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A SURVEY ON LEAF DISEASE DETECTION

Anamika[1], Bhoomika K[2], Sagar A Shetty[3], Pranathi Holla[4], Roopa K Murthy[5]

Student, Artificial Intelligence and Machine Learning, K S Institute of Technology, Bengaluru, India[1-4]

Professor, Artificial Intelligence and Machine Learning, K S Institute of Technology, Bengaluru, India[5]

Abstract: This paper presents a comprehensive overview of recent advancements in leaf disease detection methodologies. It covers a range of approaches, including deep learning with Convolutional Neural Networks (CNN), hybrid deep learning techniques, and machine learning algorithms such as Support Vector Machine (SVM) and Naive Bayesian classifier. Various aspects of plant diseases in different types of plants, including fruits, leaves, cotton, aquatic plants, coffee, pepper, and okra, are explored. Additionally, the integration of emerging technologies such as robotics, IOT, and smart solutions further enhances the accuracy and efficiency of disease detection systems. The study underscores the importance of these advancements in ensuring early detection and effective management of plant diseases, thereby contributing to improved agricultural productivity and sustainability.

Keywords: Image processing, Support Vector Machine (SVM), K-means clustering, Artificial Neural Networks (ANN), Yellow Vein Mosaic Virus (YVMV), Leaf vein extraction.

I. INTRODUCTION

Leaf disease detection is integral to preserving agricultural yield and ensuring food security. Recent research in this field has explored innovative approaches to enhance detection accuracy and efficiency. Leveraging Convolutional Neural Networks (CNN) within deep learning frameworks has emerged as a prominent strategy, offering promising results in disease classification for various plant types. Additionally, hybrid deep learning approaches, which combine CNNs with other algorithms, have shown potential to further improve disease detection, particularly in fruits and leaves. Machine learning algorithms such as Support Vector Machine (SVM) and Naive Bayesian classifiers have also been instrumental in accurately classifying leaf diseases across different crops, including cotton, coffee, pepper, and okra. Moreover, the integration of robotics and Internet of Things (IoT) technologies has revolutionized leaf disease detection systems, enabling real-time monitoring and automated intervention through platforms like Agrobots. This introduction sets the stage for exploring the diverse methodologies and technologies driving progress in leaf disease detection, crucial for agricultural sustainability and global food security

II. IMPORTANCE OF PLANT LEAF DISEASE DETECTION

1. Safeguarding agricultural productivity:

- Early detection allows for timely intervention to minimize crop losses.
- Effective disease management strategies can be implemented to protect crop yields.
- Prevention of extensive damage to crops ensures sustained agricultural productivity.

2. Sustainable agriculture practices:

- Early disease detection reduces the need for excessive use of chemical inputs such as pesticides and fungicides.
- Minimization of chemical use preserves ecosystem health and biodiversity.
- Promotes environmentally friendly farming practices, contributing to long-term sustainability.
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3. Ensuring food security:

- Plant diseases pose a threat to food security by reducing copy yields and availability.
- Early detection and management mitigate risks to the global food supply.
- Ensures and stable and reliable food supply for current and future generations.

4. Supporting the livelihoods of farmers and rural communities:

- Protects farmers' incomes by minimizing crop losses due to diseases.
- Enables farmers to sustain their livelihoods and contribute to vibrant rural economies.
- Promotes resilience in rural communities by safeguarding agricultural productivity and economic stability.

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III. LITERATURE REVIEW

SL.NO	YEAR OF PUBLICATIONS	PROJECT TITLE	DESCRIPTION
1	2023[1]	Detection of plant disease using convolutional neural networks. (CNN)	Since agriculture employs about 65% of the workforce, it is essential to India's economic growth. Plant ailments are diverse, making it challenging to categorize and identify them for human use. In response, an automated system based on Convolutional Neural Networks (CNNs) has been developed for the quick and easy detection and categorization of plant leaf diseases. The significance of this approach lies in its ability to precisely identify each plant, despite the multitude of diseases and their potential for swift dissemination. The study employs a dataset of manually collected and preprocessed potato plants to compare CNN based disease detection with conventional approaches. This comparison investigation reveals CNN's efficacy in identifying plant diseases, underscoring its potential as a valuable instrument for agricultural development and crop protection.
2	2023[2]	Enhancing disease detection in fruits and leaves through a hybrid deep learning approach	The detection of diseases in fruits and leaves is essential to agriculture and impacts small-scale, urban, and large-scale activities. Traditional methods need tedious, prone to error manual visual inspection. A hybrid deep learning approach that combines Recurrent Neural Networks (RNNs) and Convolutional Neural Networks (CNNs) demonstrates accurate sickness diagnosis. This method has the ability to enhance disease identification across all agricultural sectors due to its accuracy and efficiency. Automated detection speeds up early action and reduces crop losses and disease transmission. Higher agricultural yields, better-quality goods, and sustainable farming practices that use fewer pesticides are the main outcomes.
3	2023[3]	Cotton disease detection	Cotton is a major crop in India, however it is susceptible to diseases like Verticillium wilt, Alternaria spot, Cercosporin leaf spot, bacterial leaf blight, and red spot. This study suggests a ground-breaking method for assisting farmers and improving illness diagnostics. The method comprises segmenting, feature extraction, selection, and classification of pictures based on partial differential equations (PDEs) using a Multiclass classification Support Vector Machine (SVM) algorithm. The technology integrates texture, color, and form features obtained using the codebook method to assure acceptable attributes through the application of the relief feature selection process. Additionally, a dataset of 2000 leaf pictures is used to develop a Convolutional Neural Network (CNN) program for disease diagnosis.

