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Features Analysis and its Impact over the Identification and Classification of Date Palm Disease

Husnara khan[1], Dr. Anubhav sharma[2] and Prof. Manmohan Singh[3]
[1-3]IES university Bhopal /Computer Science and Engineering, Bhopal, India
Email: husnarakhn@gmail.com, anubhav.sharma0025@gmail.com, Kumar.manmohan4@gmail.com

***Abstract*— Date palms are vital agricultural crops with significant economic and cultural importance in many regions. However, their productivity is frequently at risk from a variety of diseases that may severely impact yield and fruit quality 30–40% crop losses per year so this research is dedicated to diagnosis and grouping of date palm diseases by analyzing key features extracted from images and other Pertinent information through cutting-edge approaches in ML, involving feature extraction and classification of computational processes, with correlation factor of features. The planned system is meant to accurately detect and categorize common diseases affecting date palms. The approach enhances early diagnosis, enabling timely intervention and improved crop management. Results from experiments confirm the model's effectiveness in delivering accurate outcomes, providing a reliable tool Enabling agricultural professionals and farmers to monitor and protect date palm plantations.**

***Index Terms*— Date Palm, Plant Disease Detection, Disease Classification, Feature Extraction, Machine Learning, Image Processing.**

I. INTRODUCTION

Feature analysis is essential for effective identification and categorization of ailments affecting date palms. By extracting important visual traits from images of infected leaves, it enables precise disease detection using machine learning algorithms. Features such as color changes, texture patterns, lesion shape, and size can help distinguish between different date palm diseases, greatly enhancing disease management approaches in date palm farming. Date palm holds growing significance in India's horticultural landscape, particularly in arid and semi-arid zones. Major production hubs include Gujarat (notably Kutch), Rajasthan, Maharashtra, Tamil Nadu, and Kerala. In Kutch district of Gujarat, approximately 19,000 hectares cultivate date palms, yielding around 180,000 metric tonnes annually. At the national level, India imports over 250,000 metric tonnes of dates annually due to limited domestic production [9] disease and climate stress which significantly reduce productivity. In Kutch, shifting weather patterns—such as monsoon rains arriving earlier and more frequently—are causing 30–40% crop losses per year, as unripe or spoiled fruit becomes unsellable.

II. KEY ASPECTS OF FEATURE ANALYSIS IN IDENTIFYING DATE PALM DISEASES

A. Visual Indicators

Date palm diseases typically exhibit noticeable symptoms such as discoloration, spots, wilting, or alterations in leaf structure.

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These visual changes can be analyzed through imaging techniques and converted into distinct features for disease identification.

B. Feature Extraction Methods

Various image processing techniques are employed to extract meaningful features, including color space transformations (e.g., RGB, HSV), analysis of pattern features (such as from Gray Level Co-occurrence Matrix) and shape analysis, aiding in accurate disease classification.

C. Common Date Palm Diseases

Feature analysis aids in detecting various date palm diseases, such as Sudden Decline Syndrome (SDS), black leaf scorch, trunk rot, inflorescence blight, and root rot, each exhibiting unique visual symptoms.

D. Machine Learning Integration

The derived features are employed in training machine learning techniques such as Support Vector Machines and Neural Networks, and Convolution Neural Networks, enabling accurate classification of date palm diseases from new image data.

III. Impact of Feature Analysis

A. Early Detection:

Feature analysis through image processing facilitates the early identification of diseases, enabling prompt intervention and management before severe damage occurs.

B. Accurate Classification

By extracting distinctive features, the system can differentiate between visually similar diseases, ensuring precise identification and classification.

C. High-Throughput Screening

Automated image analysis and feature extraction allow for rapid screening of large date palm orchards, enhancing monitoring efficiency and disease detection.

IV. Challenges in Feature Analysis

- Environmental Variability: Factors such as lighting conditions, leaf differences, and plant growth stages can influence the visual appearance of disease symptoms, necessitating robust feature extraction techniques.
- Disease Severity: Distinguishing between early and advanced disease stages can be complex, often requiring sophisticated feature analysis methods for accurate assessment.

Overall, feature analysis plays a vital role in advancing disease detection systems for date palm cultivation. By leveraging image processing techniques to extract key visual characteristics, it enables precise and timely identification of various diseases, ultimately improving disease management strategies.

