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A Comparative Analysis of Fruit Disease Detection and Classification

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A B S T R A C T

In India, agriculture takes a significant part in the Indian economy. This is the necessary and main income for many humans. So, we need to increase fruit production. Fruit diseases detrimentally affect the fruits. Majorly effect of fruit diseases is caused by fungi and bacteria. Early detection of fruit disease is used to predict fruit disease and saves investments for farmers. Finding the best fruit disease detection technique is used to prevent fruit disease in the early stages [1]. Some researchers take note to find the fruit disease recognition system to save the investments for farmers. The objective of this paper is to compare a deep learning classification technique for fruit disease detection. This study noticed that a convolutional neural network (CNN) gives greater accuracy and predicts many fruit diseases.

Keywords: Fruit disease detection; Classification; Deep Learning; Machine Learning

1. Introduction

All over the world, agriculture is a key development of growth and economic development. There is always a big issue to give agricultural products all over the world. The fruit yield aims to increase fruit production and increase economic growth for farmers. Agriculture part is playing an important source of profitable development, employment, import, and export sectors. The sustainability of farming fruits against diseases is an essential part of increasing the production of the fruits [1].

Farmers can search and collect information from accurate agriculture in technology to achieve a great profitable income in farming. Using these methods, it is feasible to attain greater profitable development. Precise agriculture can be used for plant disease, fruit disease detection, and pest detection. The diseases in fruits are the greatest economic losses to farmers and low production. Accurate and advanced detection of fruit disease is important to reduce the disease spread and reduce the damage to the fruit. If the fruit farmers have state-of-the-art devices and methods, in the future they able to cultivate and prevent more crops and use their funds effectively. So, it is necessary to find the fruit disease prediction [2].

In fruit growth procedures, for example, apple, orange, citrus, pomegranate, and plum these fruits have mineral nutrients and play a major role. The crucial mineral nutrients in fruits are magnesium, zinc, phosphorous, folic acid, potassium, nitrogen, and calcium. The insufficiency of these nutrients affects the fruit's growth, production, and standard. Due to the cold chain infrastructure, 16% of fruits are wasted every year. To prevent the fruit from disease care should be taken for detecting the fruit disease in earlier stages and this way is used to stop the further spread of disease in other fruits. In current years, fruit manufacturing is generally affected by canker, anthracnose, black spot, fruit rot, thread blight, and brown rot. Recently no agricultural automation systems are used in the agriculture field in harvesting, pruning, and spraying. Detection of fruit disease and predicting the disease attached time of fruit plays a major role in the victorious growth of fruit production. This paper briefly explains the deep learning and machine learning methods employed in fruit disease identification and explanation of various classifiers and limitations are recognized.

General Method Of Fruit Disease Detection

The fruit disease can be classified by noticing the fruit. To identify the diseased fruit, deep learning and machine learning detection systems can be utilized. Deep learning techniques involve six basic steps. At first, images will be collected followed it pre-processing, segmentation, feature extraction,

and classification after the kind of disease will be predicted. The block diagram is shown below in Fig 1.

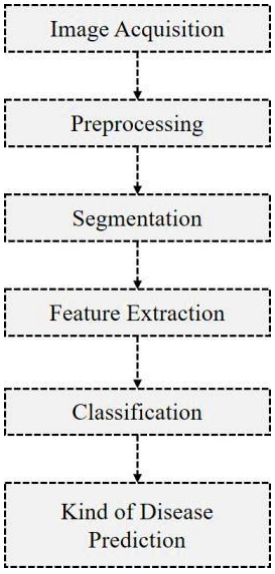

Fig 1 - General Method of Fruit Disease Detection

- **Image Acquisition:**

The first phase of the fruit disease detection system is image acquisition. It is the technique of obtaining a technique from a remote location for further processing. The best quality images can be captured by sensors, drones, or camera

- **Pre-processing:**

The pre-processing step is a necessary step for enhancing desired features and proceeding further process.

- **Segmentation:**

The image acquired from cameras or sensors that have poor scene images which may affect the segmentation process. To increase the segmentation accuracy, use image resizing, cropping, image converting, image filtering, image enhancement, etc. The purpose of segmentation is to clarify and transform the representation of an image into an entity that can be analysed.

