Farm Care Using ML

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***Abstract*—Timely and accurate detection of plant diseases is essential for crop health and food safety in modern agriculture. This paper presents an advanced plant disease detection application that uses Convolutional Neural Networks (CNN) for image analysis, TensorFlow for deep learning, FastAPI for backend support, and React.js/React Native for front-end user-friendly interfaces occur.The main functionality of the application is based on the CNN model trained on the trained plant images, which enables accurate detection and classification of plant diseases TensorFlow facilitates training and efficient simulation, and ensures execution real-time image processing.FastAPI acts as the backbone of the application, managing data processing, instance statistics, and user authentication. Its speed and scalability make it ideally suited for handling easy user requests and simultaneous transactions.On the front end, React.js is used for web interactions, while React Native is used for mobile devices to ensure a consistent user experience across platforms. Users can easily use their smartphones to take pictures of sick plants, upload photos to the web, or select photos from their device's gallery.**

***Keywords* -** Plant disease, Tomato diseases, CNN, Machine Learning, Potato Plant, FAST API, Classification.

I. Introduction

Plant diseases pose a significant threat to agricultural productivity, impacting food security and economic stability worldwide. Traditional methods of disease detection, relying on visual inspection by experts or laboratory tests, are often time-consuming and costly, leading to delays in diagnosis and treatment. Consequently, this delay can exacerbate the spread of diseases and result in increased crop losses. Thus, there is a critical need for efficient and accurate methods of disease detection to ensure the sustainability of agriculture.

The scope of machine learning (ML) technologies for plant disease detection is extensive, with applications across various crops and environments. These technologies can be employed to monitor both large-scale commercial farms and small-scale subsistence farms, as well as crops grown in diverse

Fig. 1. output of Tomato late blight (disease affected leaf)

Fig. 2. output of Tomato late blight (disease affected leaf)

Fig. 3. output of Tomato late blight (disease affected leaf)

environments, such as indoor hydroponic farms or outdoor fields. By providing real-time monitoring and analysis of plant health and environmental conditions, ML technologies empower farmers and stakeholders to make informed decisions about crop management, ultimately leading to increased yields and improved food security.

The primary aim of this plant disease detection project, employing ML technologies, is to offer a reliable and efficient method for detecting early stages of plant diseases. By doing so, it aims to mitigate the risk of crop loss and enhance yields. Additionally, the project seeks to provide farmers with timely interventions to prevent disease spread and minimize the use of harmful pesticides and chemicals. Through early disease detection, the project aims to enable farmers to take proactive measures to safeguard their crops and improve productivity, particularly in emerging nations where agriculture forms a significant portion of income.

The objectives of this project are multifaceted:

Improve food security and sustainability by preventing crop losses due to plant diseases and pests. Utilize ML algorithms to accurately identify plant diseases and pests based on images uploaded by users. Offer personalized recommendations for treatment and prevention based on the identified diseases and pests, encompassing natural and chemical solutions. Facilitate user connectivity with experts and fellow farmers for advice and support through a community forum. Provide educational resources and information about plant health, empowering users to make informed decisions about crop management.

II. Literature Survey

Plant diseases pose significant threats to agricultural productivity and food security worldwide. Rapid and accurate detection of these diseases is crucial for timely intervention and effective management. In recent years, machine learning (ML) techniques have emerged as promising tools for automating the process of disease detection in plants. This literature survey aims to provide an overview of various studies conducted in this domain.

”Plant Disease Detection Using Machine Learning” by Shima Ramesh, Ramachandra Hebbar, Niveditha M., Pooja R., Prasad Bhat N., Shashank N., and Vinod P.V. (2018) [1]. This paper explores the application of machine learning algorithms for the detection of plant diseases. It provides an initial insight into the potential of ML in addressing this agricultural challenge.

”iDahon: A Terrestrial Plant Disease Detection Mobile App Based on Android” by Brian Irvin D. Fernandez, Arlene R. Caballeo, John C. Valdoria, and John Marco M. Condino (2019)[2].The authors introduce a mobile application, iDahon, designed for the detection of terrestrial plant diseases using deep learning techniques. This study highlights the practical implementation of ML in a user-friendly interface.

