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RESEARCH ARTICLE

Application of support vector classifier for mango leaf disease classification

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Abstract

In India, mango is a fruit of high economic and ecological importance as it exports in large quantities. A total of 1000 varieties of mangoes are cultivated and mostly supported commercially. Among all the Indian fruits, mangoes are in high demand. In the majority of the Indian region, mango crops are suffering from several diseases that reduce both the production and the quality and parallel, reduce its value on the International market. Mangoes are highly affected by many diseases, which hamper its appearance and taste and has a huge impact on the economy. The Indian commercial growth rate has not risen. Manually identifying those disease is a complex task and time consuming, since lack of knowledge, poverty, infrastructure and facilities the identification of the disease in earlier stages are not done by the farmers. In recent years, plant pathologists apply different techniques to identify diseases but then again, these techniques are time-consuming and relatively expensive for mango growers and the solutions proposed are often not very accurate and sometimes biased. The disease has to be diagnosed to provide solutions to the farmers to increase the productivity with high quality. Researchers have proposed several solutions to the diagnosis of mango diseases automatically to gain high returns. The use of machine learning algorithms to identify diseases of plants from leaf photos is a very exciting field for advancement and research has been carried in the proposed system using a support vector machine. Using non-linear SVC, achieved an accuracy of 88% for the dataset.

Keywords: Mango leaf disease, Support vector machine, Feature extraction, Machine learning, Support vector classifier.

Introduction

In India, agriculture remains the backbone of its society. It employs approximately 58% of the population (Sujatha *et al*., 2017) relies on income from this. Fruits like guava, pomegranate, apple, banana, grape, and mango are among the most common fruits grown in India. Furthermore, India is a vast, affordable producer of fruit, and agriculture has significant potential for export. Because of the favorable soil and climate conditions, many farmers rely on fruits such as pomegranate, mango, and grape. Fruit infections are considered one of the most important factors affecting both the quantity and the value of agricultural products.

There is a lot of study in the precision agriculture field about expanding automatic systems for disease detection and classification. During the past few years, researchers have been exploring a variety of cultures that use various sections of the plant. The mango is a highly popular fruit and is available in summer (Khan *et al*., 2019). Agriculture-dependent nations face severe danger and significant loss as a result of plant diseases, that reduce the quality and quantity of fruits and crops (Tran *et al*., 2019). Diseases that affect plants are caused by environmental changes such as water accessibility, climate, and several more. An important task is the ability to analyze disease at an early stage. Plants, like humans, can be affected with several diseases.

These diseases have a negative impact on both yield and output, resulting in a major decrease in the productivity of agriculture, leading to the fundamental reason for their slow growth. According to agricultural specialists, the conventional method for identifying diseases of plants is through naked eye inspection. This is both costly and

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time-consuming because it necessitates regular surveillance (Runno *et al.*, 2021, Akram *et al.*, 2020). But it is not easy to recognize the disease at an early stage. Mangoes are high in minerals, vitamins, fibre, and healthy fat. A lot of microorganisms are present in mango plants. Suppose these diseases aren't identified and treated during the early stages of development. In that case, they will harm specific areas of the mango plant, reducing total yield (Selvakumar *et al.*, 2020). The diseases in the plants are cause for dropping the quality and the quantity of the agriculture production (Iqbal *et al.*, 2018)

Disorders are produced by abiotic variables such as temperature, rainfall, nutritional inadequacy, moisture, etc. while diseases are caused by biotic causes such as fungi, bacteria, or algae (Chouhan *et al.*, 2018). Mango leaves can be affected by different disease like powdery mildew, anthracnose, dieback, phoma blight, bacterial canker, red rust, sooty mould, mango malformation and cutting weevil. Notable mango-growing regions in Tamil Nadu include Dharmapuri, Krishnagiri, Vellore, and Theni. The wind-prone window planting lessens the impact and harm that pests and diseases can bring. The planting of occurs between July and December (Vikram *et al.*, 2022). The weevil has become a significant danger to mango cultivation in tropical and subtropical locations around worldwide, particularly in India and Bangladesh.