- **Feature Extraction:**

It transforms the raw data into numerical features. Extraction of color, shape, texture, structure of hole of the fruit, and feature of disease part of the fruit.

- **Classification:**

Finally, a convolutional neural network may be utilized to classify various fruit diseases using deep learning approaches.

2. Related Work

Previous work has been compared to machine learning and deep learning techniques for detecting and classifying fruit diseases. These approaches are used to detect fruit diseases and their effectiveness: Support Vector Machine with K-Means (SVM), Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Multi-Class Support Vector Machine (MSVM), K-means clustering, and Learning Vector Quantization Neural Network.

A. SVM With K-Means:

SVM is a supervised learning method in machine learning and it is used for classification. K-means clustering is an unsupervised learning algorithm that divides the unlabelled dataset into various clusters. The consecutive authors used SVM and K-Means clustering in fruit disease detection. [3] Detection of diseases on apple fruit and it is attacked by diseases of apple blotch, apple rot, and apple scab. The exploratory result obtained 93% of the acceptance rate. [4] Developed a method to classify disease in orange fruit. Three types of fruit diseases are detected which are Citrus canker, Brown rot, stub burn, and Melanose. This report has a classification accuracy of 90%. [5]. Apple fruit diseases over 400 images are taken with an accuracy of 95%.

B. Support Vector Machine (SVM):

Related work on SVM in fruit disease detection is an author [6] presented a method to identify the presence of citrus fruit diseases which are anthracnose, Citrus scab, Greening, Melanose, Blackspot, Canker. The algorithm has been tested on infected fruits, with an average classification accuracy of 93.12% for citrus fruit diseases.

C. Artificial Neural Network (ANN):

The recently enhanced and better pattern of the artificial neural network has greatly donated to the investigation, comprehension, and use of feasible practical resemblance in the middle of human and artificial information processing systems. ANN is a physically cellular system that can acquire, keep and utilize exploratory understanding. They are brain-energized systems that deliberate the method of human knowledge. The neural networks include input, output, and hidden layers. Hidden layers transform some methods from the input layer to the output layer. It is a computational model in machine learning or precisely in deep learning and pattern recognition. The following is a list of related work on fruit disease diagnosis using an ANN Classifier. [7] Assessed a proposed work for the recognition of fruit disease using k-means clustering and the GLCM method. It performed well with a precision of around 90%. The investigational result acquired 88.96% of the authentic acceptance rate. [6] Citrus fruit diseases Anthracnose, Citrus scab, Greening, Melanose, Blackspot, and Canker were detected and give 88.89% average accuracy for the two diseases.

D. Convolutional Neural Network (CNN):

CNN is a type of deep neural network that is most typically used to analyse optical data. [8] Proposed a model to detect diseased fruit in 1200 images used in the dataset and it achieved an accuracy of 89.1%. [9] Developed a method of fruit disease identification using 5000 images of healthy, brown rot, shot hole fruit, shot hole leaf, and nutrient deficiency diseases and performed with the accuracy of 92%. [10] Designed a model to identify strawberry diseases crown leaf blight, leaf blight, fruit leaf blight, gray mold, and powdery mildew, using original and feature image datasets using CNN classifier. The dataset contains 1306 and it achieved an accuracy of 99.32%.

E. Multi-Class Support Vector Machine (MSVM):

It can be calculated with the accuracy, sensitivity, and specificity of the MSVM classifier. Associated work on MSVM in fruit disease detection is an author [11] presented a method to identify the presence of disease in apple fruit images using MSVM. The algorithm has only been tested on a single type of fruit disease that can be recognized from a single image with various background colors. There are four different types of dataset. Apple blotch (33), Apple rot (40), Apple scab (37), and Normal Apple (50) are all employed in this experiment. There are 160 apple fruit images in total, with a 94 % accuracy.

F. K-means clustering and Learning Vector Quantization Neural Network:

Learning Vector Quantization is a sort of Artificial Neural Network that is based on biological neural system models. This algorithm's purpose is to locate groups in the data, with K representing the number of groups. [12] Apple fruit diseases are apple scab, apple rot, and apple blotch diseases. The algorithm's apple fruit disease recognition rate can reach more than 95% based on detection over 24 sample images and these exploratory outcomes.

