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Deep Learning based Solution for Leaf disease Detection in Crops and Fertilizer Recommendation

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Abstract— The field of agriculture faces significant threats, including diseases that attack plant leaves. To address this issue, our system assists farmers in promptly detecting plant diseases using advanced technology. The user, typically a farmer, only needs to capture an image of the affected leaf and input it into our system. Our system then analyzes the uploaded image to accurately identify the specific disease afflicting the leaf. This analytical process is facilitated by deploying two algorithms: Convolutional Neural Network (CNN) and Artificial Neural Network (ANN). The CNN is particularly adept at capturing intricate visual features, making it highly effective for image-based analysis. It processes the leaf images, identifying patterns and anomalies that are indicative of specific diseases. On the other hand, the ANN excels in unraveling complex data relationships and can complement the CNN by providing a broader context to the detected visual patterns. The ANN processes the features extracted by the CNN and analyzes them further, considering additional data inputs that may be relevant to disease identification. By scrutinizing the outcomes of both algorithms, our system derives an amalgamated result. This result represents an elevated diagnostic insight, informed by the distinctive strengths and perspectives of both CNN and ANN. The combined approach enhances the accuracy and reliability of disease detection.

Our system expedites the identification of plant diseases, empowering farmers with timely and precise information essential for effective disease management. Early detection allows for prompt intervention, reducing the spread of diseases and minimizing crop damage. The integration of CNN and ANN ensures that our system not only identifies diseases accurately but also provides a comprehensive understanding of the disease dynamics, aiding in better decision-making for disease control. This technological advancement stands to significantly benefit the agricultural sector by safeguarding crop health and ensuring higher yields.

Keywords— **Modern Agriculture, Disease Identification, Fertilizers, Convolutional Neural Network, Deep Learning**

I. INTRODUCTION

Leaf disease detection and fertilizer recommendation are important aspects of modern agriculture and plant health management. The combination of technology and data analysis can greatly improve the efficiency of these processes. Modern agriculture faces the challenges of ensuring optimal crop health and yield while minimizing resource wastage and environmental impact. To address these challenges, innovative technologies have emerged to revolutionize traditional farming practices. Two such technologies, leaf disease detection and fertilizer recommendation systems, have gained prominence in recent years. These systems harness the power of data analysis, deep learning, and agronomic knowledge to provide farmers with intelligent solutions for improved crop management. Early detection is crucial for implementing effective disease control measures. By analysing visual cues and patterns in leaf images, this system empowers farmers with real-time information about the health status of their crops. This knowledge enables timely interventions, such as targeted pesticide applications, reducing yield losses and optimizing resource utilization. The combination of CNN and ANN ensures precise and comprehensive disease identification, enhancing the system's reliability. By providing accurate and actionable insights, the system supports farmers in making informed decisions, ultimately improving crop health and productivity. This technological advancement not only safeguards crops but also promotes sustainable agricultural practices by minimizing the unnecessary use of chemicals and resources. The result is a more efficient and effective approach to crop management, benefiting both farmers and the environment.

II. LITERATURE REVIEW

The literature survey providing insight into the development and application of deep learning algorithms, particularly CNN, in image recognition and disease detection within the agricultural domain, highlighting the significance of technology in addressing challenges in farming and crop management is done as follows

Xin jia Explored image recognition methods based on deep learning in 2017 [1]. Author discussed recent advancements and improvements in deep learning programs for computer vision tasks. Further Md Tohidul Islam et al. in 2018 investigated image recognition with deep learning, particularly focusing on food image classification [2]. This study utilized CNN for identifying different types of food from images, achieving a 92.86% accuracy rate. Later, Rahul Chauhan et al. Introduced Convolutional Neural Network (CNN) for image detection and recognition in 2018 [3]. Authors demonstrated high accuracy in recognizing and finding objects in pictures using CNN models, tested on MNIST and CIFAR-10 datasets.