The development of computerized models enabling reliable, and prompt identification of plant leaf disease has advanced with the introduction of computer vision (CV), machine learning (ML), and artificial intelligence (AI) technologies. In last decade, due to the accessibility of several computing processors and systems AI and ML technologies have attracted enormous attention in the classification and detection of plant disease. In recent years, in agriculture techniques like AI, ML, deep learning (DL) has been mostly utilized (Ferentinos 2018), (Edna Chebet Too *et al.*, 2019), and (Webster *et al.*, 2020)

Analysis

Today, mango is grown in tropical and subtropical regions, either a vegetable tree and a source of cover to be processed into economic fruit. In a variety of climates, mangoes can thrive without experiencing frost. The tree produces the most fruit in locations where there is a clearly defined, somewhat cold dry spell during which flowering and development of fruit occurs with a strong increase in temperature.

Detecting leaf disease has become a popular topic of research in recent years. To improve the efficiency of disease diagnosis detection, scholars have investigated a number of machine learning and pattern recognition-based strategies. Techniques like Convolutional neural network in (Uday *et al.,* 2019), (Sunayana *et al.*, 2019) and (Gina *et al.*, 2019) and other image processing techniques (Shriroop *et al.*, 2017) and (Zahid *et al.*, 2018) are examples of machine learning methodologies, as are back propagation network (Kamlesh Golhani *et al.*, 2018), VETS. *Mangifera indica* represents the scientific term for the kind of mango disease (Priyadharshini *et al.*, 2019).

Pathology of plants investigates the origins of plant illnesses as well as their prevention and treatment strategies as suggested in (Chouhan *et al.,* 2018). (Al Bashish *et al.*, 2011) proposed the research on various classification techniques that have been applied for classifying plant leaf diseases.

Authors (Ullagaddi *et al.*, 2017) presented their concept for employing modified rotational kernel transform characteristics to identify disease in mango crops. Image processing and machine learning approaches were used to detect mango flaws (Sharma *et al.*, 2017).

CNN techniques are used to distinguish normal mango leaves from anthracnose disease-affected leaves (Singh 2019). The research carried out by this author examines the image processing methods implemented to recognize and categorize the signs of a variety of horticultural or agricultural fungal diseases (Jagadeesh 2015). For GLCM and GLRM features, the average accuracy of classification is 91.37 and 86.71%, respectively.

Segmentation, recognition, and identification procedures were taken into account by (Iqbal *et al.* 2018). They discovered that nearly all techniques are in their infancy. They also covered nearly every technique now in use, along with its benefits, drawbacks, difficulties, and models of ML (Image Processing) for disease recognition and identification.

When segmenting images, the c-means method must deal with the issue of high-dimensional data sets. By (Krishnan *et al.*, 2013) employed morphological operator to identify and recognize bacteria that cause leaf scorching.

In (Sutrodho *et al.*, 2018) mango leaf ailment detection was implemented using support vector machine and neural network and produced the result of 80% accuracy in detecting the type of disease like scab, anthracnose, red rust and sooty mold.

Identification of the sooty mold and powdery mildew disease by proposing the segmentation approach was given in (Sutrodhor 2018). Identification of anthracnose, gall midge, and powdery mildew mango diseases were classified using a feed-forward neural network (FFNN) with hybrid metaheuristic feature selection (HMFS) as suggested by (Pham 2020) were the accuracy of the suggested model was 89.41%.

Proposed neural network ensemble techniques to detect the disease like dag, golmachi, shutimold and red moricha in mango leaf with accuracy as given in (Umamageswari *et al.*, 2022) of and the accuracy of the same disease using neural network techniques with 80% as mentioned by (Rasel *et al.*, 2020)

Materials and Methods

Classification of Mango Leaf Disease

There are seven different types of mango leaf disease in the dataset with a maximum of 4000 images of mango leaf. 500 images are present in the dataset for each category, including the healthy leaf.

