Apple Disease Detection and Severity Prediction

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Abstract-In addition to providing food for an expanding population, farming is a vital source of energy and may be able to combat global warming. The primary focus of efforts is on locating and treating plant diseases, which present a substantial difficulty. Since fruits are essential for boosting human immunity, detecting fruit diseases also demands more focus. Fruit infections must be accurately detected by computer-based approaches because doing a manual, naked-eye inspection of fruits can be time-consuming and difficult. It has been demonstrated that artificial intelligence, in particular convolutional neural networks (CNNs), is effective at extracting information about the color, shape, and texture of fruits, making it simpler to recognize illnesses. In image classification challenges, CNN techniques have achieved outstanding results. In addition to reducing fruit output, plant diseases have a considerable negative economic impact. Researchers have created a dataset of green apple fruit that uses VGG 16 to forecast illnesses in order to address this problem. Using whale-controlled entropy, a number of citrus fruit diseases are found in this study, and numerous disease forecasts are generated. The authors provide a technique for identifying apple fruit illnesses using this as a guide. They make precise predictions using the VGG-16 algorithm for more accuracy. They suggest disease prediction based on the accessibility of the dataset and establish moderate disease severity. A suitable approach will be made to address the problems based on the degree and kind of disease discovered. The suggested design surpassed previous methods in terms of accuracy and execution time.
KEYWORDS: Fruit disease detection, severity calculation, VGG 16, deep learning and apple fruit.

I.INTRODUCTION

India is a nation of farmers. When choosing fruit and vegetable crops, farmers have a lot of options [1]. Research in horticulture space is pointed towards increment the quality and amount of the item at less use with more benefit. The nature of the farming item might be debased because of plant infections. Agriculture is both the largest employer and the largest sector of the Indian economy. As a result, the agricultural sector contributes significantly to the expansion of the Indian economy. As a result, there is a lot of time to send out, which is another way for the rancher to make more money. In the long run, this will make farming pay more, which makes the Indian economy grow. In order for this to be possible, we need to produce more fresh fruits [2].Organic fruits and vegetables like mango, grapes, and apples are referred to as "cash crops," so there must be an increase in their productivity. Several diseases, including Flyspeck, Apple Rot, Sooty Blotch, and others, can harm apples. As a result, early detection is essential.Due to their potential to significantly reduce the quantity and quality of agricultural products, fruit diseases have become a problem. Acknowledgment Frameworks of typical and tainted Macintosh activities use PC vision methodologies that consider highlights like tone, shape and surface for acknowledgment. The most common method used in practice for determining whether an apple is healthy or infected is naked eye observation by experts. However, this method is time-consuming, expensive, expert-oriented, and not always feasible.

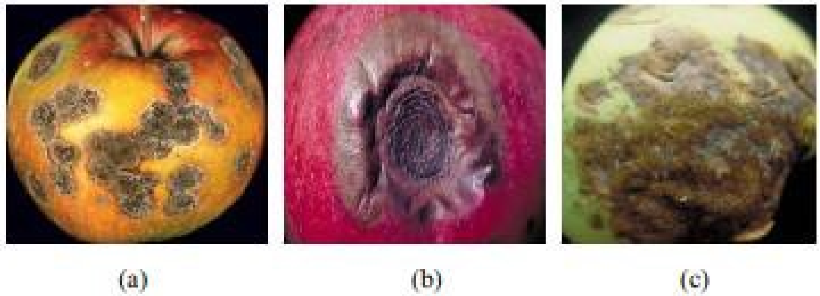


Figure 1: Fruit diseases a) apple scab b) apple rot c) apple blotch

Benefits in apple:

Consuming apples can help you lose weight and improve your heart health because they are high in fiber. Apple pectin contributes to healthy digestion. Apple consumption has been linked to a lower risk of diabetes, certain cancers, and cardiovascular disease, according to research. Quercetin, a flavonoid that may have anti-cancer properties [3], is also abundant in apples.

