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Machine Learning Techniques for Banana Disease Detection: A Comprehensive Review and Analysis

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***Abstract*— This research paper investigates the utilization of machine learning methods in the domain of banana disease detection, with the objective of improving the accuracy and effectiveness of disease diagnosis. Many diseases pose serious risks to banana crops, which are essential for maintaining global food security and can result in large yield losses. This study offers a comprehensive analysis of the situation of both conventional and contemporary methods for detecting banana disease. The study focuses on current developments that have improved the precision and effectiveness of disease diagnosis, including the use of cutting-edge technology like machine learning and remote sensing.**

This research could completely change the way banana diseases are managed by giving farmers a reliable, accurate, and timely tool for early disease detection. For banana growers, this can result in higher-quality produce, higher yields, and more profitability. The created system can also be modified to identify illnesses in different crops, which will greatly enhance agricultural output and food security overall.

***Index Terms*— Global food security Banana diseases, image processing, machine learning, disease detection, classification.**

I. INTRODUCTION

Bananas, a staple food for millions, are vulnerable to diseases like Panama disease, Black Sigatoka, and Bunchy Top. These diseases can have devastating consequences, threatening not only farmers' livelihoods but also global food security.

Historically, visual inspection and symptom-based identification have been the main methods used for disease detection in banana crops. Although these techniques have proven useful, they are time-consuming, labor-intensive, and prone to human error. Modern technologies are being investigated as a result of the demand for methods that are more automated and efficient.

Numerous diseases and pests have an impact on banana production. Novel and rapid methods for detecting pests and diseases will allow for more efficient surveillance and development of control measures. Deep learning, neural networks and transfer learning have been successfully applied in a variety of fields for crop disease detection.

One of the mainstays of global agriculture, banana farming is essential to tackling issues related to food security. However, a number of illnesses that can negatively affect yield and quality pose a threat to the sustainable

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production of bananas. The application of deep learning techniques to agricultural practices has demonstrated encouraging potential in recent years for revolutionizing disease detection and providing a more accurate and efficient substitute for conventional methods. This work aims to provide insights into the current state-of-the-art, challenges, and future directions in this important field by presenting a thorough review and analysis of the application of deep learning techniques for the detection of banana disease.

Fig1:- Banana Disease Detection

Fig 2 Banana Disease Detection

It was observed that diseases affect all banana crops. Leaf, stem, flower, fruit, roots, and suckers all exhibit symptoms. The most common leaf diseases are Xanthomonas wilt, Fusarium wilt, and black and yellow Sigatoka.

Banana Leaf Diseases

Banana Xanthomonas Wilt (BXW) is a bacterial infection caused by Xanthomonas campestris.
Wilt Fusarium It is commonly known as Panama infection, a deadly fungal infection caused by the soil-borne fungus Fusarium oxysporum.
The Bunchy Top Virus is a plant pathogenic virus ancestor nanoviridae that contaminates banana plants.
Black Sigatoka is called a black leaf streak caused by mycosphaerella. The multifaceted Sigatoka infection is a collection of intimately related fungi.

1. Methodologies

(i) *Image Acquisition*: Using smartphones or specialized cameras, high-resolution pictures of banana leaves with symptoms of different diseases will be taken.
(ii) *Image Processing* : To improve the characteristics important for illness identification, acquired images will be enhanced. Techniques like background removal, noise reduction, and color space conversion may be used in this.
(iii) *Feature extraction*: From the previously processed photos, pertinent features will be taken out. Color, texture, shape, and the spatial relationships between the various affected areas are examples of these features.
(iv) *Disease Identification and Classification*: To analyze the retrieved features and identify the existence and kind of disease, machine learning algorithms such as Support Vector Machines (SVM), Convolutional Neural Networks (CNNs), or Artificial Neural Networks (ANNs) will be trained.
(v) *Evaluation and Optimization*: Using a sizable dataset of labeled photos of banana leaves, the developed system will be assessed. Performance will be assessed using metrics such as F1-score, recall, accuracy, and precision. The system will undergo additional optimization to enhance its performance, taking into account the evaluation results.

