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Deep Learning Based Tomato Leaf Disease Detectionand Classification

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Abstract: One of the most important industries in our society, agriculture seems to be where we have focused our attention since the Middle Ages. In India, the agricultural industry supports between 60 and 70 percent of the population. Globally, crop losses caused by a variety of factors, including weeds, diseases, and arthropods, have increased at an alarming rate, from around 34.9% in 1965 to over 42.1 percent in the late 1990s. Bacteria and fungi frequently cause illnesses in tomato plant life. Early blight and late blight are fungus diseases that affect plants. In our research, a CNN model and a set of guidelines are presented for identifying such illnesses on crop leaves. The model we developed is taught to look at and comprehend a diseased leaf before identifying the cause of the ailment. We are using InceptionV3 in our work to identify tomato leaf diseases. The proposed model is effective on the PlantVillage Dataset.

***Index Terms* – Convolutional neural network, Deep Learning, Inception V3, Tomato Leaf Disease, Transfer Learning, PlantVillage.**

I. INTRODUCTION

Farmers are now well versed in the use of engineering science and agricultural management technology. Agricultural-related technical skills are required for agricultural development. Plant health and growth often depend on the environment, which we may not always be sure of. Therefore, greater efforts require rapid development of the agricultural life cycle. The use of technology has always helped agricultural sectors to find profitable, environmentally friendly processes, and to contribute to the well-being of farmers. However, farmers face unique challenges and need expertise and training to ensure their success. Artificial Intelligence and Deep Learning technologies help farmers incorporate the latest scientific advances and design tools into their daily activities. The results are to improve their performance with these technologies, which increase efficiency and reduce environmental damage, food pollution and increase profits.

Tomatoes are an important vegetable for everyone. Tomatoes are high in nutrients, and they also contain heart disease and anti-cancer drugs called lycopene. The latest technology Artificial intelligence and in-depth learning are finding new economic opportunities, knowledge to improve tomato quality. Proposed tools and technologies improve the performance of tomato farming and increase profits that improve productivity and marketing strategies. Early improvement can be achieved through accurate identification of daily tomato leaf changes that will now improve and control harvest time, pest control, crop forecast, farm monitoring, disaster warning and tomato health. Agricultural research strategies play an important role in the growth of farmers and ultimately contribute to the development of the nation, as India is an agricultural country and 80% of people and businesses rely on agriculture.

II. RELATED WORK

2.1 Cotton Plant Disease Detection Using Deep Learning

The main objective is to develop a simple approach for detecting cotton crop diseases. This picture is used as an input in image processing. The diseased leaf's digitized color picture is the beginning point for image processing. The goal is to protect agricultural produce against quantity losses. The network CNN is being used. Cotton leaves have been successfully identified using a web-based approach for crop disease identification. A Convolutional neural network with three hidden layers was constructed to categorise the cotton leaf disease photographs. The importance of gathering large sums of money for data augmentation and transfer learning is boosting classification accuracy. The importance of amassing large sums of money, data augmentation, transfer learning, and the display of CNN activation maps in datasets with substantial variability in order to improve classification accuracy.

2.2 Deep Learning Based Automated Detection of Diseases from Apple Leaf Images.

The study's main purpose is to use an automated digital method to identify illnesses like Marsonina Coronaria and apple scab in apple leaves. For automated identification of sick apple leaf photos, three distinct convolutional CNN networks are presented. On the dataset, machine learning techniques employed in CAD systems are implemented, which can aid in the detection of apple illnesses. Taking 200000 histopathological pictures with the suggested CNN model C yielded a 99.2% accuracy and a 99.7% sensitivity. Following that, several machine learning performance parameters such as accuracy, sensitivity, specificity, false positive rate, classification error, and precision are analysed.The essential metric for judging the best classifier is accuracy and sensitivity, which is picked from the performance measurements. There is a need to build mobile-based applications that would aid farmers in detecting illness in their own fields in order to provide real-time treatments. The classification is done in two stages: first, using convolution neural networks, with CNN-C providing the best results, and then by machine learning techniques, with SVM classifier providing the best results.

