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PLANT SPECIES HEALTH DETECTION USING AI

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Abstract: Rice plant disease detection using Convolutional Neural Networks (CNN) and the VGG16 architecture is a popular research topic in the field of computer vision and agriculture. The goal of this research is to develop a model that can accurately identify different types of rice plant diseases based on images of the plant. CNN is a deep learning architecture commonly used for image recognition tasks. The VGG16 architecture is a popular variant of CNN that has achieved high performance on many image classification tasks. To train a model for rice plant disease detection, a dataset of images of healthy and diseased rice plants must be collected and labeled. The dataset should have a sufficient number of examples of each type of disease to ensure that the model can accurately distinguish between them. Once the dataset is prepared, the next step is to train the CNN model using the VGG16 architecture. During training, the model learns to extract features from the images and use them to classify the plants as healthy or diseased. After training, the model can be tested on a separate set of images to evaluate its performance. The model's accuracy can be measured using metrics such as precision, recall, and F1 score.

The Rice plant disease detection using CNN and VGG16 algorithms involves collecting and labeling a dataset of rice plant images, training a CNN model using the VGG16 architecture, and evaluating the model's performance on a separate test set. This research has the potential to help farmers detect and treat rice plant diseases early, leading to better crop yields and increased food security. It is an interesting approach to address the issue of rice plant disease detection using drone technology and machine learning algorithms. The proposed Deep Convolutional Neural Network (DCNN) transfer learning-based approach seems to be an effective method to accurately detect and classify six distinct classes of rice plant diseases. The use of IoT and drone technology can enable farmers to monitor their farmlands efficiently, reducing the need for costly manual inspections. The high accuracy of the proposed approach is promising and indicates its potential to be implemented in real-world applications. It is impressive that the proposed approach outperforms similar approaches reported in the literature, highlighting the effectiveness of the proposed modifications. Overall, the proposed

approach has the potential to increase crop yield and contribute to food security by enabling early detection and treatment of rice plant diseases.

Keywords: Machine learning; VGG-16; disease detection; convolutional networks; Plant Village; modern farming.

I. INTRODUCTION

Agriculture is a crucial sector for India's economy, providing employment to over 50% of the workforce and contributing around 18-20% to the country's GDP. However, the agriculture field faces numerous challenges such as inefficient farming techniques, inadequate use of fertilizers, water scarcity, and plant diseases. Plant diseases can cause significant losses in crop yields, accounting for up to 30% of crop damage. Manual recognition of plant diseases is time-consuming and prone to inaccuracy, making it necessary to explore new solutions. The development of technology has led to the possibility of detecting and identifying plant diseases accurately and providing better treatment. This proposed system focuses on detecting 14 varieties of plant diseases, including apple, blueberry, cherry, corn, grape, orange, peach, pepper, potato, raspberry, soybean, squash, strawberry, and tomato, using deep learning techniques, particularly convolutional neural networks (CNN). The system utilizes a statistical model that processes input images to classify output tags. .

Rice is a staple food for many countries across the globe, particularly in densely populated regions like China, India, and Pakistan. It belongs to the Orza family, which also includes other grains like wheat, corn, and cereal. Rice is popular due to its high nutritional value, making it an essential part of the diet for billions of people. However, there are various types of rice, and the method of cultivation can vary. Rice plants share common developmental phases before harvest, and rice farming accounts for approximately 15% of agricultural land worldwide, with the primary production taking place in eastern India and Pakistan. Unfortunately, rice production has decreased significantly in recent years, primarily due to plant diseases such as sheath blight, leaf blasts, and brown spots. These maladies can significantly impact grain quality and production. Early detection is critical, but constant monitoring is a challenge due to the vast size of the farms and the inability of farmers to examine each plant individually. Routine daily checks by farmers are not only impossible due to the scale of the farms, but it would also be expensive, prone to human error, and potentially damaging to the plants. Diagnosing and classifying agricultural issues can be a daunting task that involves various factors such as the environment and conditions. However, recent advancements in technology have paved the way for the use of Artificial Intelligence (AI) and Machine Learning (ML) to assist farmers in detecting rice plant diseases early. The ongoing improvement in digital image processing and recognition methods has made it feasible and easier to detect infected crops and classify the disease that a crop has. Nonetheless, researchers are still in search of the most optimal ML solution for plant disease detection and diagnosis, with some proposing the use of drone technology, the Internet of Things (IoT), and cloud computing to complement AI and ML. The motivation for a system that can assist rice farmers in the early detection of rice disease is clear, as it will increase production and quality while reducing cost for both farmers and consumers. Research in this field is crucial, as rice is a staple food for more than three billion people globally. Therefore, the objective of this work is to develop a system that utilizes novel optimized ML and deep learning techniques to detect, classify, and diagnose rice disease automatically without human intervention.

