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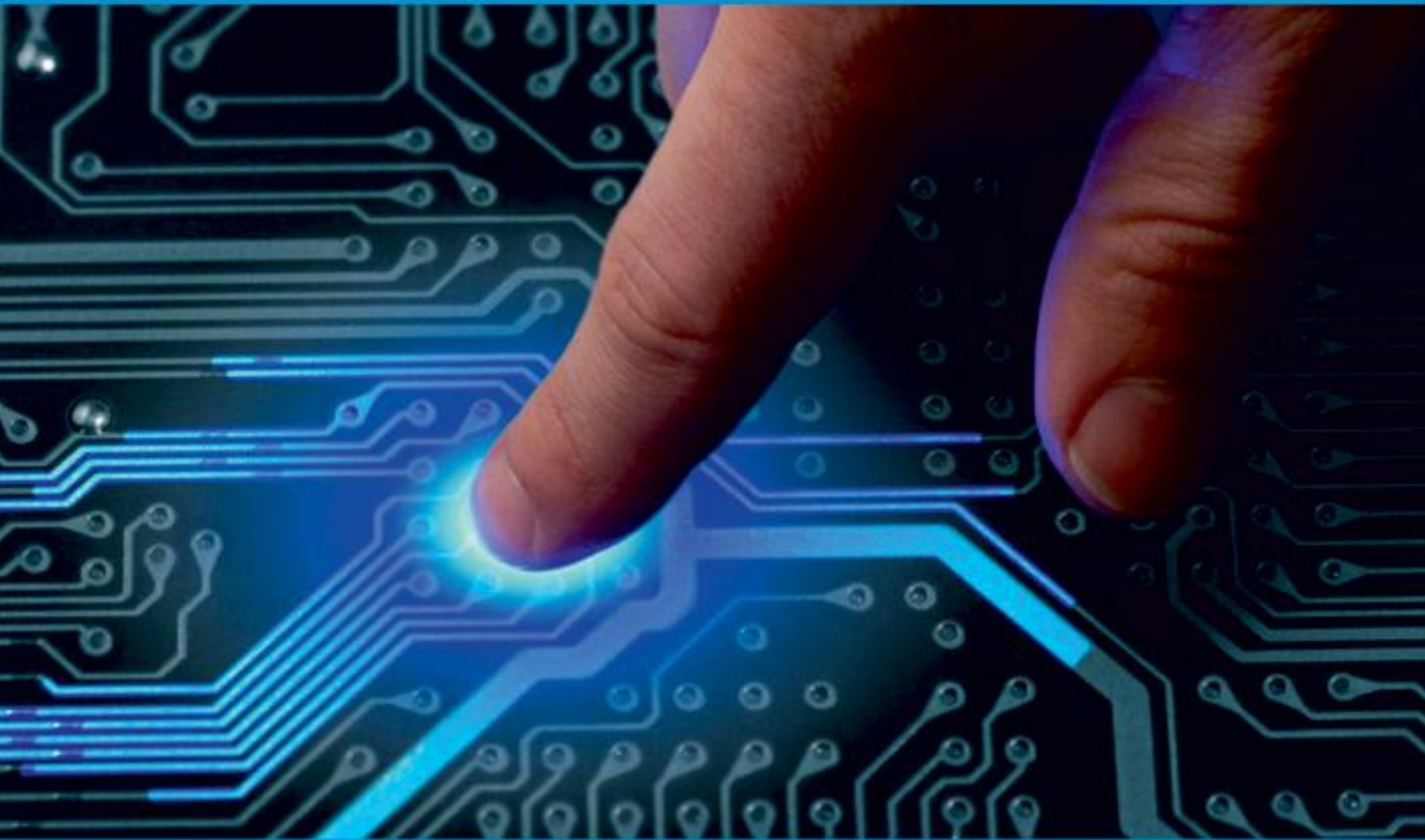

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Citrus Leaf Disease Detection using Deep Learning

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ABSTRACT: An integrated approach leveraging convolutional neural networks (CNNs) is proposed for automated citrus leaf disease detection, addressing significant yield declines in citrus fruit production. The CNN model is designed to distinguish healthy citrus fruits and leaves from those afflicted with prevalent diseases like black spot, canker, scab, greening, and melanose. By integrating multiple layers, the CNN model extracts complementary discriminative features for accurate disease recognition. Evaluation against state-of-the-art deep learning models on Citrus and Plant Village datasets demonstrates superior performance across various measurement metrics. This research underscores the efficacy of deep learning methods in addressing agricultural challenges and presents a promising solution for combating citrus leaf diseases.