*Role of deep learning in disease identification***:**

The early detection and treatment of illnesses can be helped by deep learning methods based on apple detection and recognition. Fruit diseases pose a huge threat to agriculture since they can drastically lower crop yield and quality. Particularly apple illnesses exhibit distinct, observable characteristics and behaviors. Thus, a system that combines human knowledge and encourages wise decision-making is necessary for effective prevention. Apples' features can be used to extract form, color, and roundness properties that can be used to identify their structure. A pattern recognition system may conduct sequential pattern categorization by combining several parameters including entropy, color, shape, and border size. This technique can be used in a variety of domains, such as teaching, the retrieval of food packaging images, and plant science research, as a useful image processing tool to categories and differentiate between healthy and diseased fruits.

Objective of proposed work:

- VGG 16 is implemented to detect fruit disease accurately.
- Based on it affected region severity level of affected fruit is identified and categorized into high, low and medium level respectively.

II. RELATED WORKS

Using a mix of color, texture, and form traits, AartiManjramkar and Shaikh RakhshindaNahid M. Ayyub have proposed a method for classifying and diagnosing apple fruit disorders. Image segmentation, feature extraction (color, texture, and shape), feature combining, and identification and classification of apple disorders as diseased or normal using multi-class support vector machines are the four primary procedures included in the suggested methodology. [4].

S. Malathy et al. provide a method for identifying specific illnesses that target fruits based on similarities and for detecting diseases that harm fruits. Due of this, the method uses CNNs (Convolutional Neural Networks), a deep learning technique that uses input in the form of images to discriminate between them based on a variety of factors. CNNs are most frequently used to analyze visual data. The farmers will undoubtedly benefit from this since it will accelerate the growth of their crops in the near future. Python has been selected for further investigation in this method [5].

S.B.D.H. Dharma Siri and S. Jayalal use the suggested method, which includes the following essential steps: image preprocessing, image segmentation, feature extraction, preparation, training, and testing of datasets are all included. In this strategy, images of both healthy passion fruit and two different diseases—passion fruit scab and woodiness—were used. K-Means clustering was used for segmentation. The k values 2, 4, 6, and 8 were used to group pictures. Photos were first converted to the RGB, L*a*b, HSV, and Grey color models in order to choose the best color model for this strategy. The model was made with Support Vector Machine, and the features were taken out with Local Binary Pattern [6].

R. Ramya et al. show how to identify and analyze fruit illnesses that are present in plant regions, save information about the agricultural sector and about farmers in databases, and retrieve that information using cloud computing. There are additional fruit illnesses that develop as a result of environmental variables, mineral content, farm area insects, and other causes. Image processing is used to identify and save in the database the observed data from the plant area [7].

Plant and fruit diseases have a significant impact on production's quality and quantity, as demonstrated by Kuwaiti Kaur and Chetan Marwaha. These days, diseases are widespread. The major problem in this area is pesticides and other toxic wastes. This essay examines illnesses brought on by fruit picking. Techniques for image processing are utilized to examine fruit crop damage. Comprehensive analysis of filtering methods related to distortion detection is provided [8].

A technique for identifying and categorizing exterior fruit illnesses has been put out by Ashwini Await and her coworkers. Since images are a more direct means of communication than the thousands of terms used by conventional methods, their solution makes use of image processing technologies. Using the K-means clustering method, the pictures are categorized and assigned to the relevant illness groups based on four feature vectors: color, morphology, texture, and structure of the fruit hole. Two image databases are utilized by the system: one is utilized for query image implementation, and the other is utilized for illness image training with photos that have already been stored. Disease classification and pattern matching are two applications of the ANN concept [9].

III. PROPOSED METHODOLOGY

Ranchers actually make the determination of most plant sicknesses right now. However, the lack of a clear line separating the various grades of the same disease and the similar image features of some diseases may result in significant deviations in the artificial diagnosis results. This makes it harder to deal with diseases. Additionally, due to their erratic occurrence, some diseases cannot be promptly identified. This will hurt the growth of the farming economy as well as the quality and yield of organic products. Consequently, computer vision and deep learning's capacity for automatic and precise disease diagnosis is growing in importance. Apple fruit detection is detected using the VGG 16 algorithm, with citrus fruit disease detection serving as the foundation. In addition to predicting the Disease, the proposed system also identifies its three severity levels—high, low, and medium.