II. RELATED WORK

Several researchers have proposed different systems for detecting and classifying plant leaf diseases using various machine learning techniques. Hossain et al. [1] used the K-nearest neighbor (KNN) classifier to extract features from diseased leaf images and achieve a classification accuracy of 96.76% for several common plant diseases. Sammy et al. [2] employed a convolutional neural network (CNN) to classify nine different types of leaf diseases from tomato, grape, corn, apple, and sugarcane with an accuracy of 96.5%. Kumari et al. [3] combined K-means clustering and artificial neural network (ANN) to compute several image features and classify four different diseases, achieving a comparatively low average accuracy. Merecelin et al. [4] utilized a CNN to identify disease in plant leaves (apple and tomato) achieving an accuracy of 87% after training on a dataset of 3663 images.

Several studies have been conducted on the detection of tomato fruit and leaf diseases using deep learning models. Jiayue et al. [5] used the YOLOv2 CNN technique for the recognition of tomato fruits with disease and achieved a MAP of around 97%. Robert G et al. [6] proposed a CNN-based system to detect the type of tomato leaf diseases, and obtained 80% confidence score with the F-RCNN trained model, while the Transfer Learning model achieved 95.75% accuracy. Halil et al. [7] deployed deep learning models with Alex Net and Squeeze Net architectures, achieving accuracies of 95.6% and 94.3%, respectively. Sabrol et al. [8] used a simple mechanism for classifying different types of diseases that occur in tomato leaves, achieving high accuracy with supervised learning method, although decision tree has some disadvantages such as overfitting with noisy data. The major limitation of Jiayue et al. [5] was the need to perform different tuning for images, whereas Ch Usha Kumari et al. [3] reported comparatively low accuracy in their system that deployed K-Means clustering and Artificial Neural Network methods.

III. PROPOSED SYSTEM

The current system of rice plant disease detection involves manual detection by farmers which requires extensive work to visually observe vast farmlands and requires disease knowledge. This makes early diagnosis difficult and expensive, potentially leading to significant production losses of up to 20-40% annually. The proposed system using CNN and VGG16 algorithms has a higher accuracy in detecting rice plant diseases, making it a more efficient and cost-effective solution. The proposed system offers several advantages over the existing system, including a significantly higher accuracy of 96.08% using the non-normalized augmented dataset, as well as precise precision, recall, specificity, and F1-score. The system is also designed to be fitted onto drone technology and combined with IoT technology, enabling real-time diagnosis of rice disease in vast farmlands. This approach can potentially save time and money for farmers and ultimately reduce the cost of rice for consumers.

Key Technologies:

Here are some of the deep learning techniques that can be used for rice plant disease detection using CNN and VGG16:

- Transfer Learning: Transfer learning is a deep learning technique that involves using a pre-trained model for a new task. In the case of rice plant disease detection, the pre-trained VGG16 model can be fine-tuned for the specific task.
- Data Augmentation: Data augmentation is a technique used to increase the size of a dataset by artificially creating new training examples. This technique can be used to generate new images of rice plants with different angles, lighting conditions, and backgrounds.
- Dropout: Dropout is a regularization technique used in deep learning to prevent overfitting. It involves randomly dropping out some neurons during training to reduce their reliance on each other and encourage the network to learn more robust features.
- Batch Normalization: Batch normalization is a technique used to improve the speed and stability of training in deep neural networks. It involves normalizing the input of each layer to have zero mean and unit variance.
- Convolutional Neural Networks (CNN): CNN is a type of neural network architecture that is particularly well-suited for image recognition tasks. It involves applying convolutional filters to input images to extract relevant features.
- Gradient Descent Optimization: Gradient descent is an optimization technique used to minimize the loss function during training. The Adam optimizer, a variant of gradient descent, is commonly used in deep learning.

These deep learning techniques can be combined and adapted to suit the specific requirements of rice plant disease detection using CNN and VGG16.

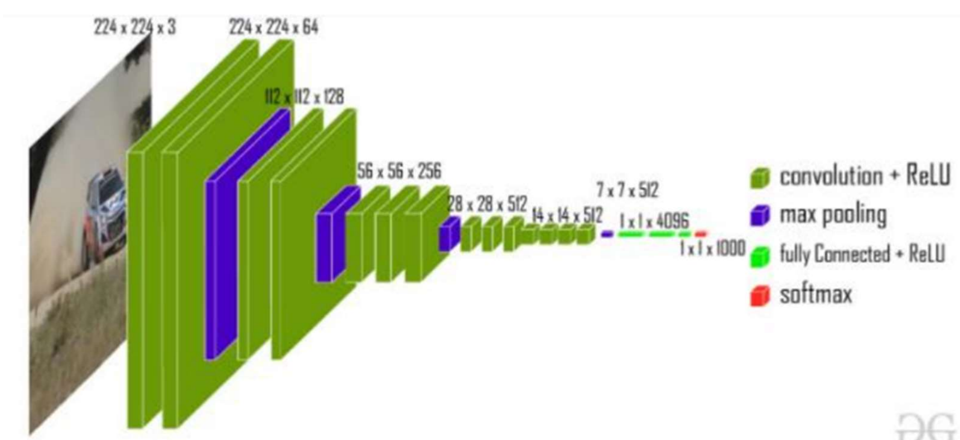

Fig1: VGG16 Model

IV. STEPS FOR PROPOSED MODEL

Here is a proposed model for rice plant disease detection using CNN and VGG16 algorithms:

- Data Collection: Collect a dataset of images of healthy and diseased rice plants, with different types of diseases labeled.
- Data Preprocessing: Preprocess the dataset by resizing the images to a fixed size, normalizing pixel values, and applying data augmentation techniques such as rotation, flipping, and cropping.
- Splitting the Dataset: Split the dataset into training, validation, and test sets in a ratio of 70:15:15, respectively.
- Model Selection: Choose the VGG16 architecture as the base model for the CNN.
- Fine-tuning: Fine-tune the pre-trained VGG16 model by freezing the first few layers and adding custom layers on top for disease classification.
- Training the Model: Train the model on the training set using the Adam optimizer and categorical cross-entropy loss function. The model should be trained for a sufficient number of epochs to achieve good performance on the validation set.
- Model Evaluation: Evaluate the trained model on the test set and measure its performance using metrics such as accuracy, precision, recall, and F1 score.
- Model Deployment: Deploy the trained model for use in real-world applications, such as an app for farmers to identify rice plant diseases.

The proposed model involves using a pre-trained VGG16 architecture as the base model for the CNN, fine-tuning it for rice plant disease classification, and evaluating its performance on a separate test set. This model has the potential to assist farmers in early detection and treatment of rice plant diseases, leading to increased crop yields and food security.

V. RESULT AND DISCUSSION

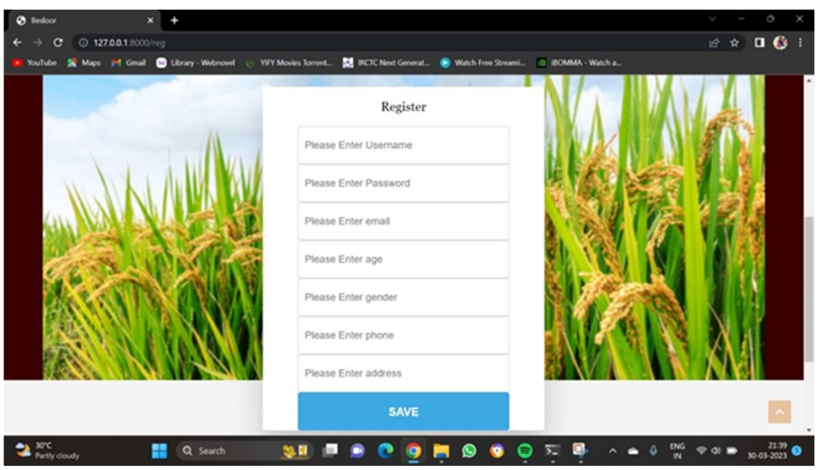

Fig2: Registration Page

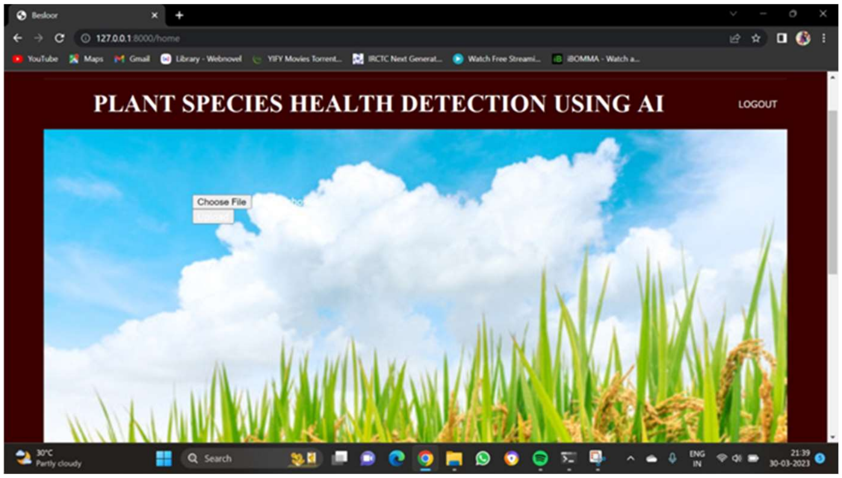

Fig3: Upload Dataset

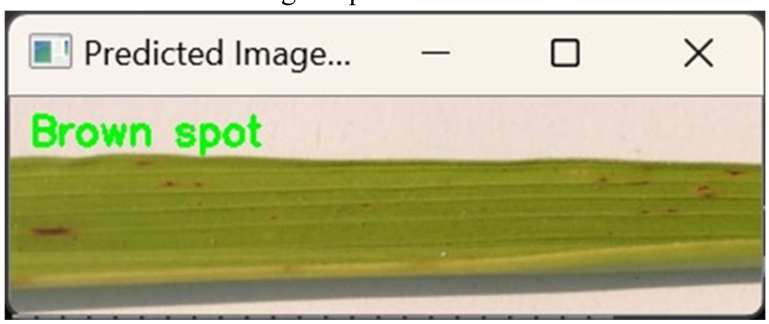

Fig4: Train Model

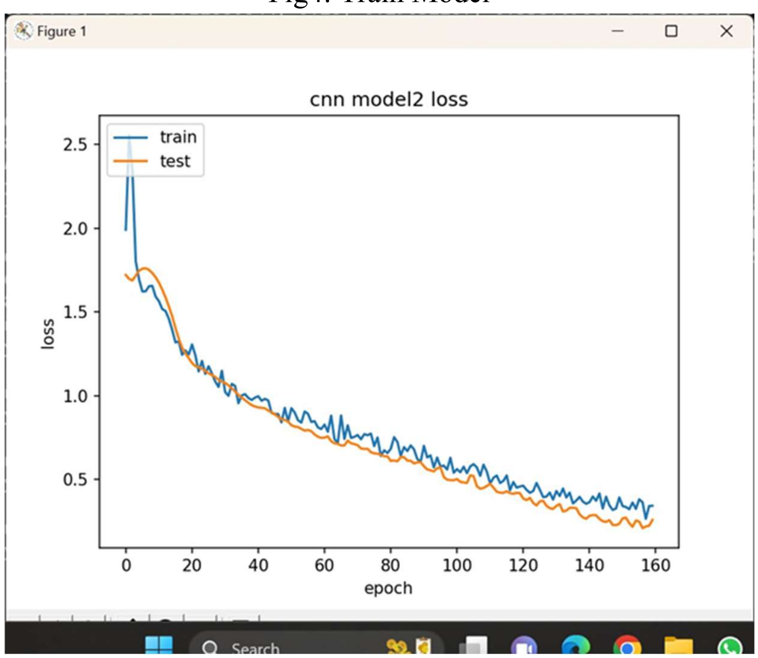

Fig5: CNN Model

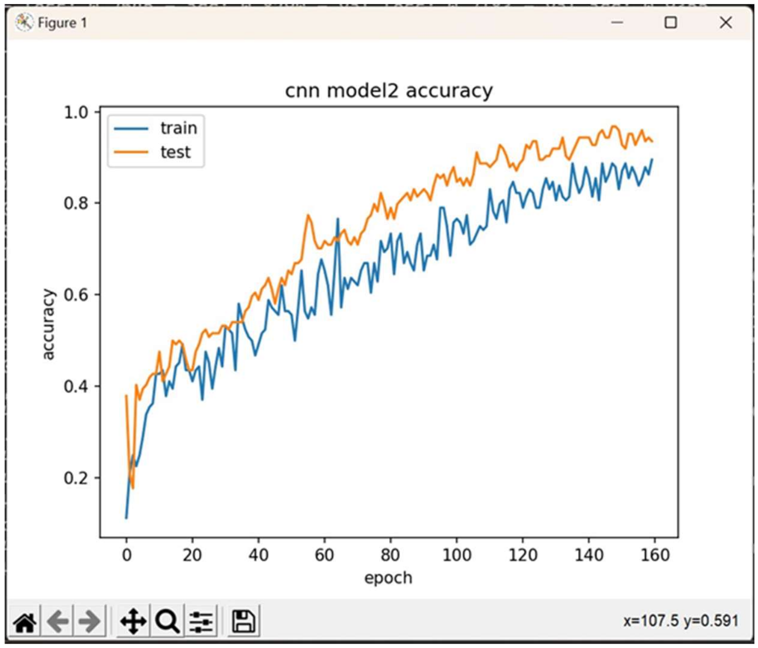

Fig6: CNN Model accuracy.