2.3 Potato Leaf Diseases Detection Using Deep Learning

It is critical to perform adequate research to promote sustainable agriculture, given the advancement of agricultural technology and the application of artificial intelligence in the detection of plant diseases. Premature extinction and late blight, for example, have a substantial influence on the quality and quantity of potatoes. Various models have been presented in the past to identify a variety of plant diseases. In this article, a model is used to optimise (transfer learning) the extraction of important characteristics from a database using pre-trained models such as VGG19. The identification of these diseases effectively and automatically in the germination period can help enhance the output of potato plants, but it takes a high degree of knowledge. They employed the idea of transfer learning to create an automated system to identify and diagnose potato leaf illnesses such as early rot, late damage, and a unique solution that achieves 97.8% accuracy in test data with 5.8% and 2.8 percent development, respectively. They developed a method that achieves 97.8% accuracy in test data using the principle of transfer learning. Their approach can aid farmers in detecting infections at an early stage and increasing productivity.

2.4 Deep Learning Precision Farming: Grapes and Mango Leaf Disease Detection by Transfer Learning

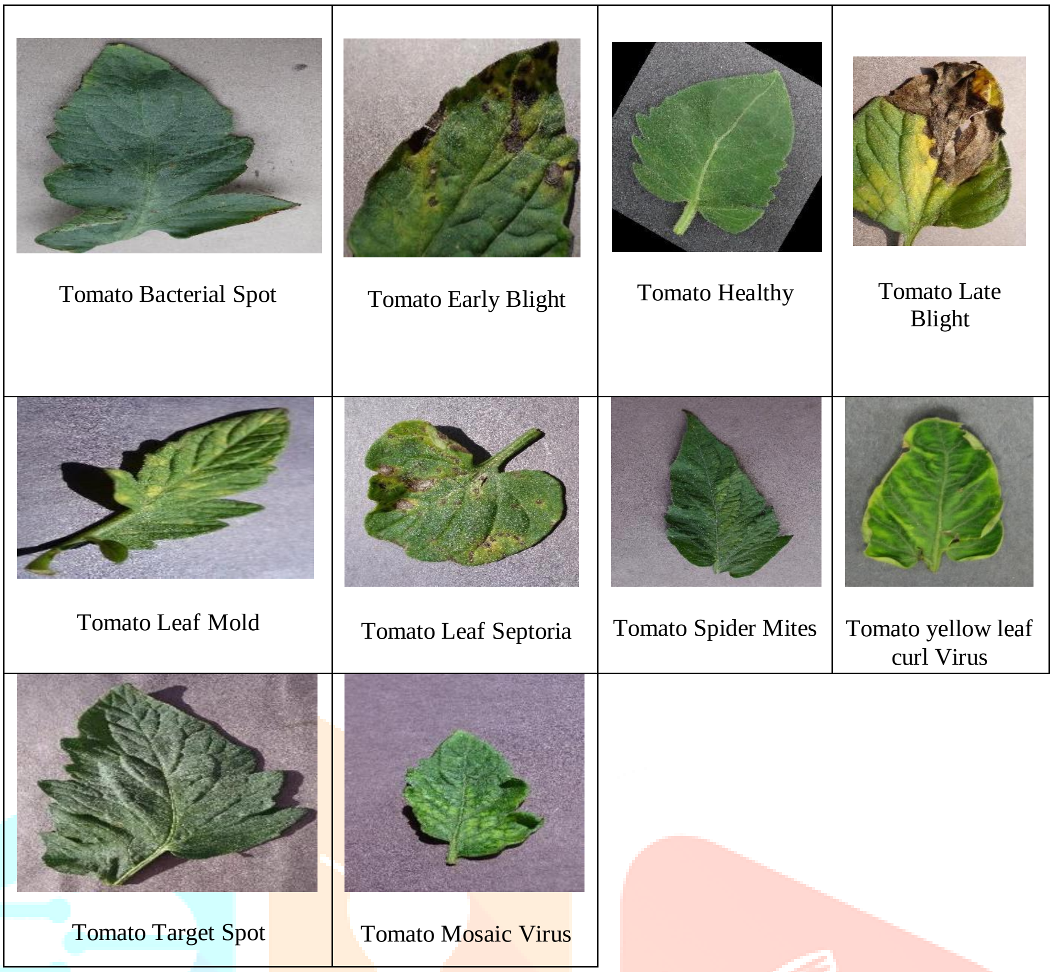
With AI, automatic detection of plant diseases in immature images may be used. This paper aims to identify and differentiate grape and Mango leaf diseases. Deep convolutional neural network (CNN) is trained to diagnose or rule out infections. MATLAB achieves an accuracy level of 99% and 89% of grape leaves and mango leaves respectively. An app called JIT CROFIX is designed for the same use on Android Smartphone. Using a pre-existing advanced learning model - AlexNet - an advanced machine learning model has been constructed to identify grapevine and mango leaf diseases. The model was trained using 7,222 vividly accessible grape leaves from the PlantVillage database and 1,266 self-purchased mango leaves, as well as real-time plantation pictures. The suggested model classified grape leaves with an accuracy of 99.03 percent in cases when the model had previously failed to identify them. The model will be taught to differentiate more phases of illness from the leaves in the future, and a suggestion system will be built to give a step-by-step guidance for farmers to cure the condition.

