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## **AUTOMATIC DETECTION OF MANGO FRUIT DISEASES USING MACHINE LEARNING BY PHENOTYPING**

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### **ABSTRACT**

Regrettably, fruit diseases may fail agricultural productivity and the global economy. Numerous studies have established that fruits are critical for sustaining optimal health. A healthy diet must include plenty of fruits if it is effective. The use of physical characteristics to diagnose fruit diseases is a novel and improved approach described in this study. The novel technique incorporates Artificial Neural Networks and Support Vector Machines. It maps images to their corresponding disease classifications using phenotypic traits such as texture, color, shape, fruit's hole structure, and physical makeup. Due to the usage of Artificial Neural Networks, this approach offers a few benefits over others in terms of detection and classification accuracy. They need far less preprocessing than conventional image classification approaches. There is a strong indication that the filters were analyzed by a network rather than a person. An essential benefit of this trait is that it is entirely independent of past knowledge and human effort. The Artificial Neural Network is combined with a Support Vector Machine to boost classification accuracy. The Proposed system can enhance disease identification and classification through more precise and automated approaches.

**Keywords: Fruit Diseases, Machine Learning, Phenotyping, SVM, ANN**

## INTRODUCTION

Agriculture has a substantial economic impact on the planet. Food is the most pleasurable thing on earth. Both humans and animals need agriculture. Thus it should be given top priority, regardless of its variety, type, yield, or output, every sort of crop. Diseases are a significant issue in agriculture. Mango (fruits) are essential to agriculture and are consumed daily by practically everyone. It is no secret that Mango fruit diseases are a huge issue, affecting the quality and quantity of global harvests. Mango fruits are susceptible to a wide array of diseases. They include but are not limited to canker, greasy spot, and black spot. Certain diseases affecting Mango fruits are listed below, and they are categorized and investigated in depth. The Mango fruits were examined using image processing technologies for detecting items. A proposal for an automated method for detecting Mango fruit infections based on indicators has been created; the proposed technique also solves concerns with Mango fruit photographs. This study makes use of a subset of a more extensive dataset. We cannot survive without Mango fruits. As a result, agricultural enterprises worldwide seek novel techniques and procedures to

increase output while minimizing damage caused by Mango plant diseases.

A Support Vector Machine (SVM) simplifies the identification of diseased agricultural and horticultural crops. SVM was used for the study due to its utility in dealing with complex issues and sparse data sets. SVM creates an associated hyperplane for each input vector in the training set, categorizing data based on its distance from the contiguous training data. A parallel hyperplane is constructed on either side of the isolating plane, and during the margin computation, it is strapped in opposition to the two different data sets. There have been several attempts to identify and classify Mango diseases.

A new technique, detecting two Citrus fruit-borne *Penicillium* fungus might be more accessible. The goal is to keep financial losses to a minimum. These faults, which are harmful because they cannot be recognized by UV (Ultraviolet) light, cannot be discovered by optical inspection of a computer vision framework. Using a hyperspectral computer vision framework provides for better object separation [1]. Additionally, as the number of characteristics increases, it becomes impossible to include

them directly into a classifier, necessitating feature selection methods.

A desire for large yields to fulfill agricultural enterprises' higher-quality fruit yields is necessary, and an automated method for detecting disease on fruits is required [2]. Artificial neural networks have been presented as a mechanism for classifying fruit illnesses, and this approach may prove advantageous. The infected region on the fruit may be identified using K-Means clustering, although this method has a high estimation weight. As a result, better products and quicker decisions will be pushed—image processing and machine learning methods [3].

Additionally, to the initial scope, work has incorporated crops such as rice. In the rice crop, image processing techniques such as preprocessing, segmentation, and extraction are applied to locate the issue. Improved Fruit Detection Algorithm Using Multiple Features by utilizing a range of attributes enables a more accurate location of the fruits on the plant [4]. Extorting numerous features is achievable through a procedure that comprises phases such as deleting color and intensity information from a feature map and orientation information. Because it is entirely automated, it can operate even when the user is not there. It considers a range of aspects to

optimize the outcome [5]. Fruit ripeness is determined by the color or texture of the fruit. Established methods and manual inspection are used. This leads to categorization inaccuracies and economic losses due to defective products in the market chain. Manual inspection is not an option here. While some ways are ineffective because of the high cost of setup and lengthy procedures, the discrete cosine transform, a method for assessing fruits, has an accuracy of up to 98 percent [6].