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4	2023[4]	A Review on Various Plant Disease Detection Using Image Processing	India's main industry has always been agriculture, as everyone is aware. Since agriculture is the main industry that supports rural communities, any disturbance to this sector would have a severe negative impact on farmers and the country as a whole. Here, climate change, barren soils, and plant diseases could cause instability. This article explains how plant diseases can be identified using image processing techniques. If these conditions continue undiagnosed, there could be significant losses. In order to establish which is better for leaf disease identification, a number of machine learning and deep learning algorithms are used in this work, including Random Forest Classifier (RFC), Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and Convolutional Neural Network.
5	2023[5]	Aquatic Plant Disease Detection Using Deep Learning	Aquatic plants should also be considered when talking about plant diseases. The disease in these plants may cause many aquatic animals to die. Therefore, it's imperative to identify these. In this paper, the deep learning technology was used to diagnose illnesses. Deep learning may be used to identify aquatic plant sicknesses in order to lessen the downsides of artificially selecting disease spot attributes, enhance objectivity in the extraction of aquatic plant disease features, and hasten scientific and technological advancement. In this work, the deep learning and cutting-edge imaging techniques are used to investigate the existing patterns and challenges in the diagnosis of aquatic plant leaf disease.
6	2023[6]	SVM based Leaf Disease Classification Assisted with Smart Agrobot for the Application of Fertilizer	The project's objective is to detect diseases in leaves, namely in curry, hibiscus, and neem leaves, in order to enhance the quality of agriculture. The proposed approach combines machine learning with Support Vector Machines (SVM) to enable targeted fertilizer spraying and disease diagnosis utilizing an Agrobot (Agricultural Robot). The system uses Internet of Things technology to monitor environmental conditions and communicate with the farmer. The hardware setup includes sensors for moisture, humidity, and temperature; a camera captures images of leaves for the purpose of supporting vector machines (SVM) classification. The Agrobot's timely fertilizer application ensures both prevention and control of leaf diseases. Accuracy increases with more samples used in SVM training, indicating the effectiveness of the recommended approach.

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7	2023[7]	Detection of Powdery Mildew Pest in Apple Tree Leaves Using Deep Learning in Intelligent Sprayer Robots	Using deep learning and leaf image processing, powdery mildew in apple trees is recognized, helping to identify pests and illnesses in agriculture early on. A novel transfer learning technique is introduced, utilizing minimum input photos that are categorized into classes for both healthy and powdery mildew images. Three CNN designs (VGG16, Alex Net, and Google Net) are used for evaluation, and the results demonstrate that the proposed method addresses angle and illumination intensity difficulties in real-world scenarios with good accuracy. With an accuracy of 99.53%, Alex Net notably outperforms expectations, highlighting the method's potential for accurate and efficient pest and disease diagnosis in apple trees.
8	2021[8]	Leaf Recognition and Disease Detection using Content based Image Retrieval	Although Indians' major and traditional occupation is agriculture, one of the main causes of this problem is plant disease. Because of the drop in output in their crops, farmers are suffering significant financial losses. Despite the high prevalence of plant diseases, improper plant management has had negative effects. It cannot, however, carry on inspecting each and every one of the thousands of plants. Consequently, this work establishes a methodology that provides faster and more precise results on plant leaves and the diseases linked with them.
9	2021[9]	Leaf Life: Deep Learning Based Plant Disease Detection Application	Using Convolutional Neural Networks (CNN) and image processing, the study presents a novel approach to plant disease detection. A tailored CNN achieved a high accuracy of 98.88% after training on a large dataset of 87,867 plant leaf images, comprising both healthy and diseased samples. In addition, an Android app was developed that lets users capture pictures of diseased leaves using the trained model to diagnose plant ailments. This method facilitates early identification and action, which helps to rapidly halt the spread of disease in plants.
10	2021[10]	Sensitivity Analysis of Coffee Leaf Rust Disease using Three Deep Learning Algorithms	This paper addresses the significant issue of Coffee Leaf Rust disease, which has the potential to significantly reduce global coffee industry output. To solve this, the study integrates three deep learning algorithms, with a focus on early detection: Back propagation Neural Network (BPNN), Convolutional Neural Network (CNN), and Recurrent Neural Network (RNN), all implemented within the Tensor Flow framework. The algorithms are evaluated using the dataset that was sourced from Columbia. The modified BPNN method produced the lowest Mean Absolute Error of 1.2462 after 1500 training epochs with a 50:50 dataset split, indicating that it was the most successful algorithm based on the results. These findings suggest that an early detection system may be developed, which would be crucial for preventing further damage to coffee plants and giving farmers relevant information