”Potato Disease Detection Using Machine Learning” by Marjanul Islam Tarik, Sadia Akter, Abdullah Al Mamun, and Abdus Sattar (2021)[3].Focusing on potato disease detection, this study demonstrates the effectiveness of machine learning approaches in identifying plant diseases. It contributes to the growing body of research aimed at improving crop health management.

”A Smartphone Image Processing Application for Plant Disease Diagnosis” by Nikos Petrellis (2017)[4].This study presents a smartphone application for plant disease diagnosis, showcasing the potential of mobile technology combined with image processing techniques for rapid disease detection.

”Plant Leaf Detection and Disease Recognition Using Deep Learning” by Sammy V. Militante, Bobby D. Gerardo, and Nanette V. Dionisio (2019)[5].Utilizing deep learning methods, this research addresses both plant leaf detection and disease recognition, offering insights into the integration of advanced neural network architectures for accurate diagnosis.

”A Color and Texture Based Approach for the Detection and Classification of Plant Leaf Disease Using KNN Classifier” by Eftekhar Hossain, MD. Farhad Hossain, and MD. Anisur Rahaman (2019)[6].The authors propose a method based on color and texture features for detecting and classifying plant leaf diseases, highlighting the efficacy of K-nearest neighbor (KNN) classification in this context.

”Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification” by Marko Arsenovic, Darko Stefanovic, Andras Anderla, Srdjan Sladojevic, and Dubravko Culibrk (2016)[7].This study employs deep neural networks for recognizing plant diseases through leaf image classification, demonstrating the potential of advanced ML techniques in disease identification.

”Tomato Leaf Disease Detection Using Machine Learning” by Rakesh Sharma, Ankita Panigrahi, Mamata Garanayak, Sujata Chakravarty, K. Paikaray, and Lalmohan Pattanaik (2021)[8].Addressing tomato leaf diseases, this research leverages machine learning for detection purposes, contributing to the development of efficient disease management strategies.

”Leaf Disease Classification Using Machine Learning” by Sandip Bobade, Aniket Patil, Satyajeet Bhalerao, Revan Bhonde, and Rutuja Borkar (2022)[9].This study focuses on the classification of leaf diseases using machine learning techniques, emphasizing the importance of accurate classification for effective disease control.

”Automatic Leaf Disease Detection and Classification using Hybrid Features and Supervised Classifier” by S. Raj Kumar and S. Sowrirajan (2018)[10].The authors propose an automatic detection and classification system for leaf diseases using hybrid features and a supervised classifier, aiming to streamline the disease diagnosis process.

”Green Leaf Disease Detection Using Raspberry Pi” by Sankar M, Mudgal DN, Todkar varsharani jagdish, Nandi wale Geetanjali Laxman, and Mane Mahesh Jalinder (2019).This study presents a method for green leaf disease detection utilizing Raspberry Pi, showcasing the potential of embedded systems for agricultural applications[11].

”Machine Learning based Image Classification of Papaya Disease Recognition” by Md. Ashiqul Islam, Md. Shahriar Islam, Md. Sagar Hossen, Minhaz Uddin Emon, Maria Sultana Keya, and Ahsan Habib (2020)[12].Focusing on papaya disease recognition, this research utilizes machine learning for image classification, contributing to the development of automated disease diagnosis systems.

”Leaf Disease Detection Using Raspberry Pi” by Sahitya G, Kaushik C, Pilly Sujith Simha, Dhanush Reddy, Shashi Kumar, and Vinay Vinay (Year not provided).This study proposes an automated method for identifying and categorizing plant diseases using image processing and SVM classification[13].

”Identification and Classification of Leaf Diseases Using Agribot” by Abdul Kareem, P. Brahmaji, A. Manoj Sai Reddy, A. Bharath Kumar Reddy, and B. Lakshmi Sirisha (2021).The authors propose the use of Agribot for identification and classification of leaf diseases, integrating robotics with machine learning for enhanced disease management in agriculture[14].

”Image Processing Based Leaf Disease Detection using Raspberry Pi” by Dinesh Kumar R, Prema V, Radhika R, Queen Mercy C.A, and Ramya S (2021).This study presents an image processing-based approach for leaf disease detection using Raspberry Pi, offering a cost-effective and accessible solution for farmers[15].