3. Comparison

The following table describes the comparison of differences between several types of Machine Learning and Deep Learning classifiers used in fruit disease diagnosis. in Table 1.

Table 1. Comparison of classification techniques

Algorithm	Research Work	Problem Domain	Accuracy
SVM With K-Means	Detection and Classification of Apple Fruit Diseases using Complete Local Binary Patterns [3]	Detection and Classification	93%
	Disease Classification and Grading of Orange using Machine Learning and Fuzzy Logic [4]	Classification	90%
	Computer-Based Classification of Diseased Fruit using K-Means and Support Vector Machine [5]	Classification	92%
SVM	Automatic Citrus Fruit Disease Detection by Phenotyping Using Machine Learning [6]	Classification	88.96%

ANN	Diagnosis of Pomegranate Plant Diseases using Neural Network [7]	Detection and Classification	90%
	Automatic Citrus Fruit Disease Detection by Phenotyping Using Machine Learning [6]	Classification	93.12%
CNN	A Deep Neural Network-based disease detection scheme for Citrus fruits [8]	Detection	89.1
	Disease Detection in Plum Using Convolutional Neural Network under True Field Conditions [9]	Detection and Identification	92%
	Detection of Strawberry Diseases Using a Convolutional Neural Network [10]	Detection	99.60%
MSVM	Fruit Disease Recognition and Automatic Classification using MSVM with Multiple Features [11]	Detection and Classification	94%
K-means clustering and Learning Vector Quantization Neural Network.	Detection and Classification of Apple Fruit Diseases using K-means clustering and Learning Vector Quantization Neural Network.[12]	Detection and Classification	95%

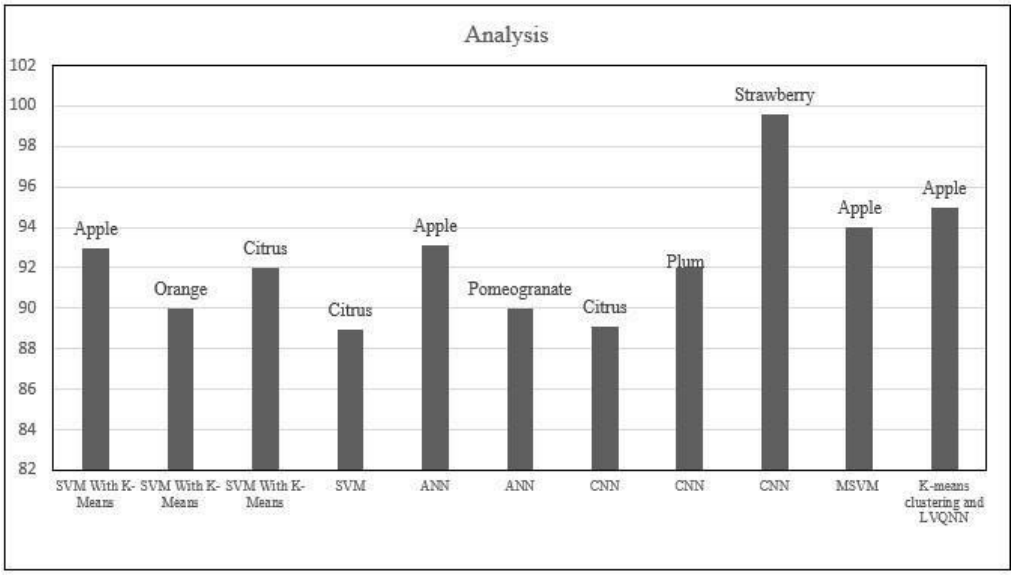

Fig 2 - Accuracy graph for comparison of various classifiers

4. Conclusion

This study compares six types of machine learning and deep learning classification approaches for recognizing fruit illness. Many authors prefer SVM with a k-means clustering alternative to classification algorithms. The results reveal that CNN Classifier accurately diagnoses fruit illnesses with high accuracy. Other machine learning and deep learning classification algorithms, such as decision trees and other classifiers, may be used in the future for disease detection in plants to help farmers in diagnosing all types of plant diseases automatically

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