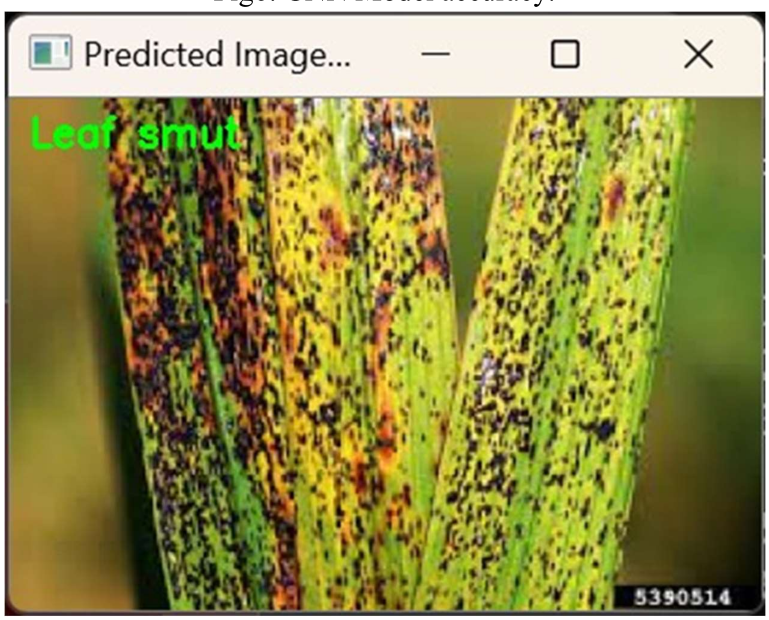

Fig7: Train Model

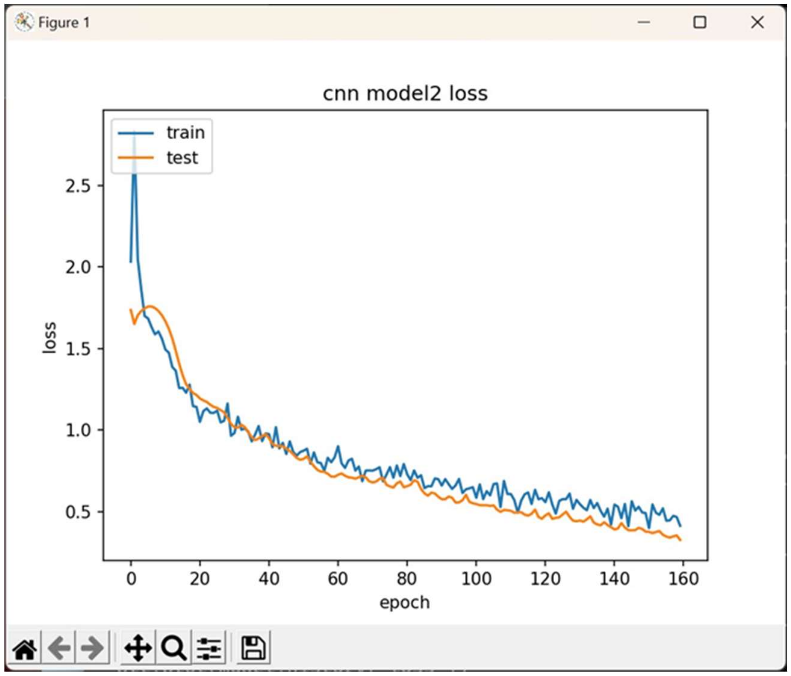

Fig8: CNN Model

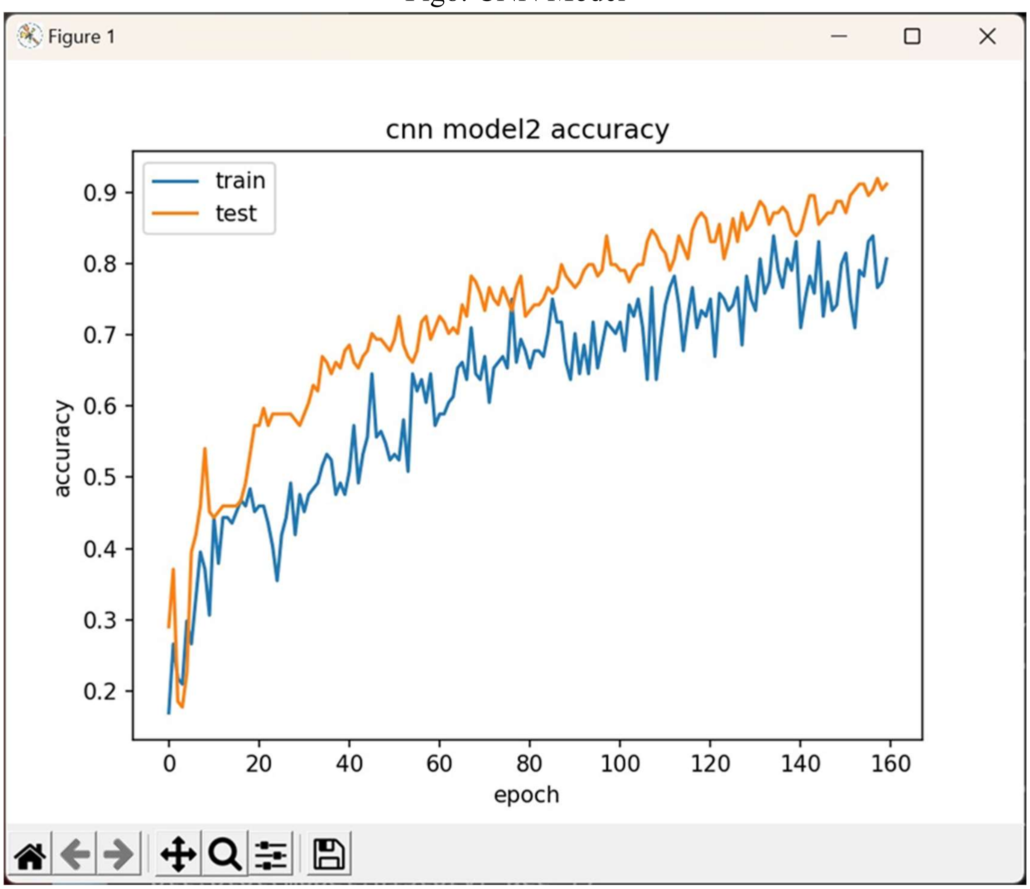

Fig9: CNN Model accuracy.