2.5 Tomato Leaf Disease Detection Using Convolution Neural Network

Agriculture productivity suffers as a result of plant diseases.For the majority of farmers, controlling and diagnosing plant diseases is difficult. There is still time for the sickness to be diagnosed, which will help to reduce future losses. The Fuzzy Support Vector (Fuzzy-SVM) machine, Convolution Neural Network (CNN), and Regional-based Convolution Neural Network are three mechanical learning techniques examined in this study for the detection of tomato leaf disease (R-CNN). Images of tomato leaves that had six illnesses while previously healthy samples were used to substantiate the findings. Images are trained using image measurement, color closure, flood filling division techniques, ternary pattern gradient area, and Zernike timeline features. The kind of illness is classified using R-CNN classifiers. To determine which approach is the most accurate for separation, R-CNN is compared to Fuzzy SVM and CNN analysis. To determine the most precise model for the plant predicting illnesses, fuzzy SVM and CNN approaches are examined and contrasted with R-CNN. When compared to other techniques of separation, the R-CNN-based Classifier has an astounding accuracy of 96.735 percent. Traditional manual diagnosis techniques and plant diagnostic identification are benefited by machine learning and image processing technology. There aren't many harmful photo examples needed. One of the most well-known routes to practical knowledge is in-depth learning. One of the numerous areas of in-depth learning employed is computer visualization. It has the ability to semantically classify photos and identify objects in them. To make the identifying procedure simpler, it employs a structure from the end. The most accurate classifier to correctly diagnose tomato leaf disease with 96.735 percent accuracy was compared in this study.

III. DATASET

This dataset contains 11K files of training and validation data for several forms of tomato leaf diseases. It comprises 11620 photos from ten different training data classes and 2911 images from ten different validation data classes. Tomato mosaic virus, Target Spot, Bacterial spot, Tomato Yellow Leaf Curl Virus, Late blight, Leaf Mold, Early blight, Spidermites Two spotted spider mite, Tomato healthy, Septoria leaf spot, are among the illnesses that the neural network can identify.



IV. PROPOSED METHOD

A. Inception Model

On picture classifications, the Inception model has been thoroughly evaluated. The model basically function as a collection of convolution filters that are applied to constant input and pooled. After that, the resultant area unit is concatenated. Prior to conception, all architectures conducted convolution on abstractions and channel-wise domains. Cross-channel correlations are implemented in the inception structure, which is executed on lower resolution input and avoids spatial dimensions. We performed leaf classification using Google's inception-v3 pretrained CNN model. Inceptionv3 has been trained on a big dataset. On a computer, the inceptionv3 model takes days or weeks to train. As a result, training a model on a regular computer is difficult. Figure 5.1 depicts the architecture of the inception model Architecture.