This work include the Features analysis and its Impact over the detection and classification of date palm diseases play a crucial role in effective farming, as timely identification and accurate categorization of plant diseases are essential for maintaining healthy crops and ensuring good agricultural practices. So identification of the diseases in very early stage is good for the farmer. The aim of this research is cantered on identifying relevant features with is impact over the Date palm disease identification. Identifying the plant disease that affect date palms and its features impact selection is challenging task. To determining the degree of infestation due particular feature its computation is also the challenging task is cover in this work. The date palm scale is a pest that feeds on plant sap and feeds on palm leaflets and forms colonies on them. In this proposed work we will work on the given factors mention below that affect date palm tree :

Temperature :Healthy Date palms required the temperatures between 21-270 C. So in this proposed work we try to compute the affect of Temperature on Date palm. The affect of temperature is also intensive factor and its impact over the date palm tree.This analysis will give some valuable outputs to help to categorization of disease in early stage.

Rain - This is also one of the Analysis factor to indentifying the date palm tree. We are proposed the analysis computation of Rain data and its impact over the Date palm disease. As of now a little rain is good for the date palms grow without any damage. So in this factor we try to analysis a ratio of Rain using the existing sample data.

Humidity: Low humidity is required for the healthy growth of palm tree and the best production of date. Based on the data set we try to analysis the impact of humidity and indentifying the disease cause by its variation.
Water- Date palms needs ground water in proper ratio. To maintain this ration is also the difficult task. Here in the proposed work we try to analysis the impact of water ratio for the date palm disease.

V. MOTIVATION

As of now many researcher work based Regarding the categorization of date palmdisease identification using the exiting Machine learning algorithm. They were used the CNN model, SVM, Deep learning model,Random Forest algorithm, KNN many more summarized information is mention in the literature work as Tabular format. The motivation of this work is to identifying the feature and its impact over the disease of date palm tree.

VI. LITERATURE REVIEW

[1] Abdallah Namoun (2024) The study presents animage dataset of date palm leaf diseases developed to aid in the early detection and classification of palm infections. The dataset includes images of eight major disorders—three physiological, four fungal, and one pest-related—namely potassium deficiency, manganese deficiency, magnesium deficiency, black scorch, leaf spots, fusarium wilt, rachis blight, and Parlatoriablanchardi. Healthy leaf samples are also incorporated as a control. A total of 608 raw images were collected over a three-month period during the autumn and spring seasons from ten operational date farms in the Madinah region of Saudi Arabia. Captured using both smartphones and an SLR camera, the images focus on infected leaves and leaflets, deliberately excluding fruits, trunks, and roots excluded. The infected leaf images underwent processing steps including filtering, cropping, augmentation, and disease category assignment. The final processed dataset contains 3,089 images and is intended for training deep learning classification models to facilitate the early prevention of date palm diseases.
[2] Tan Soo Xian et.al (2024) Plant diseases pose a significant challenge to crop quality and productivity, potentially leading to food shortages. Hence, classifying plant diseases is vital for the agricultural sector. This research focuses on classifying plant diseases through leaf image analysis using the Extreme Learning Machine (ELM), a machine learning classifier built on a single-layer feed-forward neural network. The process involves pre-processing images in the HSV color space and extracting features using Haralick descriptors analysis. These derived features serve as input data for the ELM classifier, which is trained and tested accordingly. After testing, the model's accuracy is calculated. The dataset employed consists of tomato leaf images, taken from the Plant Village dataset. Experimental results show that the ELM Obtained an accuracy score of 84.94%, outstripping other approaches like Support Vector Machine (SVM) and Decision Tree (DT).[3] Jianping Yao1et al (2023) The increasing emphasis on sustainable development has driven the adoption of various information technologies to support agricultural production. In particular, Machine learninga subfield of artificial intelligence has driven remarkable advancements, with the capacity to revolutionize methods in plant pathology. In recent years, it has been extensively employed for leaf disease classification across both academic and industrial domains. Therefore, developing a thorough understanding of recent progress in machine learning methods and their applications for leaf disease detection holds great value for researchers, engineers, managers, and entrepreneurs alike. This work provides a comprehensive survey addressing various dimensions of the field, including datasets, methodologies, and practical applications. It begins by reviewing publicly available datasets, followed by an overview of common machine learning approaches, such as basic learning methods, deep learning techniques, and augmented learning models. The paper concludes with a discussion of relevant applications. Overall, this work serves as a useful resource for future research and practical implementation of machine learning in the context of smart agriculture, specifically targeting leaf disease classification. [4] Muhammad Shoaib (2023) Plants are essential for meeting the global food supply needs, yet various environmental factors can cause diseases that lead to substantial yield losses. Manual identification of such diseases is typically slow, error-prone, and unreliable for controlling their spread. Utilizing advanced technologies like Machine Learning (ML) and Deep Learning (DL) provides a solution by enabling early and precise detection of plant diseases. This paper reviews recent advancements in the application of ML and DL for plant disease diagnosis, focusing on research published between 2015 and 2022. The analyzed experiments highlight the effectiveness of these approaches in improving both the accuracy and speed of disease detection. Furthermore, the study addresses the primary challenges and limitations of implementing ML and DL in this field, such as scarce datasets, poor image quality, and the difficulty of differentiating healthy plants from diseased ones. By tackling these challenges, the research delivers valuable guidance for researchers,