Anthracnose disease

The disease causes significant damage to new branches, blooms, and fruits. It also has an impact on fruits during preservation. Indications of the disease in the leaves include leaf spot, bloom decay, wither tip, twig blight, and fruit decay. Tender shoots and leaves are quickly impacted, resulting in "die back" of fresh stems. Mature twigs can potentially become poisoned through cuts, which can be lethal in severe circumstances, as shown in Figure 1. Black dots appear on both panicles and fruits. A severe disease damages the whole inflorescence, which leads to a lack of fruit production. Young diseased fruits become dark, shrivel, and drop off.

Dieback disease

It is distinguished by the drying back of twigs from the top downwards, especially on elder trees, accompanied by the drying of leaves, giving the impression of fire scorch. If oak tissue is cut open along its long axis, intracellular browning is visible. When they perish, branches develop splits and release tar. When a nursery the plant's patch union is compromised, it normally dies as shown in Figure 2.

Red rust disease

The fungus *Puccinia psidii* is the common cause of red rust in mango leaves. Although it mostly affects mango trees, it can also harm other members of a similar botanical family, including guava and eucalyptus. The medical condition is more common in hot, muggy settings. The inner surfaces of mango leaves will start developing small, elevated, brownish-red pustules, the first sign of red rust. These pustules that could get bigger and more frequent as the illness worsens, giving the leaves a rusty or reddish color as shown in Figure 3. The defoliation process brought on by severe diseases may weaken the tree and reduce fruit output.

Scab disease

Another fungus-related disease that affects the flowers, leaves, fruit, and limbs is mango scab (*Elsinoe mangiferae*). The early stages of a viral infection resemble anthracnose symptoms. The mango fruit, panicles, blooms, twigs, stem bark, and scab fungus are all targets of this disease, shown in Figure 4. Spots are round, moderately angular, extended, 2 to 4 mm in length, and brown; nevertheless, infections change in dimensions, form, and appearance in rainfall.

Bacterial canker disease

Mango leaf bacterial canker is a plant disease commonly brought on by the pathogen *Xanthomonas campest* is given in Figure 5. This attacks mango plants and is identified by the development of holes in the leaves or patches that are black and decaying. The spots frequently appear wet and can have a golden halo surrounding them. Bacteria thrive in warm, humid environments and spread more readily. In severe situations, the illness may also affect the mango tree's branches and fruits.

Figure 1: Anthracnose disease

Figure 2: Dieback disease

Figure 3: Red rust disease

Figure 4: Scab disease

Figure 5: Bacterial Canker

Machine Learning Techniques

In the proposed work, support vector machine is used to classify and to predict the normal and affected leaves like anthracnose, die back, red rust and scab diseases. The block diagram to classify the leaves is shown in Figure 6.

Support vector machine classifier

One of the supervised classification technique is support vector machine (SVM) that uses a line to distinguish between two separate groups. SVM is implemented in the proposed work as it suitable for image dataset. A potent algorithm that locates the best hyperplane in a high-dimensional feature space to distinguish between several classes. In limiting incorrect classification, it seeks to increase the margin between classes. SVM used to train and classify data with degree of polarity which predict the new data.

Below is a description of the stages involved in putting the SVM classifier into practice. The initial step is to gather the Kaggle image dataset, which is then pre-processed and then train the SVM classifier completely. To predict whether the new mango leaf is diseased by looking at its color, size, and texture perform the evaluation strategy.

Procedure to perform SVM classifier

- *Dataset*

The first entry is a dataset of photos of mango leaves, which includes both instances with normal leaves and those damaged by different diseases.

- *Pre-processing*

The dataset requires pre-processing procedures to prepare the images for evaluation. This may comprise scaling, normalization, and decrease in noise to provide clear and consistent data.