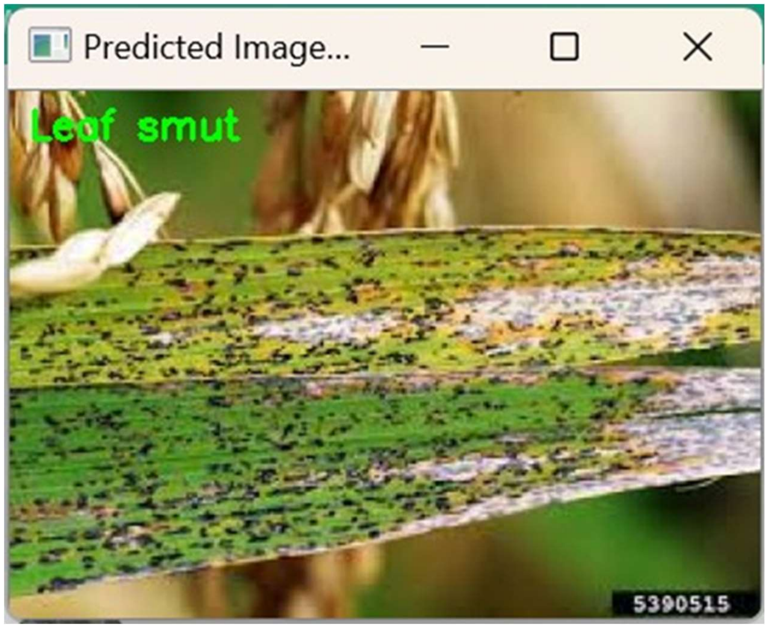

Fig10: Train Model

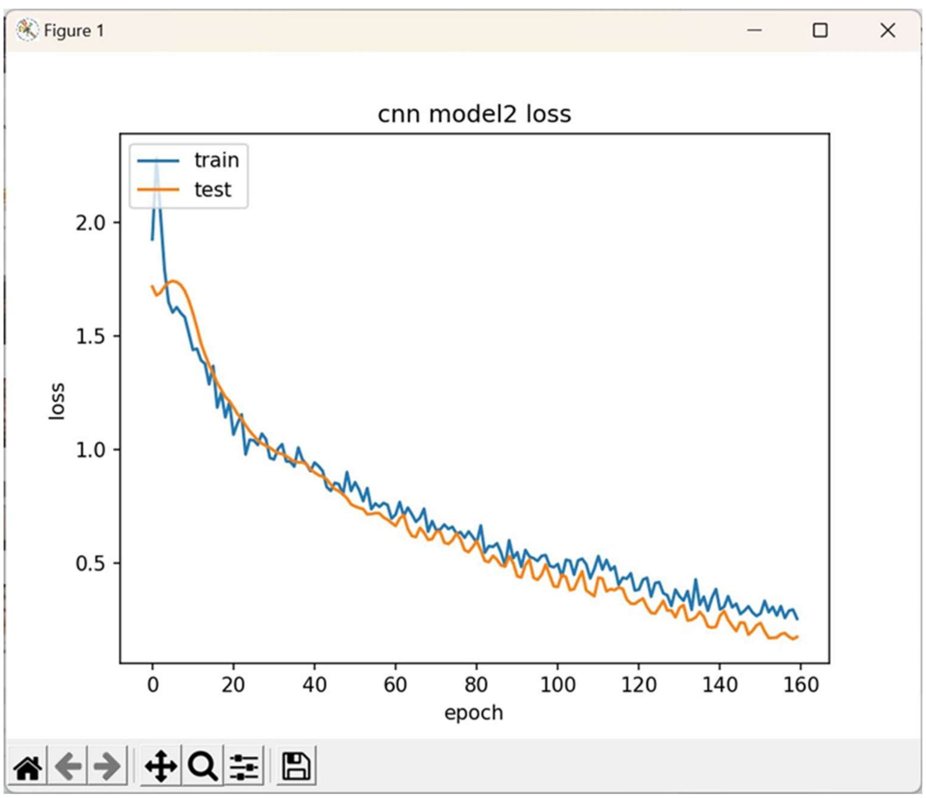

Fig11: CNN Model

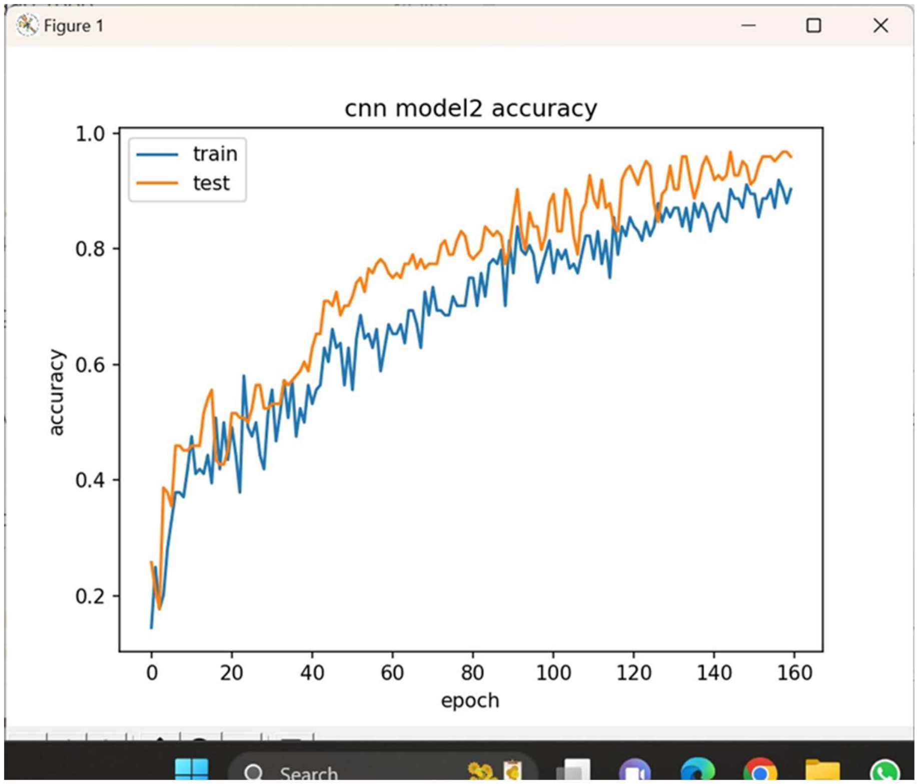

Fig12: CNN Model accuracy.