practitioners, and industry stakeholders, presenting both the advantages and constraints of these approaches and suggesting possible strategies to overcome implementation challenges.

[5] Abu-zanona M (2022)The palm tree is among the most resilient tree species and holds a prominent position as one of the most widely cultivated and valuable trees worldwide, serving numerous purposes and offering various benefits. During the last few years, date palms have been increasingly affected by various diseases. These ailments differ in symptoms and causes, often overlapping in presentation, which makes accurate diagnosis through visual inspection difficult—even for experienced specialists. This research proposes a CNN-based model for detecting and classifying four common palm diseases—Bacterial Leaf Blight, Brown Spots, Leaf Smut, and White Scale—as well as identifying healthy leaves. The CNN architecture includes four convolutional layers for feature extraction, followed by a fully connected layer for classification. To evaluate its performance, the model was compared with two established CNN architectures, VGG-16 and MobileNet, using Accuracy, Precision, Recall, and F1 Score as evaluation metrics. The proposed model attained 99.10% accuracy, compared to 99.35% for VGG-16 and 99.56% for MobileNet.. Overall, although the performance of all three models is comparable, MobileNet holds a slight edge in accuracy, whereas the proposed model stands out for its simplicity and reduced computational training time.

[6] M. Al-Shalout and K. Mansour (2022) Date palm farming plays a central role in oasis agriculture, valued for both its economic significance and nutritional benefits. However, numerous diseases endanger this essential crop, creating threats to the economy and the environment. One of the most harmful is white scale (Parlatoriablanchardi), a pest that reduces fruit quality and, in severe cases, can kill the tree. Precisely detecting infected leaves and evaluating the extent of infestation is therefore crucialand essential to determine whether chemical treatment is required—an important decision for farmers aiming to reduce yield losses while maintaining quality.To address this, a machine learning (ML)-based framework with feature extraction was developed for classifying the study investigates the infestation stages of white scale disease (WSD) in date palm leaves. From leaflet images, 80 texture features derived from the gray-level co-occurrence matrix (GLCM) and 9 color moment features in the hue, saturation, and value (HSV) space were extracted from both grayscale and color formats. Four infestation levels were identified: healthy, low, medium, and high. Two groups of machine learning algorithms were evaluated—classical approaches (support vector machine, SVM; k-nearest neighbors, KNN) and ensemble approaches (random forest, RF; light gradient boosting machine, LightGBM). The models were trained and tested on two datasets: one containing only GLCM features and another combining GLCM with HSV features. The SVM model achieved the best performance, reaching 98.29% accuracy with the combined feature set. This framework demonstrates strong potential for the early detection of date palm white scale disease (DPWSD),.helping oasis farmers implement timely preventive measures to safeguard trees and yields.In related work, Hamdani et al. (2021) tackled oil palm leaf disease detection, which primarily manifests on leaves and affects crop quality amid rising demand for high-grade palm oil. Their approach involved extracting features in multiple color spaces (RGB, Lab, HSI, HSV), dividing each color channel histogram into eight bins, and applying k-means clustering for leaf segmentation. Principal component analysis (PCA) was used to reduce the feature set to 41, which was then classified via an artificial neural network (ANN). Evaluation on 300 locally sourced leaf images (150 healthy and 150 infected) using 10-fold cross-validation achieved a sensitivity of 99.3%, specificity of 100%, and accuracy of 99.67%. In another study, Alaa et al. (2020) investigated three major palm diseases—Leaf Spots, Blight Spots, and Red Palm Weevil—which are often challenging to detect due to their hidden or inaccessible locations. The team collected both standard and thermal images of palm trees. Convolutional neural networks (CNN) were employed to differentiate between Leaf Spots and Blight Spots, while a support vector machine (SVM) was used for detecting Red Palm Weevil. The CNN achieved an accuracy of 97.9%, and the SVM reached 92.8%. Importantly, this research also introduced the first thermal image dataset of palms affected by Red Palm Weevil alongside healthy palms. This section summarizes notable studies conducted in this field. summarizing technical approaches and results in a comparative framework (Table 3.1). The comparative analysis serves as a valuable reference for the current research, offering benchmark insights to guide methodology and performance evaluation.