Figure 2: Proposed system architecture

Implementation of proposed system:

Image Acquisition:

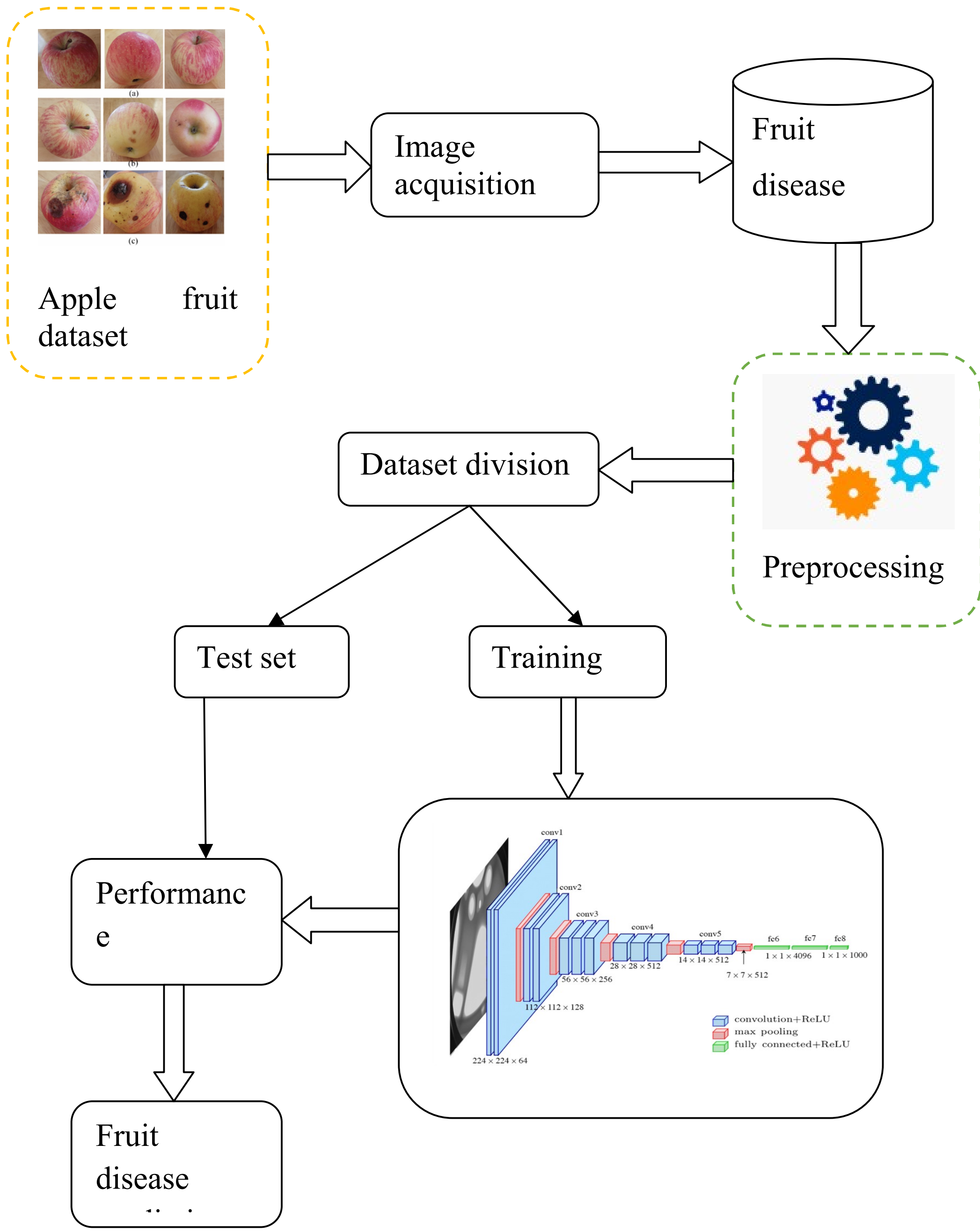
This is the first phase, and during the first phase, sample images were collected because they were required for the classifier algorithm's training and the model's construction. The apple variety is chosen for the sample images. The open-source images of healthy and diseased fruit served as the classifier algorithm's training and test sets, respectively. These images were captured from various perspectives, in various locations, and under various lighting conditions. The "JPEG" file format is used to store and use these images [5]