Afterwards in 2019, Indumath R et al. developed a system for leaf disease detection and fertilization suggestion using image processing [4]. Authors utilized KMedoid clustering and Random Forest algorithm for accurate disease detection. They calculated 13 characteristics from leaf images to determine the specific disease affecting the plant. Later in 2019, Ajay Shrestha et al. reviewed deep learning algorithms and architectures, emphasizing their importance in various domains [5]. The study explored different types of deep learning systems, focusing on advancements and potential improvements.

Further, Garima Shrestha et al. applied CNN for plant disease detection, achieving an 88.80% accuracy rate in identifying sick leaves [6] in 2020. They conducted tests on 15 cases, distinguishing between healthy and diseased leaves with high accuracy. Later in 2020, Hasnul Ajra et al. proposed a method for plant disease detection using image processing and CNN [7]. They utilized AlexNet and ResNet-50 models, achieving 96-97% accuracy in detecting diseases on potato and tomato leaves. Next, Asoke K, Nandi Introduced artificial neural networks (ANNs) for machine fault diagnosis using vibration signals in 2020 [8]. The study described various ANN algorithms and their applications in fault classification, emphasizing preprocessing techniques for data analysis.

Afterwards in 2021, Janhavi Koli et al. highlighted the significance of agriculture amidst global population growth [9]. Authors developed a CNN model for plant disease detection, achieving 94.87% accuracy in spotting sick plants.

Recently in 2022, Shriya Omar et al. employed CNN for leaf disease detection, aiding farmers and related industries in identifying and treating plant diseases [10]. Author emphasized the importance of automated systems in accelerating disease detection and prevention.

III. METHODOLOGY

The objective is to ascertain the well-being of a given plant by analysing images of its leaves through an automated system. In the event of the plant being in an unhealthy state, the system is designed to categorize the specific type of disease affecting it, thereby facilitating the implementation of appropriate corrective measures. Timely identification is crucial, as early detection enables prompt preventive actions. Procrastination in detection not only results in wasted time but also adversely impacts the overall production rate.

A. *Dataset:* The "Leaf Disease Detection and Fertilizer Recommendation" database sourced from Kaggle is a comprehensive collection of agricultural data designed to facilitate research and innovation in crop management. This dataset encompasses critical information related to leaf diseases and corresponding fertilizer recommendations, providing a valuable resource for the development and evaluation of advanced agricultural technologies. The database contains a diverse array of high-resolution images of plant leaves, each annotated with labels indicating their health status - ranging from healthy to various disease states. These images serve as the foundation for training and testing machine learning models, particularly Convolutional Neural Networks (CNNs), for accurate and early detection of leaf diseases. Additionally, the dataset includes pertinent metadata, such as plant species and disease type, further enhancing the richness and relevance of the information. Moreover, the database offers associated fertilizer recommendations tailored to specific disease conditions and plant species. This critical information aids in optimizing nutrient management strategies, contributing to healthier plant growth and enhanced agricultural yield. By combining leaf disease detection with fertilizer guidance, this dataset supports research endeavours aimed at sustainable and efficient crop production.

Block Diagram: The developed system offers a solution to empower farmers in early detection of plant diseases. By simply capturing an image of the affected leaf and inputting it into our user-friendly interface, farmers can initiate the process. Subsequently, our system employs two advanced algorithms: Convolutional Neural Network (CNN) and Artificial Neural Network (ANN) for comprehensive analysis. The CNN excels in extracting intricate visual features, while the ANN adeptly deciphers complex data relationships. This dual-algorithm approach ensures a thorough assessment of the leaf's condition. 12 Once the algorithms complete their analyses, their individual results are subjected to a meticulous comparative evaluation. By scrutinizing the outcomes of both the CNN and ANN, the system synthesizes a refined diagnosis that draws from the distinctive strengths of each algorithm. This amalgamated result signifies an elevated level of diagnostic precision. Furthermore, based on this comprehensive diagnosis, the system recommends an appropriate fertilizer from a comprehensive database. The integration of this fertilizer recommendation step completes the holistic approach to crop health management. This innovative system not only expedites disease detection but also provides invaluable guidance on optimizing plant nutrition, ultimately enhancing the overall health and yield of crops. In essence, this technological advancement represents a significant leap forward in sustainable and efficient agricultural practices, benefiting farmers and food security worldwide. At the core of this system lies the utilization of two sophisticated algorithms: the Convolutional Neural Network (CNN) and the Artificial Neural Network (ANN). These algorithms are instrumental in analysing images of affected plant leaves and deciphering complex data relationships to identify potential diseases. The CNN excels in extracting intricate visual features from the images, allowing for precise identification of disease symptoms and anomalies. Meanwhile, the ANN adeptly analyses the extracted data to discern underlying patterns and correlations, enhancing the accuracy and reliability of the diagnosis.