VII. Proposed Methodology with time Frame

This study introduces a detailed framework for detecting diseases in date palms using a combined deep learning and machine learning approach. The methodology involves several critical steps, including dataset pre-processing, feature extraction, training deep learning models, and performance evaluation. The dataset, sourced from Kaggle, contains images of date palms under various conditions, such as healthy, affected by brown spots, and infested with white scale. Pre-processing techniques are applied to prepare the dataset for analysis.

TABLE I: COMPARATIVE RESULT AND TECHNOLOGY

S.NO	In Reference	Year of Publication	Major Task (Listed disease)	Used Technology /Technical concept	Result accuracy
1	[1] Tan Soo Xian et.al	2024	Plant disease classification	ELM and ML SVM	84.94%
2	[2] Jianping Yao1et al	2023	leaf disease classification	deep learning, and augmented learning	Review
3	[3] Muhammad Shoaib	2023	existing research work Review	Deep learning and ML approach	Review
4	[4] Abu-zanona	2022	Bacterial leaf blight, Brown spots, Leaf smut, white scale Palm tree	CNN	99.67%
5	[5] Al-Shalout and Mansour	2022	feature extraction technique may be adopted as a resort to perform the sub-mentioned tasks	CNN	Review
6	[6] Hamdani H et.al	2021	Palm tree curvularia leaf spots	ANN	99.67%
7	[7] Alaa H., Waleed et.al 97.9%	2020	Red Palm Weevil date palm	CNN	

VIII. THE SUGGESTED METHOD

The block diagram in Figure 1 illustrates the fundamental process of the proposed vision-based detection algorithm in this study. Initially, images of different plant leaves are obtained from a dataset. In the next stage, machine learning techniques are applied to these images to extract valuable features for further analysis.

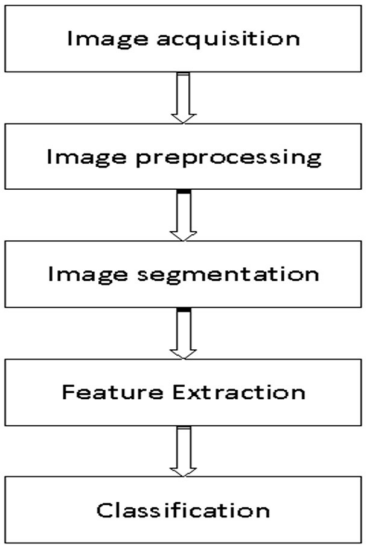

Figure 1 Block Diagram Detection of Plant Leaf Diseases

Image Capture: The dataset, obtained from Kaggle, contains Visual samples of date palms in multiple conditions, such as healthy, diseased with brown spot, and infested with white scale. It serves as the basis for training, validating, and testing the deep learning model.

Image Data Preprocessing: Prior to inputting the images into the models, various pre-processing techniques are employed to improve image quality and minimize noise. Among these techniques is the use of a median filter, which aids in smoothing the images and eliminating unwanted artifacts or imperfections.

Image Segmentation: It is a computer vision method that partitions an image into distinct pixel groupsIt holds a vital role in image analysis and processing and is widely applied in areas like plant disease detection.

Feature Extraction: Key features are derived from the preprocessed images to identify crucial details that differentiate healthy date palms from those affected by brown spot disease or white scale infestation. This step is essential in the deep learning pipeline as it enables the models to learn distinctive representations

Classification: In plant disease detection, classification involves identifying and categorizing diseases by analyzing images of leaves or other plant characteristics.

Detection: Plant disease diagnosis involves identifying the cause of a plant disease by analyzing its symptoms and detecting the presence of a pathogenic agent.