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11	2020[11]	Leaf Disease detection and classification based on machine learning	Identification of plant diseases is crucial for the agriculture sector, which has a big financial influence. Continuous observation is necessary for the detection of plant diseases, but manual inspection takes time and labor. By detecting plant diseases in their leaves, an automated method such as the proposed algorithm simplifies the process. This approach lowers the amount of human labor required and improves accuracy as compared to existing techniques. When all is said and done, the algorithm offers a more precise and effective means of identifying and classifying plant illnesses, improving agricultural practices and preserving financial stability
12	2020[12]	Robotic Vehicle for Automated Detection of leaf Diseases	This paper explores the use of autonomous robotic technology for plant leaf disease identification, with the aim of addressing the limitations of current methods. The suggested project focuses on a robotic car with voice control that is equipped with a microcontroller and an image sensor network. In order to detect leaf ailments, the robot operates in a garden and analyzes images in this instance, basil is the target plant. When a disease is identified, the system alerts the user and provides a remedy. When K clustering and SVM algorithms are used with robot mobility in challenging terrain, disease detection accuracy is increased while requiring fewer human involvement. This results in an easy-to use, voice-controlled robotic vehicle that can detect plant leaf diseases.
13	2019[13]	Leaf Disease Detection: Feature Extraction with K-means clustering and Classification with ANN	The suggested method addresses agricultural diseases, especially leaf spot, by implementing a comprehensive four stage process. The initial step in the procedure is to obtain clear, representative images of plant leaves. The next stage is picture segmentation, which locates disease-affected areas by applying the K-means clustering algorithm. The system then gathers relevant information from these segmented zones, accounting for attributes like texture, color, and shape. In conclusion, the utilization of neural networks for disease classification has yielded remarkable outcomes: 90% precision for bacterial leaf spot and target spot in cotton leaf diseases, and 100% precision for septoria leaf spot and leaf mold in tomato leaf diseases. This systematic approach provides farmers with a valuable tool for early disease detection and classification, enabling timely interventions to enhance crop health and productivity.

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14	2017[14]	An IoT based smart solution for leaf disease detection	This article examines the application of the Internet of Things (IoT) to smart farming as a means of improving the quality of Indian agriculture. The article discusses the issues surrounding the migration of people from rural to urban areas and outdated farming equipment. It also highlights recent advancements in the Internet of Things, such as sensor networks that keep an eye on temperature, humidity, and wetness. A Raspberry Pi controller, which can detect leaf illness using a camera interface, is utilized for centralized control. The system provides real-time farm status transmission and monitoring, which promotes agricultural technology.
15	2016[15]	Identification of leaf diseases in pepper plants using soft computing techniques	Creating healthy, disease-free food is the primary goal of agriculture. It is vital to identify these illnesses as a result. With the use of visual aids, these are easily understood. Digital image processing and image analysis technologies are vital to the sectors of agriculture and biology. In the context of plants, any disruption to normal physiological function that produces identifiable symptoms is referred to as a disease. Studies on plant diseases focus on the patterns that might be observed in a particular plant. Soft computing techniques make this simple to achieve. Many farmers discover and detect plant ailments by using visual inspection with their unaided eyes. Large farms find it less useful and require continual supervision.
16	2015[16]	Detection and classification technique of Yellow Vein Mosaic Virus disease in okra leaf images using leaf vein extraction and Naive Bayesian classifier	This research examines the issue of Yellow Vein Mosaic Virus (YVMV) illness in okra, which is spread by white flies (Bemisiatabaci). According to the study, YVMV is present in 87% of okra leaves, and it can be identified and categorized using image processing, K-means clustering, and a Naive Bayesian classifier. The approach classifies a dataset of 79 typical images into four categories: Highly Susceptible (HS), Moderately Susceptible (MS), Tolerable (T), and Resistant (R) based on YVMV severity. This method provides a fast and accurate way to identify and classify YVMV disease in okra by using only ten characteristics.

IV. CONCLUSION

In conclusion, there is a great deal of potential for agriculture in the recent developments in leaf disease identification, including deep learning with CNNs, hybrid approaches, and machine learning algorithms like SVM and Naive Bayesian classifiers. The accuracy and effectiveness of illness detection systems are further improved by the integration of cutting-edge technology like robots, the Internet of Things, and smart solutions. These developments are essential for guaranteeing early illness identification and efficient treatment, which raises agricultural output and sustainability. Through early detection and management of leaf diseases, farmers may reduce crop losses, maintain yields, and enhance global food security. In order to improve these techniques and turn them into workable solutions for farmers everywhere, cooperation and research must continue. Only then agriculture will be assured of a robust and sustainable future.

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