- *Feature extraction*

Relevant features are extracted from pre-processed images. Features like color, texture descriptors, shape-based features, and size and other characteristics that can aid in distinguishing among good and sick mango leaves are examples of these features.

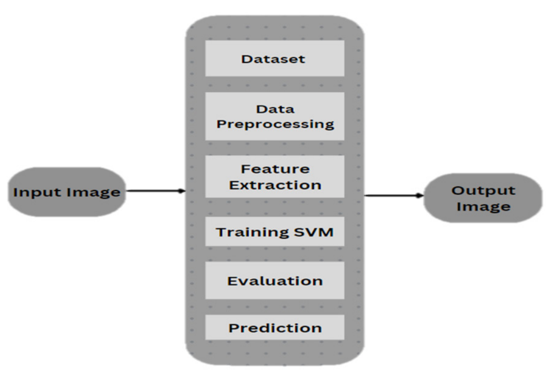

Figure 6: Block diagram of mango leaf classification

Algorithm 1 Image Classification with SVM

```
Initialize labels, data
for each directory in image_dirs do
    for each image in directory do
        Load image
        Preprocess image
        Flatten image
        Add image to data
        Add label to labels
    end for
end for
Convert data and labels to numpy arrays
Split data into training and test sets
for each kernel in ['linear', 'poly', 'rbf', 'sigmoid'] do
    Initialize SVM classifier with kernel
    Train classifier with training data
    Make predictions with test data
    Calculate and print metrics
end for
```

Figure 7: Algorithm of SVM classifier

- *SVM classifier*

The SVM classifier is trained using the pre-processed and feature-extracted data. It may be used for both binary and multiclass classification tasks. The SVM learns to locate the best hyperplane for separating the different kinds of mango leaf diseases. Depending on the derived attributes, it continues to classify new occurrences as 80 to 20%.

- *Evaluation*

The trained SVM model's performance is measured using evaluation measures such as accuracy, precision, recall, and F1 score. The extent to which the model generalizes to new image and measures its usefulness in diagnosing mango leaf illnesses (Deena and Raja, 2019).

- *Prediction*

Once trained and validated, the SVM classifier model may be used for predicting class labels of new one. The algorithm uses the retrieved properties of these examples to predict which ones correspond to the normal or are affected by disease as shown in Figure 7.

Result

The proposed algorithm was created with the Python programming language and a few examples of impacted disease images as shown in Figures 1-4 and healing plants obtained from the web as shown in Figure 8. The dataset was collected from the kaggle dataset. The result if the proposed method has been addressed using performance metrics and comparison data are provided below:

Evaluation Metrics

The proposed system is measured through different metrics like.

Accuracy

It is defined as the ratio of sum of true positive and true negative to the summation of all true and negative value of both positive and negative (Deena *et al.*, 2022) and (Attada *et al.*, 2022).

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$

Precision

The proportion of true positives to the total of true positives and false positives is how precision is evaluated.

Precision =TP/TP+FP

Recall

Recall, also known as sensitivity or true positive rate, is the proportion of true positive predictions out of all actual positive instances in the dataset. It measures the ability of the classifier to correctly identify positive instances

Recall= TP/TP+FN

F1 score

It gives an accurate evaluation of a classifier's performance and is the average of recall and precision.

F1= 2*(Precision * Recall)/(Precision + Recall)

Comparison Result

The proposed system is implemented in SVM non-linear methods, and random forest and K-nearest neighbour, where the accuracy score of each classifier is shown in Figure 9. The performance was measured using metrics like the accuracy of non-linear classifier in linear kernel is 81%, poly kernel is 88%, radial basis function (RBF) is 83%, and the sigmoid kernel is 11%. Other classifiers like random forest gives 82% and KNN gives 66%.

Discussion

Precision and Recall

Eight category of leaves was considered in the dataset. Normal leaf and various disease affected leaves for the classification. Blue in the below graph indicates the bacterial canker disease, green indicates cutting weevil and red indicates anthracnose. However, according to the given dataset bacterial canker is classified accurately using different classifiers.