A system was devised to evaluate the quality of fruits, particularly Mango. SVM and PNN (Mango) classifiers classify normal and damaged fruit images using texture characteristics derived from their surfaces. According to the classification results, the SVM classifier performed much better than the PNN classifier as a discriminator. Gathering, transporting, and manipulating fruits has been shown to cause damage by researchers. FEM models utilizing general material characteristics and unit stacks are used to investigate the stress on fruits that causes them to decay. According to models, most strain is generated in the centers of fruits, leading them to shatter [7].

## **PROPOSED METHODOLOGY**

### **The Proposed Algorithm**

Step 1: Image reading, contrast enhancement, and color space conversion.

Step 2: Using K-means clustering, a segment of Mango disease is extracted.

Step 3: Feature extraction from the segmented image.

Step 4: A multi-class Support Vector Machine and Artificial Neural Network are active to classify the disease.

Step 5: Detection of a variety of diseases

### **Artificial Neural Network**

New prototypes in artificial neural networks have made it possible to explore, analyze, and use the commonalities between human-computer interactions. An artificial neural network is a purely physical system of cellular units that may be used to gather experimental data, store it, and use it later. Systems modeled after the human brain are developed to mimic how individuals learn [8]. Layers 1 and 2 of a neural network change the input, while Layer 3 is hidden from view. To identify patterns that would be practically impossible for a person to extract and train a machine about on their own may take advantage of their tools. Because there are various neural networks, each has a specific application and complexity [9]. Imagine a neural network where all

information goes from input to output simultaneously (feedforward).

Feedforward and recurrent neural networks are two types of artificial neural networks based on the allowed flow of information. The recurrent neural network is increasingly common because it allows data to flow in several ways. For tasks like handwriting or language recognition, these neural networks are commonly employed since they are more capable of learning. [10] Since the recurrent connections have been delayed, this model knows the inputs that came before it (typically a one-time step when utilizing discrete time). When feedforward networks are used, all information is directed toward the outputs.

### **Support Vector Machine**

SVMs (Support Vector Machines) use supervised binary classification, a method. An (N-1) dimensional hyperplane divides an N-dimensional SVM into two heaps. If researchers use a hyperplane to categorize the data, ensure that the margin between each data point in each category is as large as possible. The addition of slack variables enables the application to be expanded to linearly inseparable classes [11]. The loss function then adds the norm of the slack variable. Even now, SVMs, namely linear SVMs, remain a prominent machine-learning

technique. Numerous examples exist of linear SVMs performing well when confronted with enormous amounts of data and multiple attributes. Apart from that, they are quick to pick up new skills.

It is a term that refers to inputs or samples that are hardly visible from one another. The hyperplane tries to separate the samples as much as possible by a predetermined margin [12]. Support vectors are samples near the hyperplane but not inside the margin separating margin; they are also auxiliary vectors. *Support vectors* are samples used to substantiate a claim. They are a frequently used type of Algorithm in supervised learning. New un-seed data, to identify the

model must be able to distinguish between labeled and un-seed data [13]. Frequently used approach in supervised learning for identifying photos using the attributes recovered by a deep neural network.

Support vector machines can minimize the number of training samples since the separation hyperplane is based exclusively on the class boundary vectors [14]. The suggested approach for detecting Mango fruit diseases represented in **Figure 1** below is based on phenotyping and can detect Mango fruit infections. Two components of the proposed approach are feature extraction and classifiers.