PREPROCESSING

After finish of the picture procurement process, something else called picture handling is done with the end goal of progress of the nature of the picture. All unique pictures of natural products were aggregately put away in one normal envelope. Additionally, the captured images must be resized to 250x250 pixels if their height and width were identical. The handling will be fairly postponed, just when the picture size was enormous. An image restoration technique is used to improve the image's sharpness and reduce noise after the resizing process is finished [5]. The main objective of this module is to recognize fruits and vegetables from their photographs. Since organic goods and leaf hues can be reliably represented by RGB colors, a wide range of climatic variations results in a diversity of highlights with low reliability. The resultant RGB image must therefore be converted into a grayscale image before being pre-processed for fruit recognition. We may simplify the image while retaining the crucial details needed for precise fruit detection by transforming the RGB image to grayscale. This method not only makes image processing chores simpler, but also improves the system's performance in recognizing objects. Hence, one of the key processes in fruit recognition systems is the conversion of RGB photos to grayscale.

CLASSIFICATION:

The VGG-16 is a widely used Convolutional Neural Network (CNN) architecture that has gained immense popularity due to its superior performance on the Image Net dataset for visual object recognition. It is considered one of the best models proposed so far for image classification tasks in the deep learning domain. The name "VGG-16" has a specific meaning. The "V" in VGG stands for visual, and the "G" stands for geometry, representing the research group that contributed to the creation of this CNN model. The number "16" denotes the total number of layers present in this architecture, which includes 13 convolutional layers and 3 fully connected layers. The VGG-16 model's success is attributed to its deep architecture, which allows it to learn complex features from images, leading to accurate classification results.



VGG-16 Architecture and Training Procedure:

In this study, a Multi-layer Perceptron (MLP) block was introduced as the top layer to enhance the performance of the VGG16 model on fruit disease classification. To train the model, the study used a labelled dataset of fruit illnesses. The pre-trained VGG16 model, which was initially trained on the Image Net dataset, was used in inductive transfer learning. It has been demonstrated that utilizing pre-trained models for transfer learning is helpful for deep learning tasks because it allows the model to use the information learnt from a large dataset to perform better on a smaller dataset. The VGG16 model's weights, which were acquired during training on the Image Net dataset, were employed in this work as the model's knowledge output. These weights represent the knowledge the model acquired throughout development and its capacity to categories 1000 distinct image categories out of the 14 million in the Image Net dataset. The fruit disease classification job can benefit from the model's capacity to distinguish intricate characteristics in images by applying the Image Net pre-trained weights of the VGG16 model, which will improve classification results.Weights from the pre-trained VGG16 model were used in the study to feature extract data related to fruit disease [11].