KEYWORDS: citrus leaf diseases, automated detection, convolutional neural networks, CNN model, disease recognition, deep learning, agricultural challenges, fruit yield declines

I. INTRODUCTION

Agricultural research endeavours to enhance food production and quality while concurrently reducing costs and maximizing profits, recognizing the pivotal role fruit trees play in economic development. Citrus plants, renowned for their high vitamin C content, are extensively cultivated across the Indian subcontinent, the Middle East, and Africa. Beyond their nutritional value, citrus plants serve as crucial raw materials for various agricultural products, including jams, sweets, and confectionery, contributing significantly to horticultural exports in countries like Pakistan. However, despite their economic importance, citrus fruit plants are susceptible to a spectrum of infections, including black spots, cankers, scabs, greening, and melanosed, leading to substantial crop losses and rejected export batches.

Traditional methods of disease identification in citrus plants have relied on human judgment, proving time-consuming, error-prone, and costly. Moreover, emerging diseases in previously unaffected regions pose challenges due to the absence of local expertise. Hence, there is a compelling need for automated systems to detect citrus leaf diseases. While conventional machine learning techniques have made strides in disease recognition, they are constrained by sequential image processing tasks. Deep learning, particularly Convolutional Neural Networks (CNNs), offers a transformative solution by autonomously learning hierarchical features from raw data, eliminating the need for manual feature engineering and enhancing accuracy and efficiency in disease detection.

Deep learning, a subset of machine learning, has revolutionized artificial intelligence, with CNNs at its forefront for processing visual data like images. These networks, inspired by the human visual system, comprise convolutional, pooling, and fully connected layers, enabling hierarchical feature extraction and pattern recognition. Through optimization techniques like backpropagation and gradient descent, CNNs learn to minimize prediction errors and make accurate disease diagnoses. Leveraging pre-trained models through transfer learning further enhances their efficacy in tasks like citrus leaf disease detection, exemplifying their potential to revolutionize agricultural practices and mitigate crop losses.

II. LITERATURE SURVEY

In order to get required knowledge about various concepts related to the present application, existing literature was studied. Some of the important conclusions were made through those are listed below.

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Aswini.E and C. Vijayakumaran [1] study delved into the realm of citrus plant disease detection, uncovering the immense potential of deep learning methods. Through their comprehensive analysis, they revealed that deep learning techniques offer not only heightened accuracy but also enhanced efficiency in identifying and managing citrus plant diseases. By leveraging advanced algorithms and neural network architectures, these methods provide a holistic solution for tackling the challenges posed by various pathogens affecting citrus crops. Their findings underscored the transformative impact of deep learning in revolutionizing disease prevention and management strategies within the citrus cultivation industry.

Yagnesh Challagundla, Lohitha Rani Chintalapati, Trilok SaiCharan Tunuguntla, and Amit Sur [2] research shed light on the synergistic relationship between machine learning and deep learning embedders in the screening of citrus diseases. Their study revealed that by combining these computational approaches, significant improvements can be achieved in the accuracy and efficiency of disease identification. This integrated methodology not only enhances the reliability of disease detection systems but also facilitates the implementation of effective disease control tactics in citrus farming. Their findings underscored the importance of adopting a multidisciplinary approach to address the complex challenges associated with citrus plant health management.