Fig 3. Shows the methodologies for Banana Disease Detection and the Expected outcomes.,

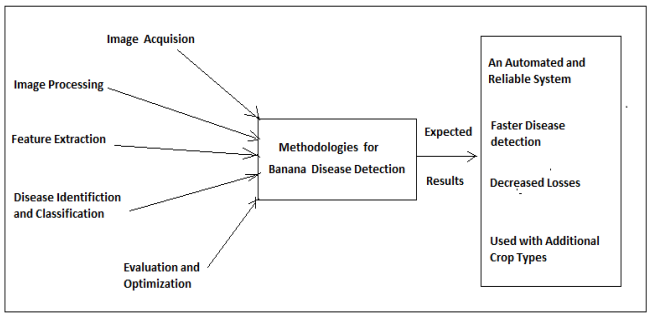

Fig 3.:- Methodologies for Banana Disease Detection

Root diseases can be avoided by keeping trees healthy and avoiding wounds in the root system and near the tree's base. It is difficult to control a root disease once it has infected a banana tree.

II LEAST SQUARES REGRESSION:

The least squares method is a mathematical approach for fitting a model to data points that is widely used. While it is not typically used directly for image-based classification tasks such as banana disease detection, it can be useful in scenarios involving quantitative measurements or predictions. Alternative machine learning methods, particularly those suited to image analysis, are more commonly used in the context of banana disease detection.
Convolutional neural networks (CNNs) have demonstrated significant success in image-based tasks such as disease detection in bananas. CNNs excel at capturing spatial patterns and features within images, making them useful for disease classification based on visual symptoms. Transfer learning, which involves leveraging pre-trained models on large datasets, can also improve CNN performance when dealing with limited datasets.
For Banana Disease numbers of bacteria and the corresponding scatter graph, the line of best fit is the straight line that can be drawn through the scatter points to best represent the relationship between them. We have the straight line equation:

$$Y = mX + Ci$$

Where Y stands for Dependent Variable.
M stands for incline and Ci for constant values of Banana disease
X stands for Independent Variable.
The goal here is to calculate the slope and y-intercept values and then plug them into the equation along with the values of the independent variable X that indicates the number of becteria to determine the values of the dependent variable Y.
Assuming we have 'n' data points, we can calculate slope using the frightening-looking formula below:

$$m = \frac{\sum(x - \bar{x})\,(y - \bar{y})}{\sum(x - \bar{x})^2}$$

$$c = \bar{y} - m * \bar{x}$$

Then substitute these values to equation Y = m X + c.
The Fig. 4 Shows the Regression Line for Banana Disease.

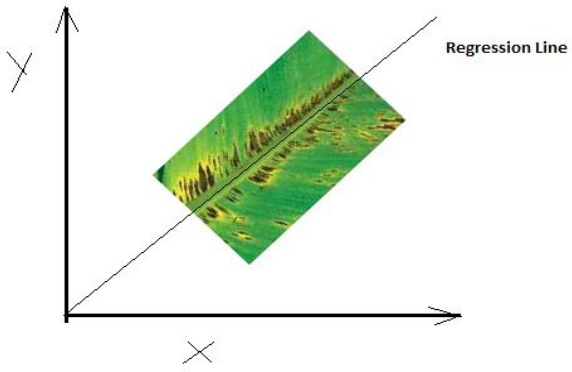

Fig. 4- Regression Line for Banana Disease

2. Expected Results

(i) An automated and reliable system for classifying and detecting banana disease.
(ii) Faster and more accurate disease detection than with conventional techniques.
(iii) Decreased losses for banana growers and improved disease control efficiency.
(iv) Possibility of use with additional crop types.

III. Conclusions

The importance of this research is that it highlights the immense potential of machine learning techniques in transforming the detection of banana diseases, providing a quicker and more precise alternative to conventional approaches. These findings significantly contribute to the continuous endeavors in precision agriculture, ultimately fostering sustainable banana cultivation and ensuring food security.

Furthermore, the developed system can be adapted to detect diseases in other crops, significantly contributing to the overall improvement of agricultural production and food security . Best fit Least square method is used to .

The analysis of current methodologies and the synthesis of existing literature reveal the transformative potential of deep learning in improving the efficiency and accuracy of banana disease detection.

Although the least squares method is not frequently employed for directly detecting banana diseases, it can be utilized in associated fields like regression analysis to forecast quantitative outcomes such as disease severity or crop yield using input variables. Nevertheless, when it comes to image classification tasks, contemporary machine learning techniques, especially CNNs, are more widely used and efficient.

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