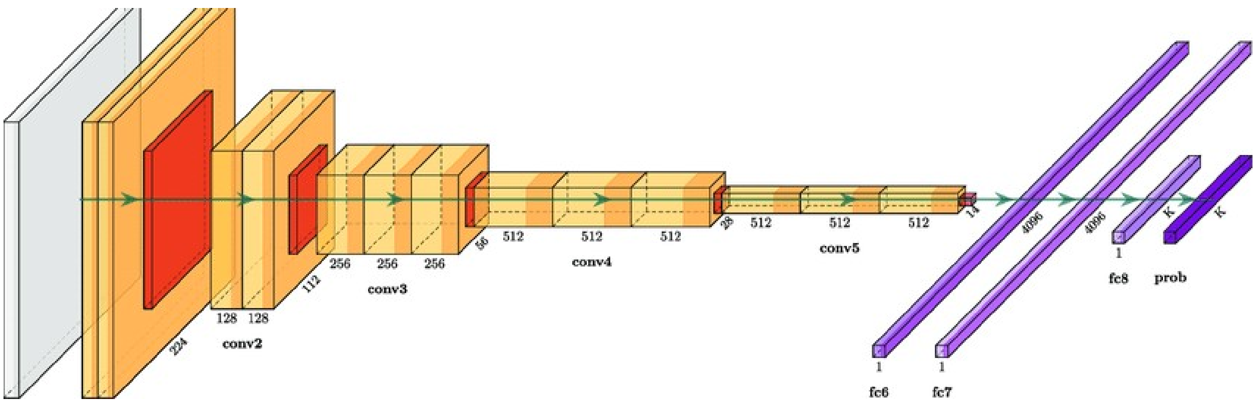


Figure 3: VGG 16 architecture diagram

The MLP block was applied to the VGG16 model to get the results of the feature extraction. The proposed architectural classifier made use of the MLP block, Soft ax activation classifier, and other regularizes, while the transfer learning feature extractor made use of the VGG16. In the suggested architecture, there were numerous layers that made up the MLP block, including a dense layer and a Flatten layer. Dropout, batch normalization, and regularized kernels were used as regularizes to enhance the system's classification performance and avoid over fitting. These regularization methods are frequently employed in deep learning to avoid over fitting, which happens when a model grows complicated and begins to closely resemble the training data. Over fitting results in poor generalization performance on fresh, untried data. The proposed architecture was able to improve classification performance on the fruit disease dataset while preventing over fitting by using these regularizes.The study used data augmentation using the Picture Data Generator from the Keas toolkit to further reduce over fitting. The dataset for fruit disease had only 140 examples per category, so data augmentation was used to make the dataset larger and more varied. The Picture Data Generator alters the photographs by rotating, resizing, and flipping them in order to produce new, slightly modified replicas of the original images. This strategy decreases over fitting by diversifying the dataset and preventing the model from memorizing the training data. Rectified Linear Unit (ReLU) activation function, a popular activation function in deep learning, was employed in the MLP block. The eight classes of the Soft ax activation function, which matched the eight different types of fruit diseases in the dataset, were used in the output layer of the MLP block. In order to forecast the most likely class for a given input image, classification models use the Soft ax activation function in the output layer to transform the model's raw output into a probability distribution over the various classes.

SEVERITY CALCULATION:

The disease can be accurately predicted using the proposed algorithm's image identification. The affected area's range is calculated, and the value is used to determine the affected level's severity, which is then divided into three stages: low, medium, and high. Based on the results, the proposed system accurately predicts disease severity and recommends taking precautions to boost production yield.

IV. RESULT AND DISCUSSION

Deep learning techniques are utilized for the effective identification of diseases, and fruit disease prediction plays a significant role in the agricultural sector. Images come from a variety of open-source websites. After image acquisition, grayscale conversion, preprocessing, and successful implementation of efficient fruit disease identification with VGG 16, the results are briefly discussed.

During picture training, validation, and testing, there are 100, 20, and 20 photos utilized for each category, respectively. The Kara's library and Python were recommended as tools for implementing the three forms of transfer-learning architecture. The callback function in the Kara's library is utilized during the model-formation process. Model Checkpoint and Early Stopping are utilized by the callback function. The quantity of ages utilized in each model arrangement is 30 ages.