”Monitoring of Hydroponics Plant and Prediction of Leaf Disease using IoT” by Deepika V, A Kalaiselvi, and Dhivyaarthi G (2021).Focusing on hydroponics plant monitoring, this research utilizes IoT technology for predicting leaf diseases, demonstrating the integration of IoT with ML for precision agriculture[16].

”Plant Disease Classification and Detection using CNN” by Revanasiddappa Bandi and Suma Swamy (2022).This study employs convolutional neural networks (CNNs) for plant disease classification and detection, showcasing the effectiveness of deep learning in automated disease diagnosis[17].

”An IoT based System with Edge Intelligence for Rice Leaf Disease Detection using Machine Learning” by Shahidur Harun S. M, Rumy, Ishan Arefin Md, Hossain, Forji Jahan, and Tanjina Tanvin (2021).The authors propose an IoT-based system with edge intelligence for rice leaf disease detection, highlighting the potential of edge computing in decentralized disease monitoring systems[18].

”Plant Leaf Disease Prediction” by Vaishnavi Monigari, Khyathi Sri G, and Prathima T (2021).This study focuses on the prediction of plant leaf diseases using machine learning techniques, aiming to provide early warnings for disease outbreaks in agricultural fields[19].

Raspberry Pi (PythonAI) for Plant Disease Detection” by Shagufta Aftab, Chaman Lal, Suresh Kumar Beejal, and Ambreen Fatima (2022).The authors present a Raspberry Pi-based solution for plant disease detection using PythonAI, showcasing the potential of low-cost, portable platforms for agricultural applications[20].

III. Project flow and Methodology

A. *Stucture of Appllication*

The Farm Care application serves as the primary interface for users to capture leaf images for disease identification. Upon capturing an image, the application processes and analyzes it using the implemented Machine Learning algorithm. The analysis results are then displayed within the Farm Care application, indicating the presence of any disease along with recommended remedies.

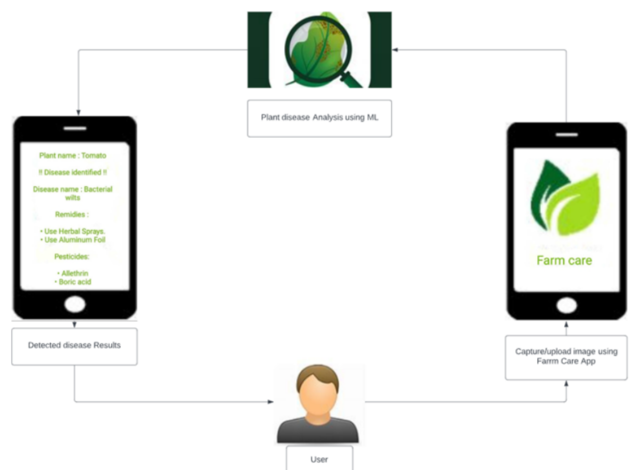

Fig. 4. Structure of Application

B. *Design of Machine Learning Model*

The design of the Machine Learning model centers around image processing utilizing a Convolutional Neural Network (CNN). CNN, a deep learning method renowned for image recognition and classification tasks, is employed. The design process involves:

1) **Data Collection:** Gathering a sizable dataset comprising images of both healthy and diseased plants.
2) **Data Preparation:** Pre-processing acquired images to ensure uniform size and format, often involving scaling and conversion to RGB or grayscale.
3) **Data Augmentation:** Employing techniques like rotation, flipping, and zooming to augment the dataset, thereby enhancing training data diversity.

4) **Model Training:** Training the CNN model using the prepared and augmented dataset to discern disease-specific patterns in images.
5) **Model Evaluation:** Evaluating the trained model's accuracy in disease identification using a separate test dataset.
6) **Deployment:** Utilizing the trained model for real-world applications, enabling plant disease identification from captured images.