Precision

Bacterial canker has been classified with the precision value of 98, 99, 97 and 98% by the classifiers like linear kernel, poly kernel, random forest and KNN classifiers, respectively as given in Figure 10.

Recall

Bacterial canker has been classified with recall value of 98, 100, 100 and 93% by the classifiers like linear kernel, poly kernel, random forest and KNN classifiers,

Figure 8: Healthy mango leaf

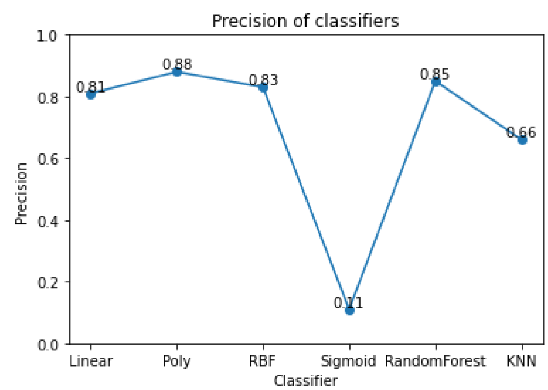

Figure 10: precision value

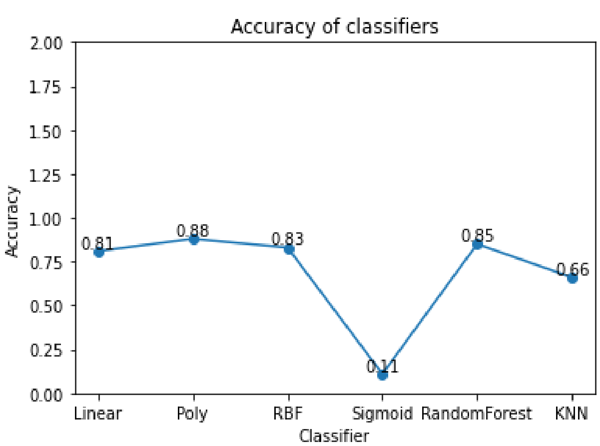

Figure 9: Accuracy of classifiers

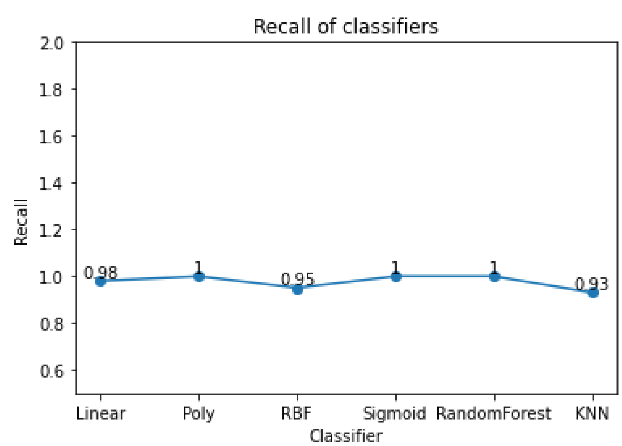

Figure 11: Recall value for different disease

respectively. Anthracnose and cutting weevil disease has been categorized with RBF and sigmoid with precision of 95 and 100%, respectively as given in Figure 11.

The evaluation metrics such as accuracy, precision, recall of the proposed technique are achieved highly efficiently under poly kernel of non-classifier for the bacterial banker disease with a precision of value of 99%, recall value as 100% and F1 score value 100% when compared with other classifiers.

Conclusion

The key problem in mango leaf disease is bacterial banker, which has been identified and predicted using classifiers like non-linear SVM, KNN, and random forest. The proposed system has obtained a high accuracy of 88% in poly kernel non-linear SVM classifiers and successfully classified and predicted the infection when compared with other classifiers like KNN and random forest. Convolutional neural networks will be used in the future to anticipate plant diseases and make recommendations to prevent them.

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