The dual-algorithm approach adopted by the system ensures a thorough assessment of the leaf's condition, combining the strengths of both CNN and ANN to achieve a comprehensive diagnosis. Upon completion of their analyses, the results from each algorithm undergo meticulous comparative evaluation. This process enables the system to synthesize a refined diagnosis that draws upon the distinctive strengths of each algorithm, thereby enhancing the overall diagnostic precision. Block Diagram of Leaf Disease Detection and Fertilizer Recommendation is shown in figure 1.

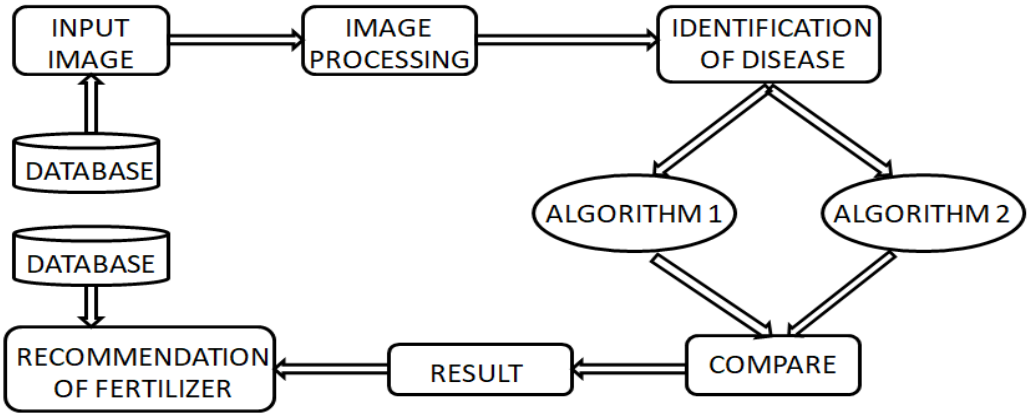

Fig 1. Block Diagram Leaf Disease Detection and Fertilizer Recommendation

IV RESULT AND DISCUSSION

The results of the analysis are presented to the user through a web application interface, offering valuable insights into the health of the submitted plant. The project ensures both compatibility and accuracy in the analysis process. By leveraging the strengths of CNN and ANN, the system provides users with precise and timely information about plant diseases. This empowers farmers to take effective measures for disease management, ultimately enhancing crop health and yields. The user-friendly interface makes it easy for farmers to access and interpret the diagnostic results, ensuring practical and actionable insights for their agricultural practices.