Nitin Jaswal, Vinay Kukreja, Rishabh Sharma, and Preeti Chaudhary [3] study introduced a novel hybrid deep learning model tailored specifically for precision agriculture in citrus farming. Their research showcased the model's remarkable accuracy in classifying citrus leaf scab, a common disease affecting citrus plants. By harnessing the power of deep learning techniques, their approach enables proactive disease control measures, thereby mitigating potential crop losses and optimizing yield. Their findings not only highlight the potential of advanced computational methods in agriculture but also pave the way for the adoption of data-driven approaches to enhance productivity and sustainability in citrus cultivation.

Naureen Zainab, Hammad Afzal, Fahim Arif, Abdul Ghafoor, Naima Iltaf, and Muhammad Zakria [4] investigation focused on leveraging machine learning techniques for the diagnosis and identification of citrus canker growth rates. Their findings underscored the pivotal role of machine learning algorithms in enabling proactive disease management strategies. By providing timely insights into disease progression, their approach facilitates prompt intervention measures, thereby minimizing the impact of citrus canker on crop yield and quality. Their research contributes to the growing body of knowledge aimed at harnessing technology to address pressing challenges in agricultural production and food security.

Ashwini S and Shanmuga Prabha P [5] work highlighted the significance of artificial neural networks (ANNs) in disease diagnosis and categorization within citrus plants. By employing ANNs, their study demonstrated significant advancements in disease control techniques, offering more accurate and reliable methods for disease identification. Their findings underscored the potential of ANN-based systems to revolutionize disease management practices, thereby safeguarding the productivity and sustainability of citrus cultivation operations.

Shree Lakshmi C M and Channa Krishna Raju [6] research showcased the transformative potential of integrating machine learning and IoT technologies in crop management, with a focus on ginger leaf disease detection. Their study revealed that by harnessing real-time data and analytics, farmers can optimize cultivation practices and minimize the impact of diseases on crop yield and quality. Their findings highlight the importance of leveraging emerging technologies to address the evolving challenges facing agriculture, thereby ensuring the resilience and viability of farming operations in the face of environmental and economic uncertainties.

2.1 Literature review summary

The literature review reveals a significant shift towards advanced computational methods, particularly deep learning and machine learning techniques, in citrus plant disease detection. Studies by various authors underscore the potential of these technologies in improving accuracy, efficiency, and proactive management of citrus diseases, such as canker, scab, and greening. Integration of machine learning with deep learning embedders and IoT technologies offers promising avenues for revolutionizing crop management practices, optimizing yield, and minimizing losses. Multimodal fusion techniques, combining image and text data, show promise in addressing challenges in disease recognition, presenting a comprehensive approach for future research and development in citrus farming. Overall, the literature highlights a growing emphasis on leveraging cutting-edge technologies to overcome the complexities of disease detection and management in citrus cultivation, ultimately enhancing agricultural sustainability and productivity.

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III. PROPOSED SYSTEM

The proposed method for predicting citrus leaf disease begins with the collection of a comprehensive dataset encompassing various citrus plant characteristics and environmental factors relevant to disease manifestation. To ensure data quality and reduce dimensionality, careful data preparation will involve selecting pertinent features or extracting them through appropriate techniques. This meticulous approach aims to optimize the dataset for training machine learning or deep learning models, including Random Forests, Gradient Boosting, and Convolutional Neural Networks, which will subsequently predict the disease status based on the input features.

Following model training, thorough evaluation using performance metrics such as accuracy, precision, and recall will be conducted to identify the most effective predictive tool. The selected model holds the potential to not only aid in disease prediction but also to be integrated into software solutions for agricultural management, enabling proactive disease control strategies. Moreover, to ensure ongoing relevance and alignment with end-user needs, community participation will be sought throughout the process. Continuous improvement initiatives will involve periodic model retraining and integration with decision support systems, fostering a dynamic approach to disease management that evolves alongside advancements in technology and agricultural practices. Through this iterative process, the predictive model can effectively contribute to sustainable citrus cultivation practices and mitigate the impact of diseases on crop yield and quality.

IV. METHODOLOGY

1. Data Collection and Labelling:

- Gather a large dataset of citrus leaf images containing healthy leaves and leaves with various diseases.
- Each image needs to be meticulously labelled with the specific disease it represents (e.g., citrus greening, canker) or labelled as "healthy."

