grading and Sorting Technique of Dragon Fruits Using Machine Learning Algorithms," *Journal of Agriculture and Food Research,* vol. 4, 2021. *Crossref,* https://doi.org/10.1016/j.jafr.2021.100118

[16] Raju Hosakoti, Soma Pavan Kumar, and Padmaja Jain, "Disease Detection in Fruits Using Deep Learning," *Journal of the University of Shanghai for Science and Technology,* vol. 23, no. 7, pp. 309-312, 2021.

[17] Muammer Turkoglu, Berrin Yanikoglu, and Davut Hanbay, "Plant Disease Net: Convolutional Neural Network Ensemble for Plant Disease and Pest Detection," *Signal, Image and Video Processing,* vol. 16, pp. 301-309, 2022. *Crossref,* https://doi.org/10.1007/s11760-021-01909-2