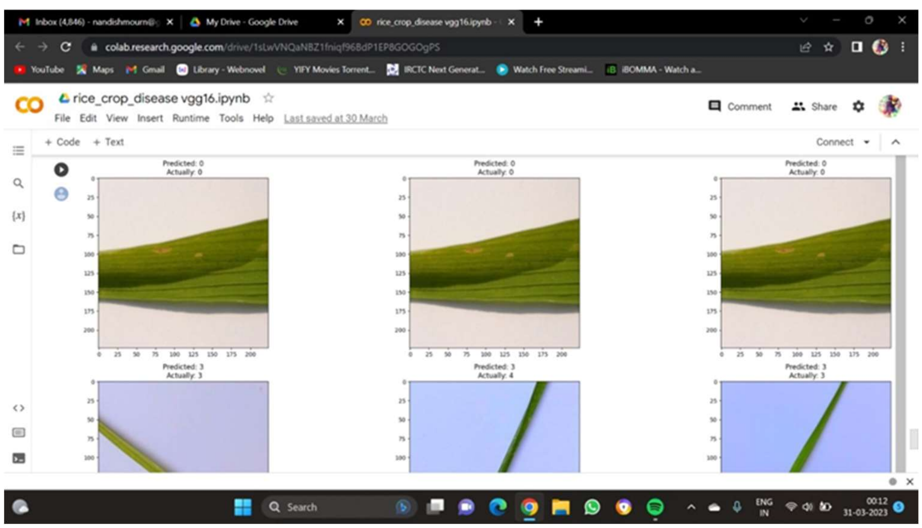

Fig13 VGG16 Model Prediction & Actuality

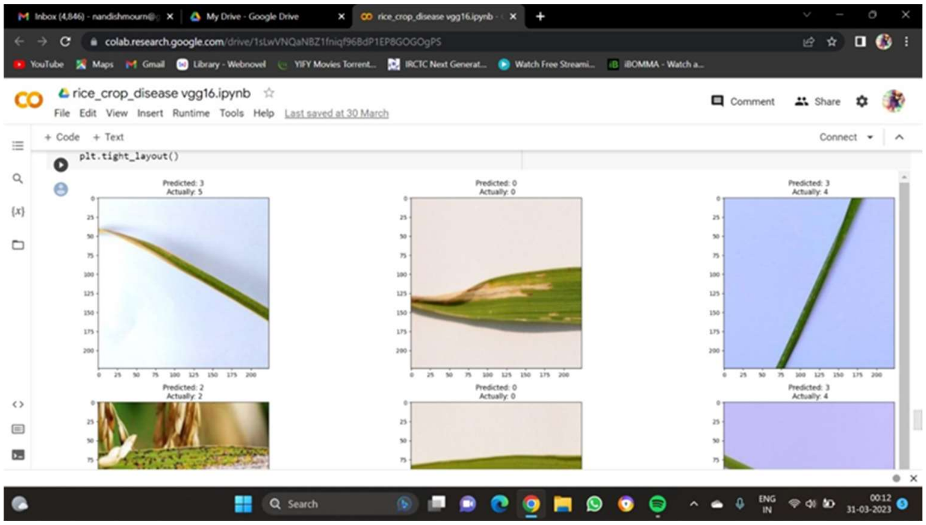

Fig14 VGG16 Model Prediction & Actuality

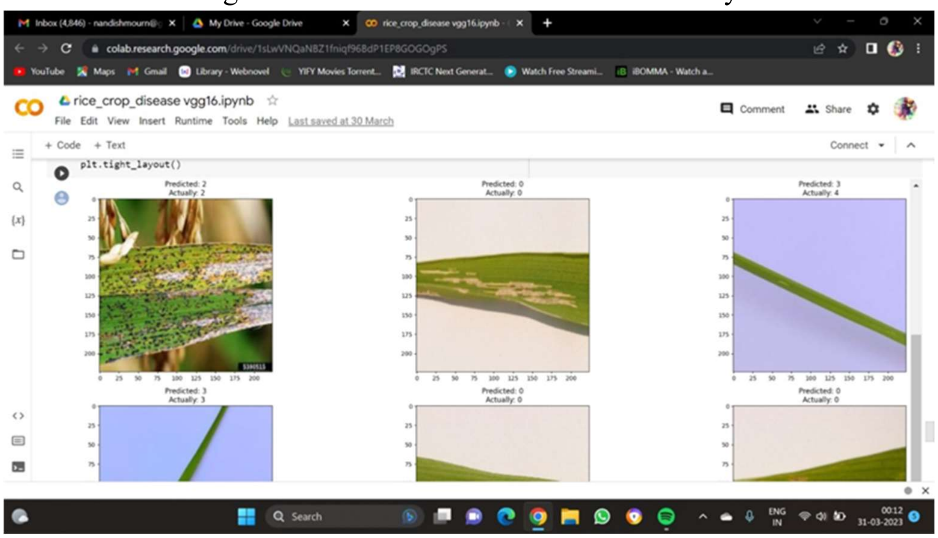

Fig15 VGG16 Model Prediction & Actuality

VI. CONCLUSION

Diseases that affect rice leaves can cause significant production losses, and manual detection is difficult and time-consuming. With advances in computer vision, there is potential for automated methods to accurately detect and diagnose rice leaf diseases. In this study, a modified deep learning transfer approach was proposed, achieving an impressive 96.08% accuracy on a dataset of healthy leaves and five common diseases. The system can be integrated with drone and IoT technology for real-time diagnosis in the field. Future work will focus on expanding the system to diagnose additional rice diseases and exploring similar applications in other important crops.

This project proposed a modified deep learning-based transfer learning approach for accurate detection and diagnosis of rice plant diseases using CNN and VGG16 algorithms. The system is capable of accurately detecting six classes of rice plant diseases, including healthy, narrow brown spot, leaf scald, leaf blast, brown spot, and bacterial leaf blight. The proposed system achieved significantly higher accuracy compared to similar approaches reported in the literature, with the highest average accuracy of 96.08% using the non-normalized augmented dataset.

The combination of drone technology and IoT technology allows for real-time diagnosis of rice plant diseases, which can potentially lead to early detection and intervention, reducing production losses and increasing food security. Future work will focus on developing a complete drone technology-based IoT system that can be tested in real-life scenarios and expanding the application of this technology to other plant leaf diseases that are similarly important to humankind. Overall, this project demonstrates the potential of deep learning-based approaches in the field of agriculture, specifically in early detection and diagnosis of plant diseases, which can have significant economic and social impacts.

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