2. Data Preprocessing and Augmentation:

- Preprocess the images by resizing them to a standard size and potentially normalizing the color channels.
- Optionally, use data augmentation techniques like flipping, rotating, or adding noise to artificially increase the dataset size and improve model robustness.

3. Model Selection and Training:

- Choose a pre-trained deep learning model like VGG16, ResNet, or a simpler convolutional neural network (CNN) architecture.
- Train the model on the labeled dataset. This involves feeding the images through the model and adjusting its internal parameters to minimize the error between the model's predictions and the actual labels.

4. Testing and Evaluation:

- Once training is complete, evaluate the model's performance on a separate test dataset that it hasn't seen before. This helps assess how well the model generalizes to unseen data.
- Metrics like accuracy, precision, and recall are used to measure the model's ability to correctly classify healthy and diseased leaves.

5. Deployment:

- If the model achieves satisfactory performance, it can be deployed as a software application or mobile app. Users can then take pictures of citrus leaves, and the model will analyse the image and predict the presence or absence of disease.

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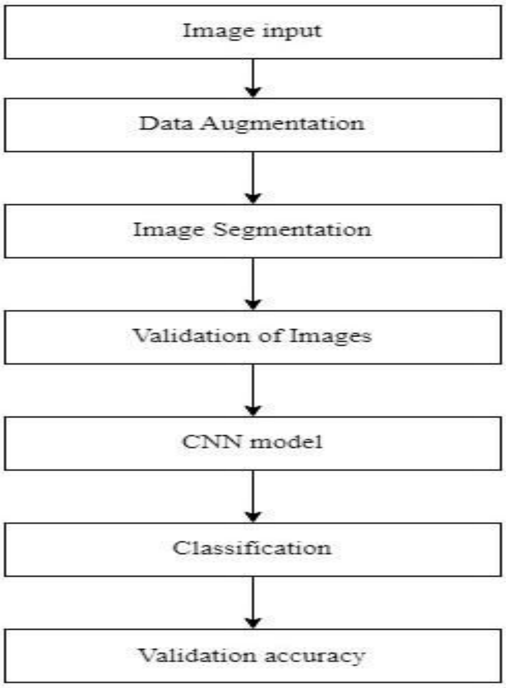