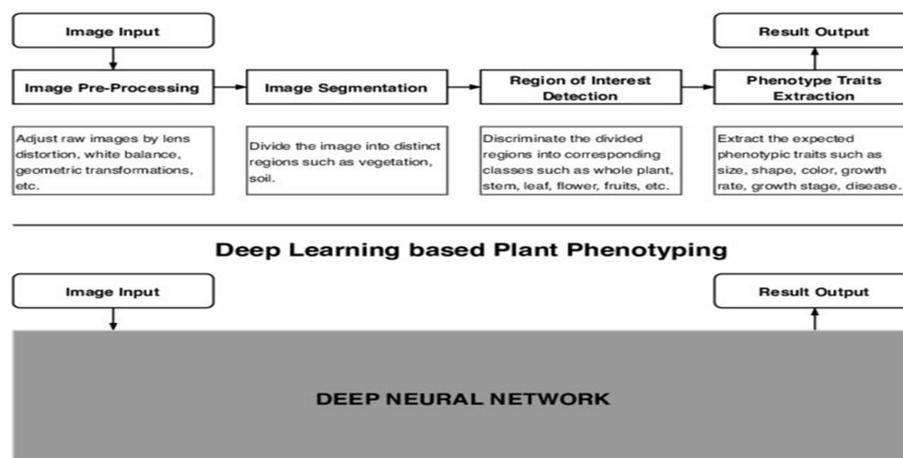


Figure 1: Architecture for Fruit Disease Detection

**Image Preprocessing:** The researcher must first create and test an image to begin the image processing workflow series, as the processing procedure can only begin with an image. Image preparation and sample testing like What You See Is What You Get

(WYSWYG), regardless of the method used to create the image on the computer or monitor.

**Image Segmentation:** Segmentation techniques separate a digital image into several distinct sections. Typically,

segmentation clarifies and alters a picture's graphical representation into something that can be analyzed more thoroughly. Image segmentation can be used to locate specific objects within a photograph and the bounding box of the photograph. Each pixel in an image has identifying components that serve as a label for the pixel. These features are shared by pixels with similar label parts by using the K-Means Clustering technique.

**Feature Extraction:** Four distinct fruit hole morphologies and textures are considered when extracting fruit holes. At times,

tremendous amounts of resources are necessary to understand massive datasets. The characteristics of the data are extracted using a multi-class SVM technique.

### Experimental Analysis

Figure 2 depicts the many forms of mango fruit diseases that have been identified. The classifiers have undergone extensive training and have been validated using photos of mango fruit diseases as cues for classification.

### Types of Mango Diseases

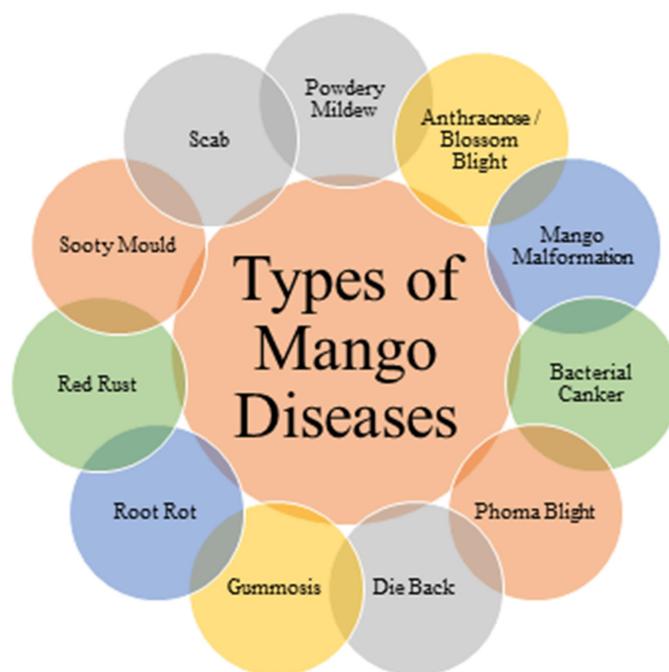


Figure 2: Types of Mango Disease

**Powdery Mildew:** Symptoms of the disease include white powdery fungal growth on the leaves, panicle stalks, blooms, and newly ripened fruits. Premature flower and fruit

drop diminish or even eliminate fruit set, considerably reducing crop load. The fungus parasitizes every component of the inflorescence, including the leaves and fruits.

Despite attacks on both sides of the young leaves, the surface of the grower exhibits the most wear and tear. When these spots coalesce, large patches of purple-brown can emerge.