It requires knowledge about the performance of each suggested design, just like deep learning. The performance of the three suggested architectures was evaluated based on their respective accuracy, precision, recall, and F-Measure values. To calculate the performance value, use the formula below:

$$\text{Accuracy} = \frac{TP+TN}{TP+FP+FN+TN}$$

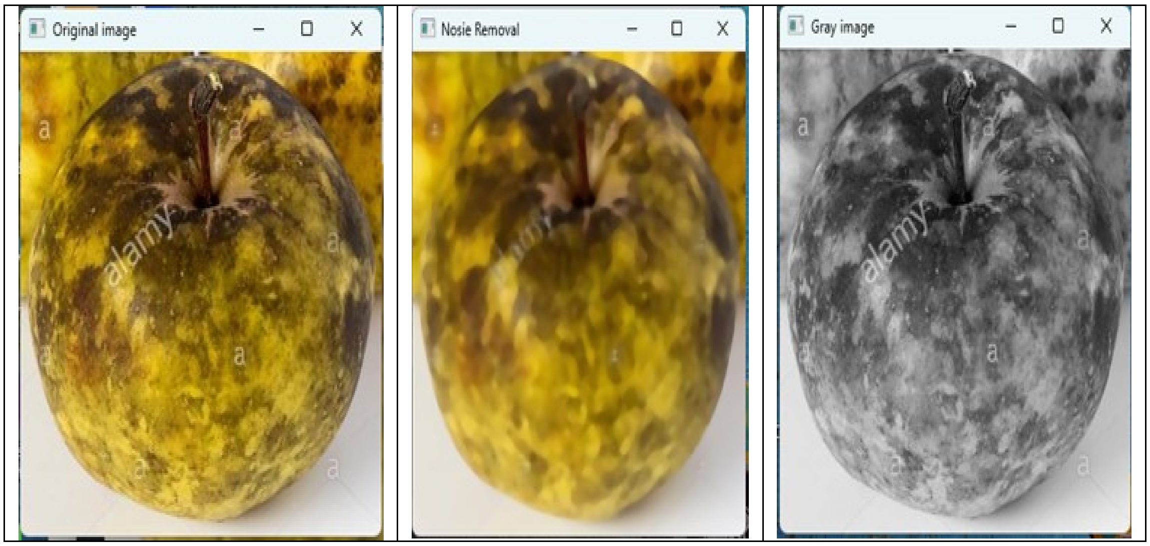


Figure 4: Preprocessing output

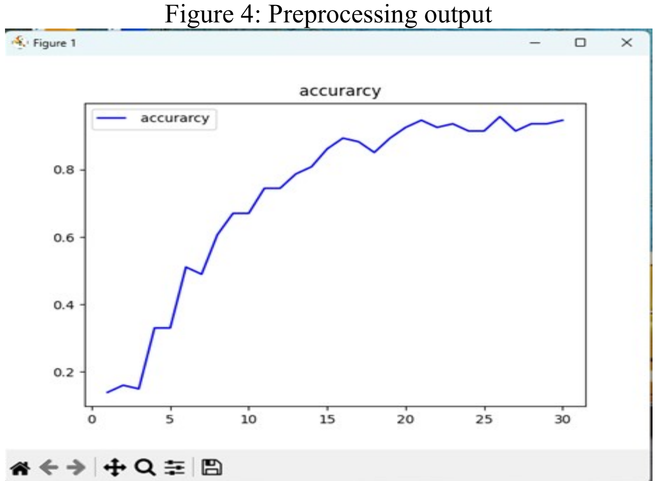


Figure 5: Accuracy of proposed system

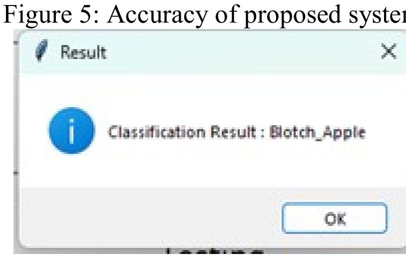


Figure 6: disease affected

V.CONCLUSION

The trials' findings show that machine learning with conventional feature extraction continuously falls short of deep learning with transfer learning. Over fitting has been decreased in this study thanks to the usage of regularizes. The average values of accuracy, precision, recall, and F-Measure on the test data show that transfer learning with regularizes can greatly improve the system's performance. In forecasting diseases and determining the severity levels of those diseases in apple fruits, our suggested system had a high accuracy of 93%. Farmers can use this technique to accurately automate disease classification in apple fruits. By eliminating the requirement for specialists in some situations, this not only saves time but also money.

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