Fig 5.1: Methodology diagram

V. RESULT

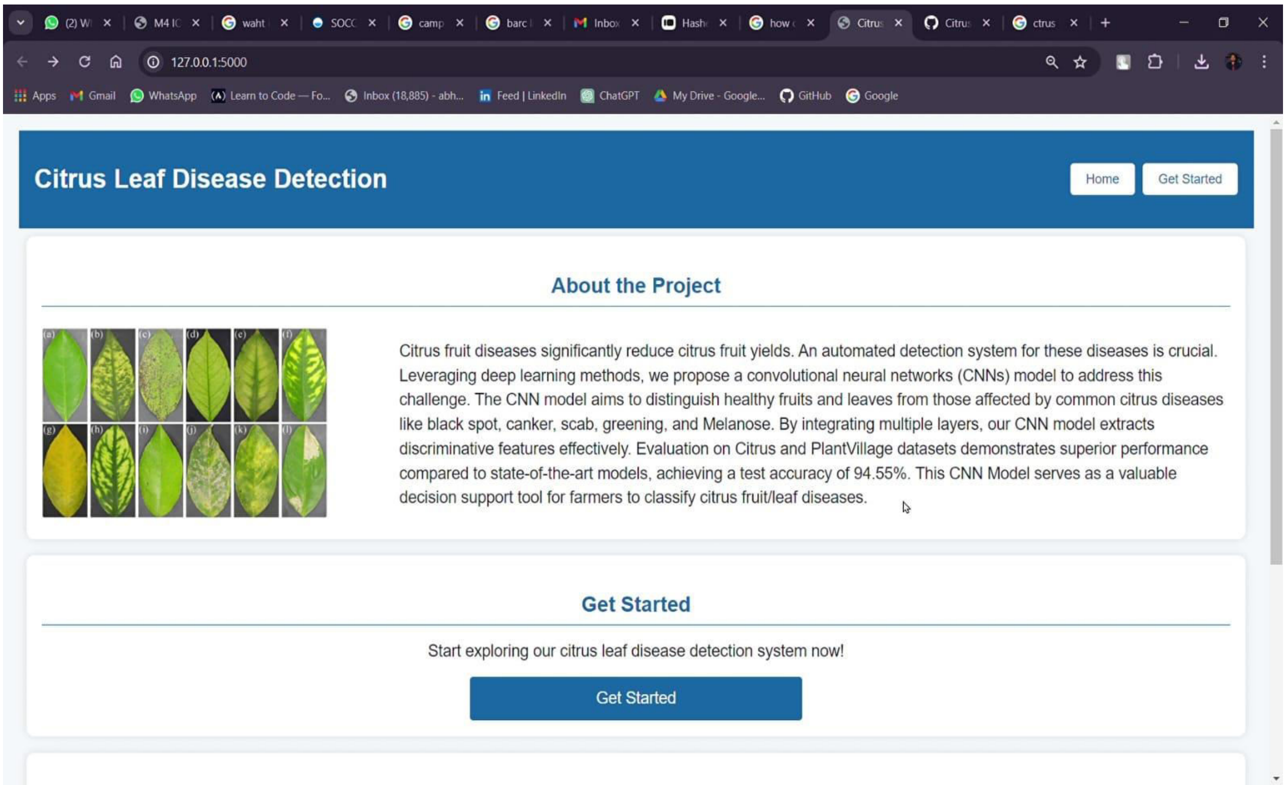

FIG 5.1: HOME PAGE

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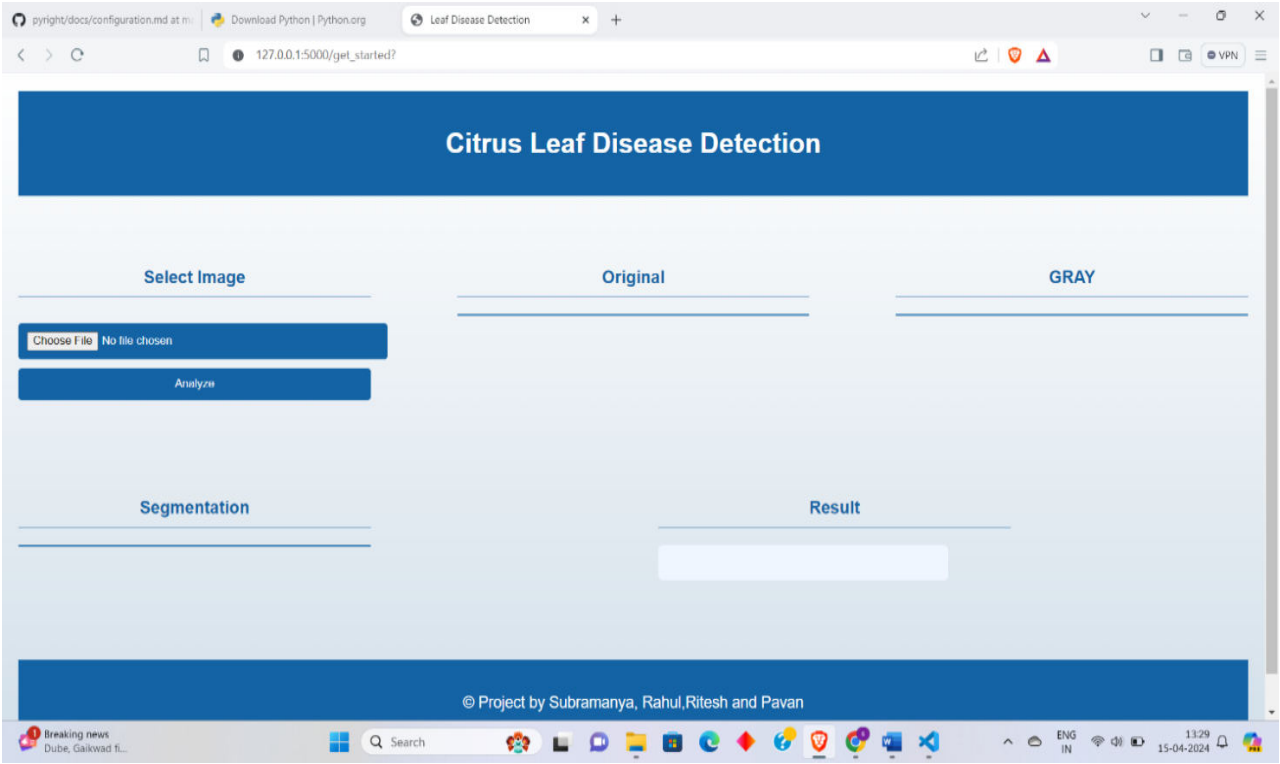