**Anthracnose:** Disease has a devastating effect on young plants, including new shoots, blooms, and fruit. When it comes to fruit storage, it has an impact. Symptoms of infection include leaf spot, bloom spot, wither tip, twig spot, and fruit rot. Because fresh branches have sensitive shoots and leaves, they are simple to kill. Infected wounds on elder branches might be fatal in certain circumstances. According to the climatic conditions, blight can range from a minor infection of the panicles to a severe illness. Black spots develop on panicles and fruits. If the infection is severe, the entire inflorescence will be destroyed, resulting in the absence of fruits. Symptoms of infected immature fruits include black blotches, shriveling, and dropping. Fruits infected with the fungus can cause substantial damage and even death before ripening is transported to storage.

**Die Back:** Microorganisms that because disease includes those that cause dieback and tip dieback, as well as graft-union and twig blight and seedling rot. October and November are the most visible months for

the illness. Examining old trees closely, we notice dried-back twigs and leaves that appear burnt by fire. Internal browning of wood tissue can be observed by cutting the material along a long axis. Branches exhibit indications of aging prior to their mortality, including fissures and the production of gum sap. It frequently perishes when a nursery plant's graft union is disrupted.

**Phoma Blight:** Only mature leaves exhibit illness symptoms. At first, a few angular, yellow to light brown lesions develop on the leaf lamina. Lesions become cinnamon-colored and more irregular in appearance as they grow in size. Fully formed lesions have dark borders and dull gray necrotic centers. When an infection is severe, these spots cluster into patches ranging in size from 3.5 to 13 cm, causing infected leaves to wither and defoliate completely.

**Bacterial Canker:** Water-soaked lesions on leaves and stalks, as well as stems, twigs, and branches, as well as fruits, are common symptoms. Irregularly shaped to elevated angular lesions ranging in diameter from 1-4 mm are seen on the underside of leaves. Their tint is mild yellowish-orange, but they develop irregular necrotic cankerous areas that eventually turn dark brown as they expand or solidify. Water-soaked, dark brown to black lesions on fruits are relatively

uncommon, and they can turn into cankerous, elevated, or flat lesions over time. As the faults increase in size, the fruit, usually 1 to 5 mm in diameter, becomes almost totally covered with imperfections. These sites frequently rupture, ejecting sticky fluids packed with highly pathogenic microorganisms.

**Red Rust:** There has been evidence of red rust disease in Mango growing areas caused by an alga. Reduced photosynthetic activity and leaf defoliation are secondary consequences of the algal attack, compromising the host plant's health. Rusty red blotches on leaves, petioles, and the bark of young twigs are apparent indicators of the epiphytic disease. The blotches have a greenish-gray tint and a velvety texture. They ultimately rust to a reddish hue. More significant, uneven spots can form when the round, slightly elevated dots collect. Orchards that are densely planted are more susceptible to infection.

**Sooty Mould:** In orchards, mealy bugs, scale insects, and hopper populations are out of control, and disease outbreaks are common. A soft black layer on the leaf surface distinguishes sooty mould in the field. There are also instances where the whole surface of a tree's branches and leaves are covered with mold. When the insects above excrete

honeydew, this affects the severity of the infection. To aid in the growth of fungus, honeydew secretions from insects adhere to leaf surfaces.

**Mango Malformation:** Young seedlings exhibit significant seedling abnormality. The seedlings that have been harmed exhibit abnormal vegetative growths that are bloated and have short internodes. When deformed flowers transform into leaves and stalks with significantly reduced internodes, resembling a witch's broom. This condition is referred to as floral malformation. Because flower buds rarely bloom, they are always a dull green tint.

**Gummosis:** If the disease is in a tree, the infected wood, the trunk bark, and the larger branches are seeping gum, but this is more prevalent on the broken branches. Gum drips down the stem in severe cases; the bark darkens, splits longitudinally, and rots completely, causing the tree to wither and die.

**Root rot & Damping-off:** The seedlings will endure sudden leaf loss from the earth, indicating the sickness. Circular to irregular water-soaked patches are formed at or below ground level during continuous wet and humid circumstances. These splotches grow until they completely cover the seedlings' roots.

**Scab:** Scab fungus may harm mango fruit and foliage. Rainy season lesions might range from round to slightly angular to elongated and between 2 - 4 millimeters in diameter. Anthracnose-like symptoms can be seen in the early stages of this illness. The infection appears as a grayish-brown tint with black irregular borders on immature fruits. The fruit's center may be engulfed by the crack fissure and corky tissues as it grows in size.