Proposed work is basically fragmented into two major part one is analysis the factor or feature and its impact over the disease of palm tree and second part is the classifying the date palm tree leave with affect of analysis feature for finding the impact of feature we used given formula.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

r = correlation coefficient

x_i = values of the x-variable in a sample

$\bar{x}$ = mean of the values of the x-variable

y_i = values of the y-variable in a sample

$\bar{y}$ = mean of the values of the y-variable

Fig 2

In the above formula value of x is selected factor or feature as mention in introduction section the quantities value we are accepting for the computation for classification impact over the feature we used Support Vector Machine based on Gray-Level Co-Occurrence Matrix analysismodel tentatively we used.

XI. Scope of the Proposed Study

This proposed work cover the various aspect of features in positive and negative manner to increases the good quality of date in exiting environment . Major scope of the proposed work to include the feature collection with it Quantitative value to perform the mathematical analysis based on the listed disease mention the above comparative study table .

X. Outcome

Feature Analysis and its impact for date palm. To compute the ratio of emerge factor as mention in the introduction section that affect the date palm. Selected Factor Ratio measurement Analysis for the growth of healthy date palm.

To achieve the highest accuracy for date palm identification based on feather impact analysis.This proposed work cover the various aspect of features in positive and negative manner to increases the good quality of date in exiting environment . Proposed work to include the feature collection with it Quantitative value to perform the mathematical analysis based on the listed disease mention in the above comparative study table .

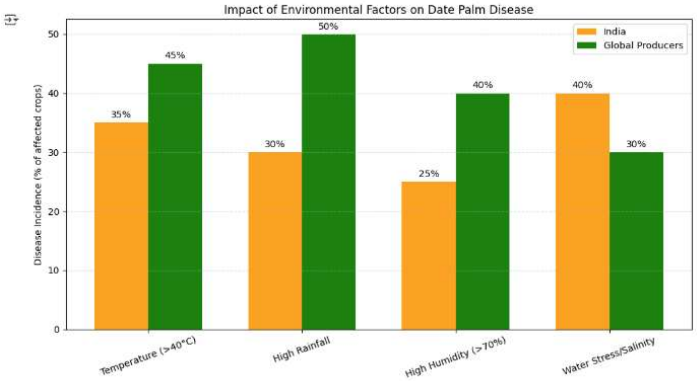

Figure 3. Impact of Environment on Date Palm Disease India vs Other Countries

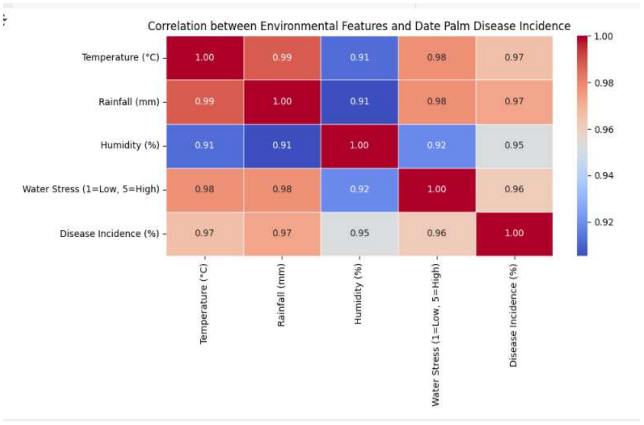

Figure 4. Computation of Correlation Heat Map

TABLE II. IMPLICATION FOR DISEASE IDENTIFICATION & CLASSIFICATION

Implications for Disease Identification & Classification	
Environmental Feature	Impact on Disease Identification and Classification
Temperature	Might make stress signs
Water	Water Stress
Humidty	Encourage certain pathogens

TABLE III. RESULT WITH FEATURE AND CORRELATION IMPACT

Hypothetical Result	
Feature	Correlation with Disease Incidence
Temperature	+0.85(+ve)
Rainfall	+0.80(+ve)
Humidity	+0.78(+ve)
Water Stress	+0.90 (+ve)

XII. CONCLUSION AND FUTURE WORK

This paper include the features aspect over the Date Palm disease identification .Using the Computation Correlation factor along with the features we identifying the disease as in result table 3. Future work increases the some other factor that leave their impact analysis over the date palm regional based analysis .

APPENDIX

A. Table

Table 1 Comparative Result and Technology
Table 2. Implication for Disease Identification & Classification
Table 3. Result with Feature and Correlation Impact

B. Figure

Figure 1 Block Diagram Detection of Plant Leaf Diseases
Figure 2. Impact of Environment on Date Palm Disease India vs Other Countries
Figuer3. Computation of Correlation Heat Map

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