FIG 5.2: INTERFACE TO PROVIDE INPUT

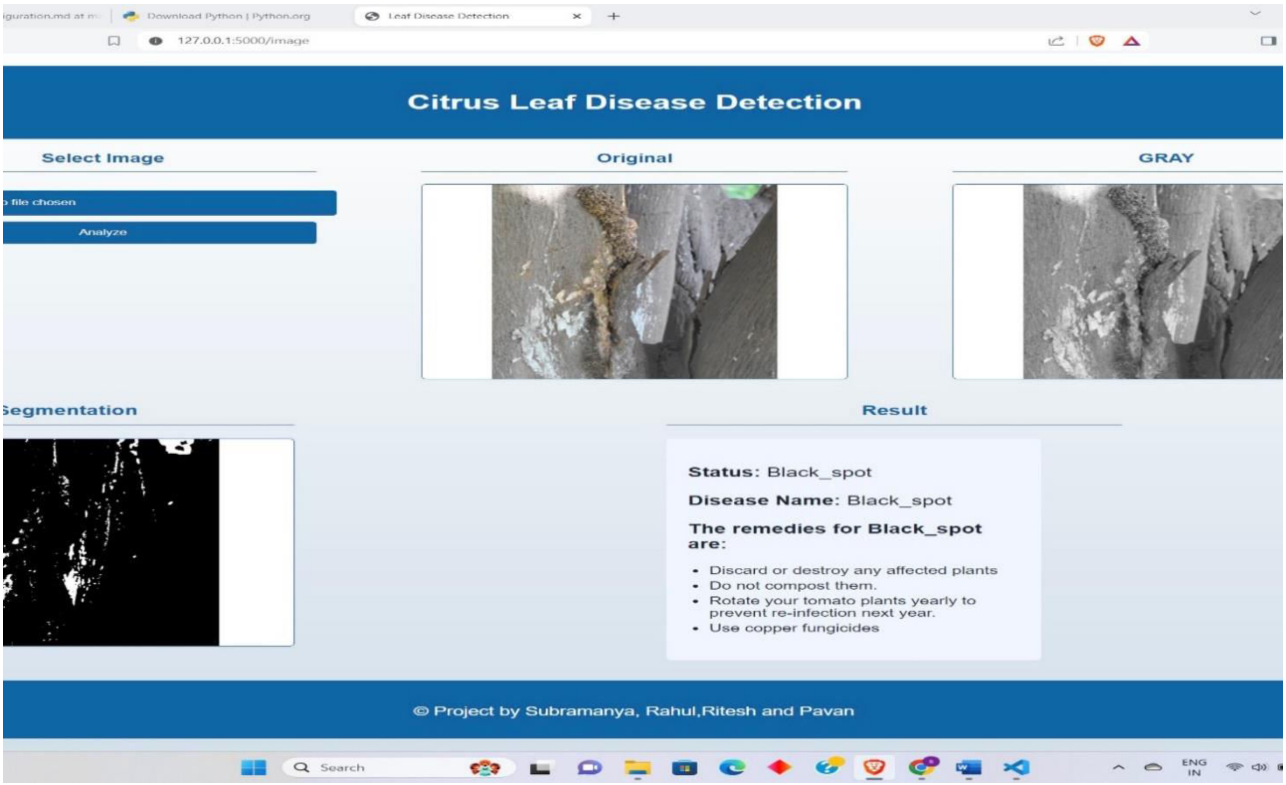

FIG 5.3 IDENTIFICATION OF BLACKSPOT

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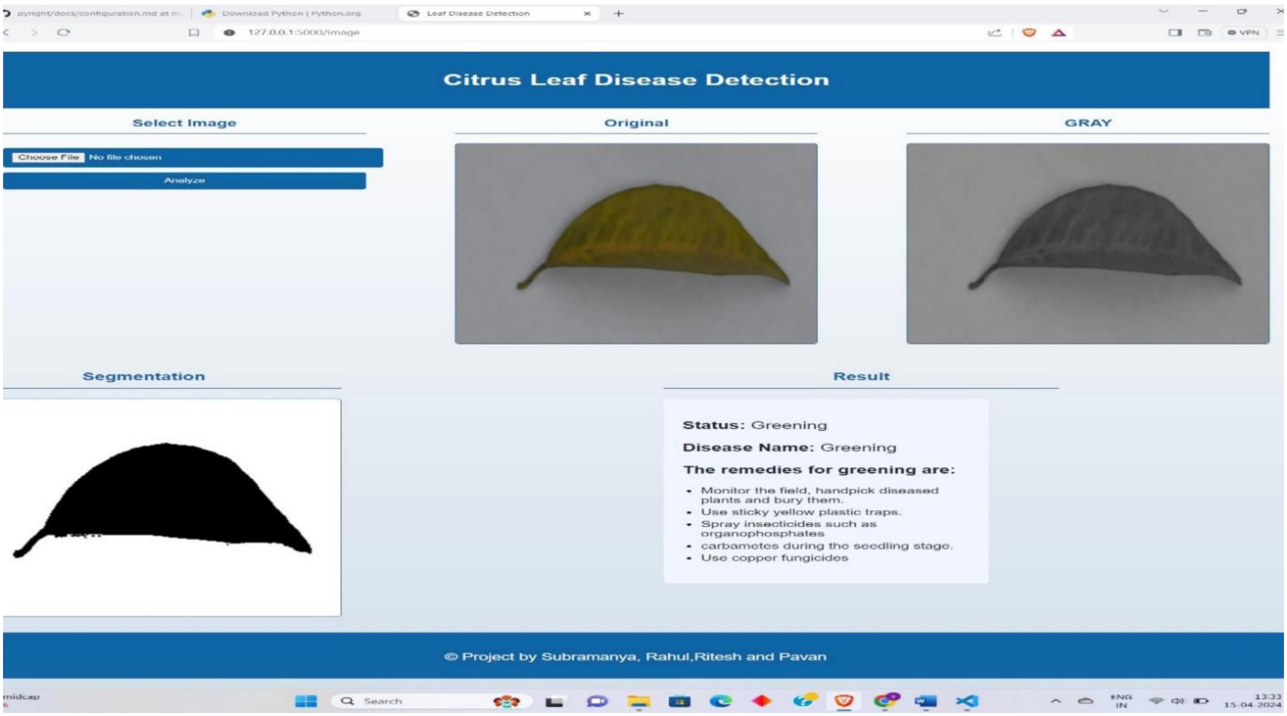

FIG 6.4: IDENTIFICATION OF GREENING

VI. CONCLUSION

The proposed CNN-based leaf disease identification model is capable of distinguishing between healthy and diseased Citrus fruits and leaves. We used the CNN model to tackle the problem of classifying diseases from citrus fruit and leaf images in this study. The modules in our proposed model are as follows: i) Data acquisition, ii) Data preprocessing, and iii) CNN model application. Two convolutional layers were used in the suggested CNN model. The first convolutional layer separates low-level features from the picture, while the second convolutional layer collects high- level attributes, yielding disease classification of citrus fruit/leaves into Black spot, canker, scab, greening and Melanose classes. On plant disease datasets, we tested a variety of machine and deep learning models and reported our findings. The suggested CNN outperformed other classifiers in terms of accuracy, scoring 95.65percent for citrus fruit/leaf disease classification experiments.

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