**Post-harvest Diseases:** Anthracnose (*C. theobromae*) and stem-end rot can cause a wide range of post-harvest infections on mango fruit for a long time after harvest (L.

*gloeosporioides*). In addition to mango rot, *Aspergillus* rot is another post-harvest disease.

Mango fruit infections are depicted in **Figure 3**. (below). They are wreaking havoc on Mango trees, substantially lowering their harvests. While the fruit remains linked to the tree, these diseases remain dormant and do not appear. After the fruit has been taken from the tree and stored, symptoms appear. Dieback, fruit drop, and leaf loss may occur if this situation goes unaddressed for too long images of diseases in mangoes that cause a significant drop in output.



Figure 3: Images of Mango fruit-related diseases

Classifiers were trained and assessed on photos of fruits extracted from a data set (Mango). Training and testing will only include photos from a single category. A support vector machine and an artificial neural network model were trained and evaluated using color and texture information.

**Dataset:** For feature extraction, photos that contain vectors, colors, textures, morphologies, and the structure of holes are used (all of a phenotypic character). A fruit's color can help in its detection, extraction, segmentation, and classification data by using Kaggle datasets.

Severe infections can result in defoliation and dieback signs on twigs and stems, which

are not uncommon. Figure 4 depicts a process of diseased Mango fruits by

phenotyping.

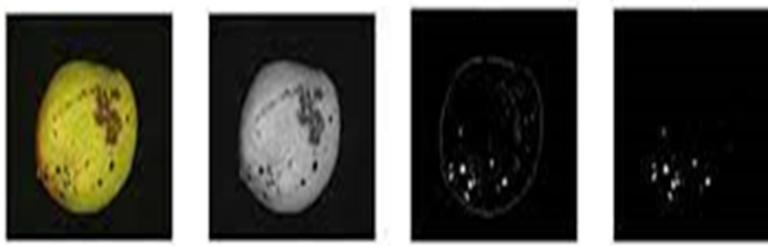


Figure 4: a) Preprocess, b) Segmentation c) Extraction d) Classification

## RESULTS AND DISCUSSION

Mango fruit diseases images are used to train and evaluate classifiers. Afterward, the classifiers are utilized to forecast outcomes. Training and evaluation to facilitate the images might be divided into two sections. The artificial Neural Network model generates results and trains and evaluates the color and texture highlights. The accuracy rate of identification and classification can be computed while examining a picture by dividing the number of successfully identified samples by the total number of samples used. The performance of both classifiers is shown in **Table 1**.

Classifiers are used to categorize items based on their properties, including color, texture, and the structure of the fruit hole. Both classifiers were reviewed and compared side by side to determine their accuracy. **Table 2** compares the classification precision of the two classifiers in response to the data's

decreased color, texture, and hole structure. The table demonstrates that the SVM performs much better than the ANN classifier by a tiny margin. Experiments demonstrated that only five texture qualities were meaningful in all of the images analyzed, as judged by these methods. When classifying plant diseases, these five characteristics are given significant weight. As a result, the total number of first-level feature reductions has been reduced to five. It is essential to use the limit and delta values to determine how much the value should be reduced. Values less than this threshold are discarded. The cutoff value is calculated by averaging the lowest and greatest feature values. They compared the performance of Support Vector Machine and Artificial Neural Network classifiers with integrated detection and classification characteristics, as shown in **Table 2**.

Table 1: Detection and classification performance

Detection and classification performance (%)	Artificial Neural Network			Support Vector Machine		
	Color	Texture	Structure Hole	Color	Texture	Structure Hole
Minimum Accuracy	82	84	87	84	88	87
Maximum Accuracy	96	98	95	95	97	98
Average Accuracy	90	91	93	89	88	84

Table 2: Performance evaluation of both classifiers

Detection and classification	Classifier	
	Support Vector Machine	Artificial Neural Network
True Positive Rate	0.964	0.876
False Positive Rate	0.937	0.958
Precision	0.961	0.873
Average Classification Accuracy ACA(%)	94.16	89.42

## CONCLUSION

The proposed technique is dependent on the initial detection of Mango diseases. The efficacy of the methods is determined using Mango fruit infections. The recommended classifiers categorize the world according to color and texture. Even though the results have changed for many Mango infectious images, the grouping of feature highlights has proven to be successful. Because the proposed technique communicates parameters, classification precision increases while calculation time is decreased compared to others. According to the findings of the studies, the proposed approach is much superior, allowing for accurate Mango infection identification with a minimum of computing effort. Support Vector Machine appears to outperform Artificial Neural Network regarding classification accuracy, resulting from Support Vector Machine. When it came to classifying plant diseases,

the Support Vector Machine proved to be an excellent tool and improved accuracy.