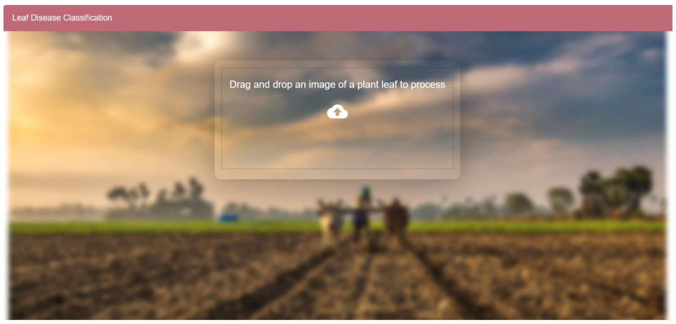

Fig. 5. Web Application demo

C. Architecture of Convolutional Neural Network

The CNN architecture comprises several layers, each serving a specific function:

- **Convolutional Layer** Detects distinct image features through the application of filters, generating activation maps.
- **Pooling Layer** Downsamples activation maps to reduce spatial image size, typically employing max pooling.
- **Fully Connected Layer** Creates a feature vector from previous layers' output, applying weights for classification or regression.
- **Output Layer** Generates predictions based on input images.

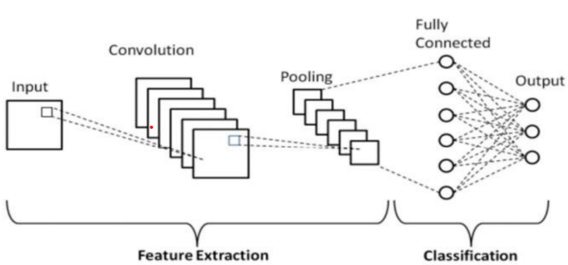

Fig. 6. Architecture of CNN

D. Flow Diagram

The application flow follows these steps:

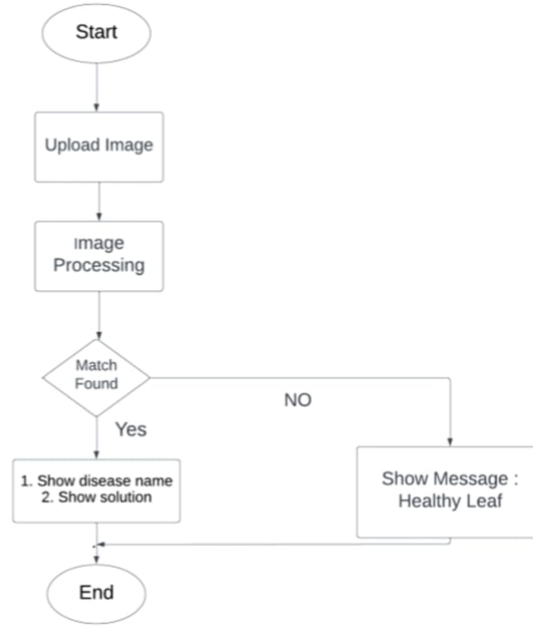

Fig. 7. Application Flow Diagram

E. Tools Used

Model Building: TensorFlow, CNN (Convolutional Neural Network), Data Augmentation, tf dataset
Backend Server: tfserving, FastAPI
Model Optimization: Quantization, TensorFlow Lite
Frontend & Deployment: Reactjs, Deployment to GCP

IV. RESULT

Once the image analysis is complete, the results are displayed within the Farm Care application. If a disease is detected on the leaf, the name of the disease along with possible treatments will be shown to the user. This allows farmers or individuals involved in plant care to quickly and accurately identify plant illnesses and take appropriate action to mitigate them, thereby aiding in crop management and ensuring healthier plant growth.

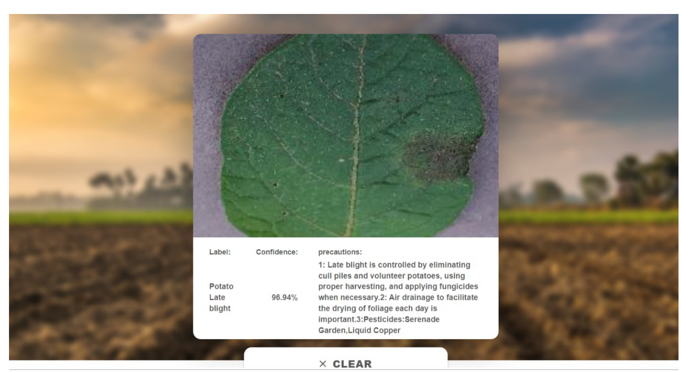

Fig. 8. output of potato late blight (disease affected leaf)