A. *Webpage* :

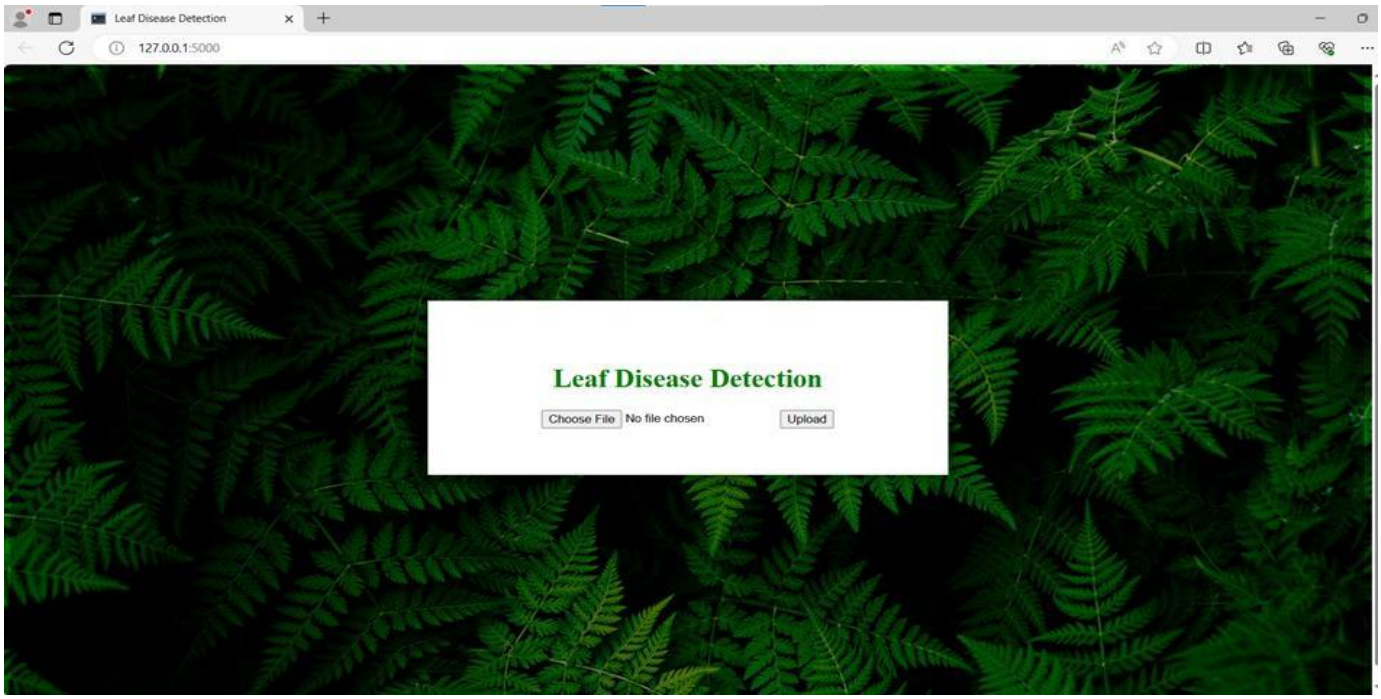

Fig. 2: WebPage

B. *Experimental Result* :

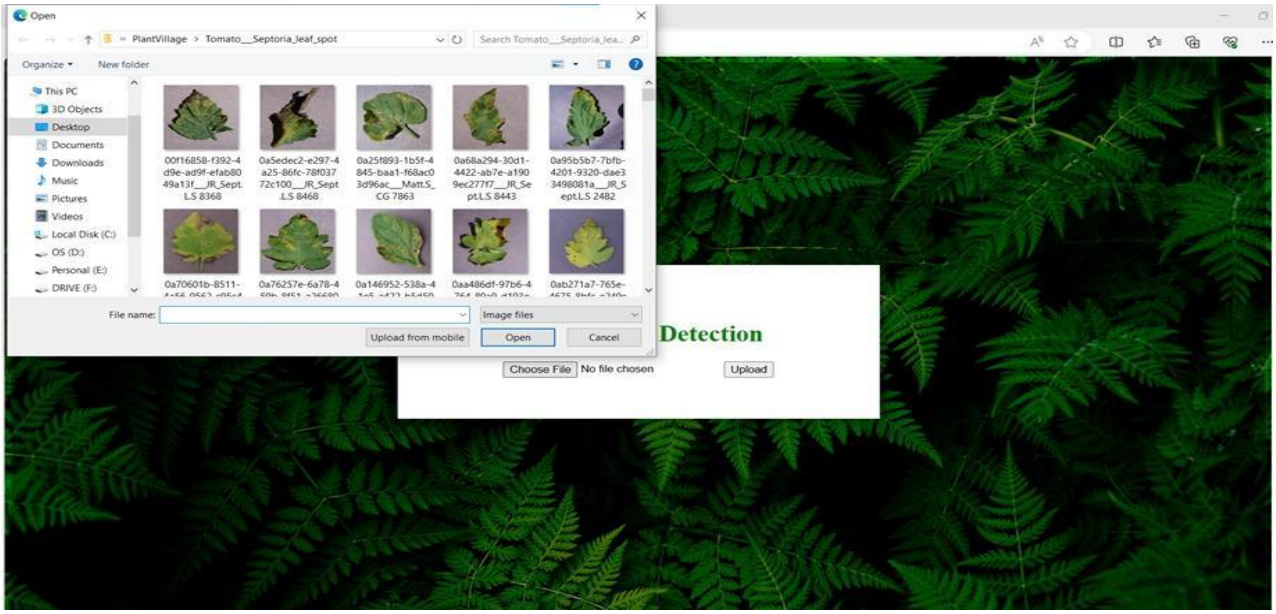

Fig. 3: Uploading the image (Disease Image)

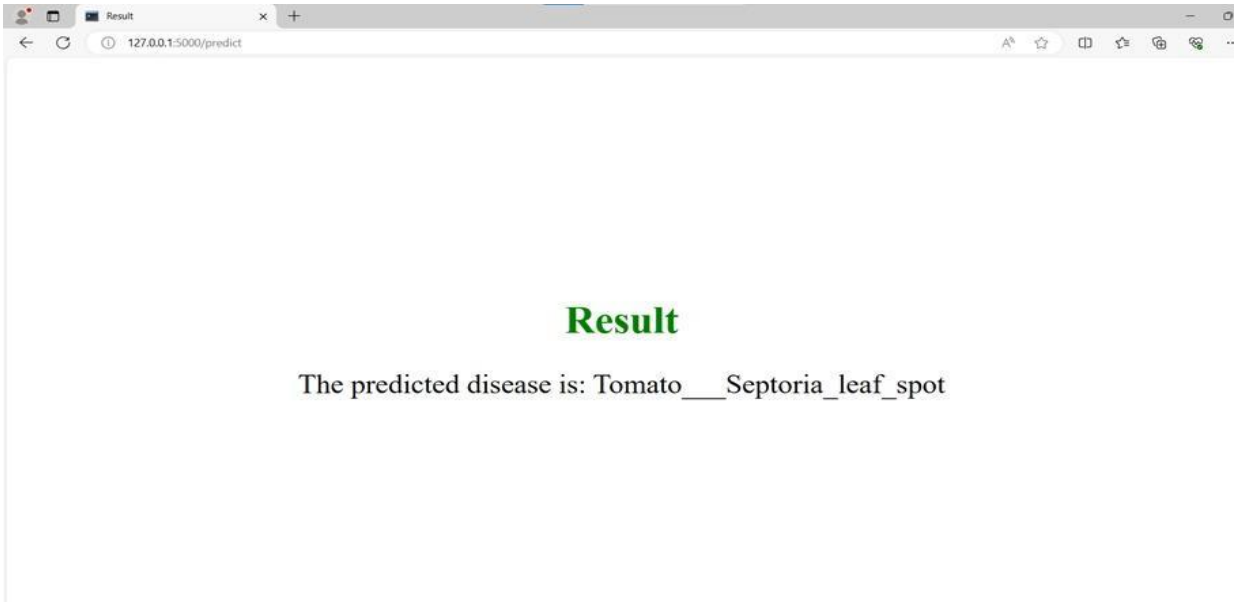

Fig. 4 Disease Detected (Tomato__Septoria_leaf_spot)

The webpage comprises multiple components geared towards facilitating plant analysis. The primary feature is an image upload functionality, enabling users to submit plant images for examination. This component ensures seamless user interaction, allowing individuals to easily contribute data for analysis is shown. By automatically adjusting image resolution and converting file formats as necessary, this feature streamlines the preparation of images for analysis, enhancing efficiency and accuracy. Furthermore, the webpage likely includes sections for displaying analysis results is shown in figure 2-4. Once images are processed by the disease detection model, the findings can be presented to users in a clear and understandable format.

II. Conclusions

Leaf Disease Detection and Fertilizer Recommendation systems represent a significant advancement in modern agriculture, bringing together technology, data analysis, and agronomy to revolutionize how crops are managed. By offering early disease detection, precise fertilizer recommendations, and data driven insights, these systems have the potential to reshape farming practices and outcomes in numerous ways.

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