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## REFERENCES

- [1] Amin R, Saryoko A. Image Segmentation For Detection and classification Apple Diseases using K-Means and MSVM. 2nd International Conference on Advanced Information Scientific Development (ICAISD) 2021.
- [2] Fenyvesi L, Fenyvesi D, Csatár A. Stress analysis in fruits. *Advances in Mechanical Engineering*. 2013;5:874673.

- [3] Gómez-Sanchis J, Martín-Guerrero JD, Soria-Olivas E, Martínez-Sober M, Magdalena-Benedito R, Blasco J. Detecting rottenness caused by *Penicillium* genus fungi in citrus fruits using machine learning techniques. *Expert Systems with Applications*. 2012 Jan 1;39(1):780-5.
- [4] Hassan NM, Nashat AA. New effective techniques for automatic detection and classification of external olive fruits defects based on image processing techniques. *Multidimensional Systems and Signal Processing*. 2019 Apr;30(2):571-89.
- [5] Jhuria M, Kumar A, Borse R. Image processing for smart farming: Detection of disease and fruit grading. In 2013 IEEE second international conference on image information processing (ICIIP-2013) 2013 Dec 9 (pp. 521-526). IEEE.
- [6] Khoje SA, Bodhe SK, Adsul A. Automated skin defect identification system for fruit grading based on discrete curvelet transform. *International Journal of Engineering and Technology (IJET)*. 2013 Aug;5(4):3251-6.
- [7] Madhav MU, Jy othi DN, Kalyani P. Prediction of pesticides and identification of diseases in fruits using Support Vector Machine (SVM) and IoT. In AIP Conference Proceedings 2021 Dec 1 (Vol. 2407, No. 1, p. 020016). AIP Publishing LLC.
- [8] Moraes JL, Oliveira Neto JD, Correia-Silva JR, Paixão TM, Badue C, Oliveira-Santos T, Souza AF. Sisfrutos Papaya: A Dataset for Detection and Classification of Diseases in Papaya. In *International Conference on Artificial Neural Networks 2021 Sep 14* (pp. 28-39). Springer, Cham.
- [9] Patel HN, Jain RK, Joshi MV. Fruit detection using improved multiple features based algorithm. *International journal of computer applications*. 2011 Jan;13(2):1-5.
- [10] Rajendra AB, Rajkumar N, Prathuksha D Shetty 2020, 'Areca Nut Disease Detection Using Image Processing', In: Pant M., Kumar Sharma T., Arya R., Sahana B., Zolfagharinia H. (eds) *Soft Computing: Theories and Applications. Advances in Intelligent Systems and Computing*, vol. 1154, pp. 925-931. Springer, Singapore.
- [11] Rauf HT, Saleem BA, Lali MI, Khan MA, Sharif M, Bukhari SA. A citrus fruits and leaves dataset for detection and classification of citrus diseases through machine learning. *Data in brief*. 2019 Oct 1;26:104340.

- [12] Rupanagudi SR, Ranjani BS, Nagaraj P, Bhat VG. A cost effective tomato maturity grading system using image processing for farmers. In 2014 International Conference on Contemporary Computing and Informatics (IC3I) 2014 Nov 27 (pp. 7-12). IEEE.
- [13] Shah JP, Prajapati HB, Dabhi VK. A survey on detection and classification of rice plant diseases. In 2016 IEEE International Conference on Current Trends in Advanced Computing (ICCTAC) 2016 Mar 10 (pp. 1-8). IEEE.
- [14] Sharif M, Khan MA, Iqbal Z, Azam MF, Lali MI, Javed MY. Detection and classification of citrus diseases in agriculture based on optimized weighted segmentation and feature selection. *Computers and electronics in agriculture*. 2018 Jul 1;150:220-34.