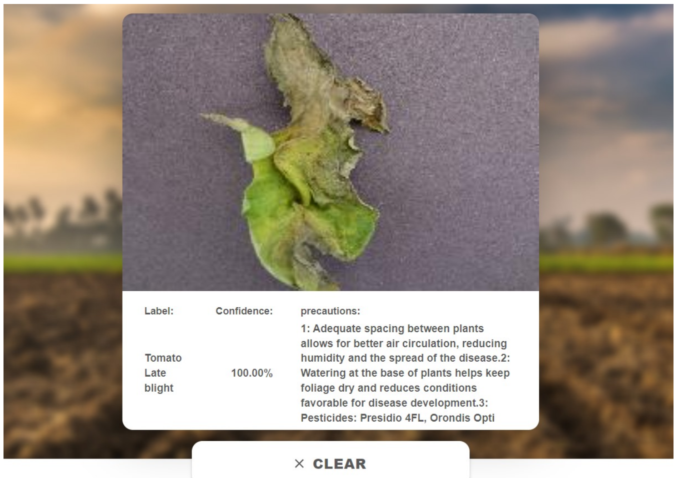

Fig. 9. output of Tomato late blight (disease affected leaf)

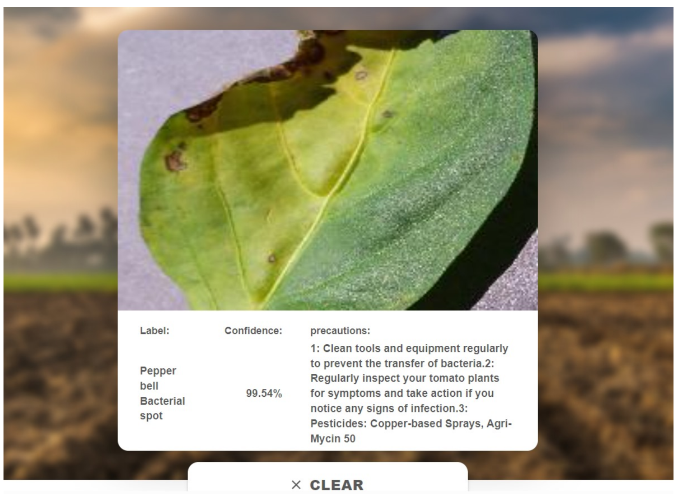

Fig. 10. output of pepper bell bacterial spot (disease affected leaf)

V. Conclusion

This project investigated applying machine learning to detect plant diseases. The developed system aims to empower farmers with a user-friendly tool for early disease identification. This technology has the potential to significantly reduce crop loss, improve yields, and promote sustainable agricultural practices.

References

[1] Shima Ramesh, Ramachandra Hebbar, Niveditha M., Pooja R., Prasad Bhat N., Shashank N., and Vinod P.V., "Plant Disease Detection Using Machine Learning," in *2018 International Conference on Design Innovations for 3Cs Compute Communicate Control (ICDI3C)*, August 2018, pp. 6.

[2] Brian Irvin D. Fernandez, Arlene R. Caballeo, John C. Valdoria, and John Marco M. Condino, "iDahon: A Terrestrial Plant Disease Detection Mobile App Based on Android," in *Deep Learning for Digital Image Processing Applications 2019 Fourth International Conference on Learning Neural Network Algorithm 2019 Information Technology Conference (InCIT)*, November 2019, pp. 6.

[3] Marjanul Islam Tarik, Sadia Akter, Abdullah Al Mamun, Abdus Sattar, "Potato Disease Detection Using Machine Learning," in *2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)*, March 2021, pp. 6.

[4] Nikos Petrellis, "A smart phone image processing application for plant disease diagnosis," in *2017 6th International Conference on Modren Circuits and Systems Technologies (MOCAST)*, June 2017, pp. 6.

[5] Sammy V. Militante, Bobby D. Gerardo, Nanette V. Dionisio, "Plant Leaf Detection and Disease Recognition Using Deep Learning," in *2019 IEEE Eurasia Conference on IOT, Communication and Engineering*, December 2019, pp. 6.

[6] Eftekhar Hossain, MD. Farhad Hossain, and MD. Anisur Rahaman, "A Color and Texture Based Approach for the Detection and Classification of Plant Leaf Disease Using KNNClassifier," in *Chittagong University Journal of Science and Technology*, vol. 14, no. 2, pp. 1-6.

[7] Marko Arsenovic, Darko Stefanovic, Andras Anderla, Srdjan Sladojevic, and Dubravko Culibrk, "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification," in *Computational Intelligence and Neuroscience*, vol. 2016, pp. 11.

[8] Rakesh Sharma, Ankita Panigrahi, Mamata Garanayak, Sujata Chakravarty, K. Paikaray, and Lalmohan Pattanaik, "Tomato Leaf Disease Detection Using Machine Learning," in *International Journal of Intelligent Systems and Applications in Engineering*, vol. 9, no. 4, pp. 6.

[9] Sandip Bobade, Aniket Patil, Satyajeet Bhalerao, Revan Bhonde, Rutuja Borkar, "Leaf Disease Classification Using Machine Learning," in *International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)*, vol. 2, no. 2, pp. 6.

[10] S.Raj Kumar, S.Sowrirajan, "Automatic Leaf Disease Detection and Classification using Hybrid Features and Supervised Classifier," in *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)*, vol. 5, no. 6, pp. 6.

[11] SankarM, Mudgal DN, Todkar varsharani jagdish, Nandi wale Geetanjali Laxman, Mane Mahesh Jalinder, "Green Leaf Disease detection Using Raspberry pi," in *2019 1st International Conference on Innovations in Information and Communication Technology (ICIICT)*, June 2019, pp. 6.

[12] Md. Ashiqul Islam, Md. Shahriar Islam, Md. Sagar Hossen, Minhaz Uddin Emon, Maria Sultana Keya, Ahsan Habib, "Machine Learning based Image Classification of Papaya disease Recognition," in *2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, December 2020, pp. 8.

[13] Sahitya G, Kaushik C, Pilly Sujith Simha, Dhanush Reddy, Shashi Kumar, and Vinay Vinay, "Leaf Disease Detection Using Raspberry Pi" in *2022 13th International Conference on Computing Communication and Networking Technologies (ICCCNT)*, September 2021, pp. 6.

[14] Abdul Kareem, P. Brahmaji, A. Manoj Sai Reddy, A. Bharath Kumar Reddy, B. Lakshmi Sirisha, "Identification and Classification of Leaf Diseases Using Agribot," in *2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC)*, September 2021, pp. 6.

[15] Dinesh Kumar R, Prema V, Radhika R, Queen Mercy C.A, Ramya S., "Image Processing Based Leaf Disease Detection using Raspberry Pi," in *International Journal of Scientific Research Engineering Trends*, vol. 7, no. 2, pp. 8.

[16] Deepika V, A Kalaiselvi, Dhivyaarthi G., "Monitoring of Hydroponics Plant and Prediction of Leaf Disease using IOT," in *2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA)*, January 2022, pp. 5.

[17] Revanasiddappa Bandi, Suma Swamy, "Plant Disease Classification and Detection using CNN," in *2022 IEEE 3rd Global Conference for Advancement in Technology (GCAT)*, December 2022, pp. 7.

[18] Shahidur Harun S. M, Rumy, Ishan Arefin Md, Hossain, Forji Jahan, Tanjina Tanvin, "An IoT based System with Edge Intelligence for Rice Leaf Disease Detection using MachineLearning," in *2021 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS)*, May 2021, pp. 6.

[19] Vaishnavi Monigari, Khyathi Sri G, PrathimaT., "Plant Leaf Disease Prediction," in *International Journal for Research in Applied Science Engineering Technology (IJRASET)*, vol. 9, no. 7, July 2021, pp. 14.

[20] Shagufta Aftab, Chaman Lal, Suresh Kumar Beejal, Ambreen Fatima, "Raspberry Pi (PythonAI) for Plant Disease Detection," in *International Journal for Research in Applied Science Engineering Technology (IJRASET)*, vol. 14, no. 3, February 2022, pp. 8.