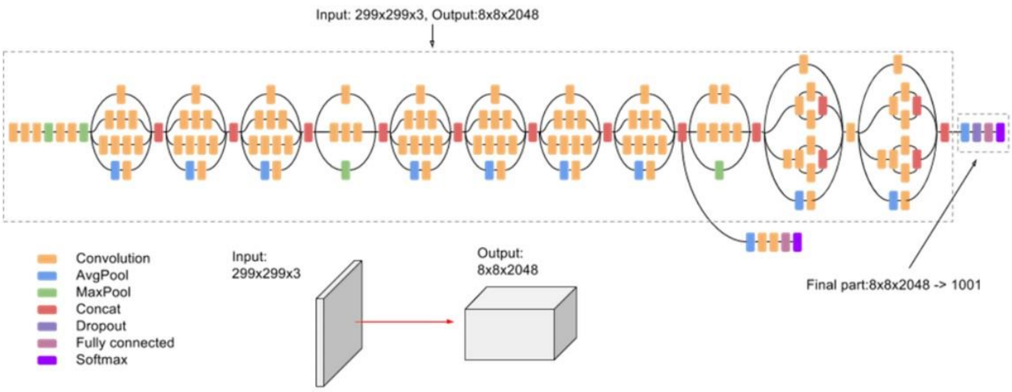


Figure 4.1: Inception model Architecture

The input 299x299x3 is the size of the image. The Output is reduced to 8x8x2048 with a concatenated output filter bank size of 2048 for each tile. Final part 8x8x2048->1001 is the classification of images.

B. Transfer Learning

Transfer learning is a method of reducing the number of parameters in a model by reusing a piece of the trained model on a familiar task in the new model. Transfer learning is a machine learning approach that use a previously trained neural network. So, when we use the new model to evaluate our original dataset, we are effectively leveraging the previously extracted features and training the model with our dataset. Because we don't need to train the feature extraction portion, we may train the model with minimal resources, datasets, and time.

The proposed System architecture (fig 4.2) comprises of data acquisition from a huge dataset, processing at different convolutional layers and then the classification of plant diseases which declares if the plant image is of a healthy class or diseased class.The proposed model designed and developed an automated system which is used for identification of plant diseases that helps to determine if the plant is infected by a disease or not.

The following are the steps in which the process is carried out:

1. Acquiring of the leaf image dataset i.e., different varieties of tomato leaf images containing 9 different classes of tomato leaf diseases and 1 healthy tomato leaf.
2. Pre-processing of the image in different convolutional layers.
3. Classification of tomato leaf diseases stating if the given tomato leaf image is diseased or healthy.

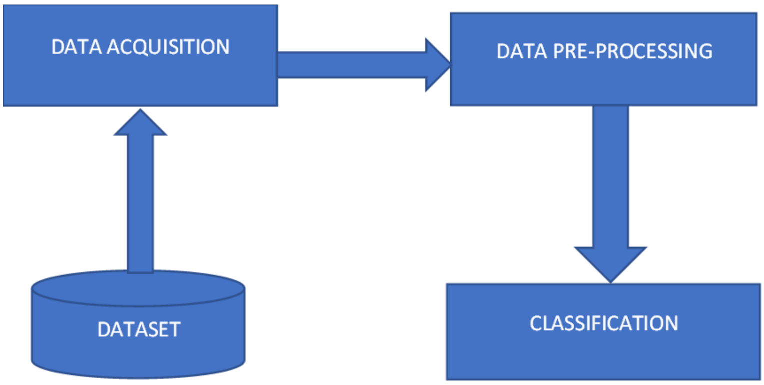


Fig 4.2: System Architecture

V. DATAFLOW DIAGRAM

Data Flow Diagrams (DFDs) describe the processes of how the transfer of data takes place from the input till prediction of the corresponding output.

1. Data Flow Diagram – Level 0: The users submitted the image of the plant leaves in DFD Level 0 (fig4.3). In turn, the system identifies and recognizes tomato leaf disease.

Fig 4.3: Level 0 Data flow diagram

2. Data Flow Diagram – Level 1: Figure 4.4 shows the DFD Level 2 model, in which the CNN model takes an image from the training dataset and predicts the kind of leaf disease.

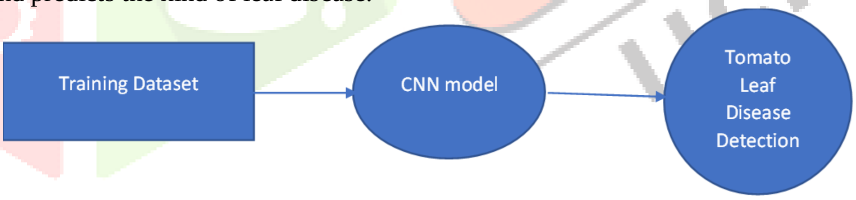


Fig 4.4: Level 1 Data flow diagram

3. Data Flow Diagram – Level 2: Figure 4.5 shows the Level 2 Data flow Diagram. DFD Level 2 explores even further into the concepts of DFD Level 1. It may be used to design or record all of the specific/necessary information regarding how the system works.

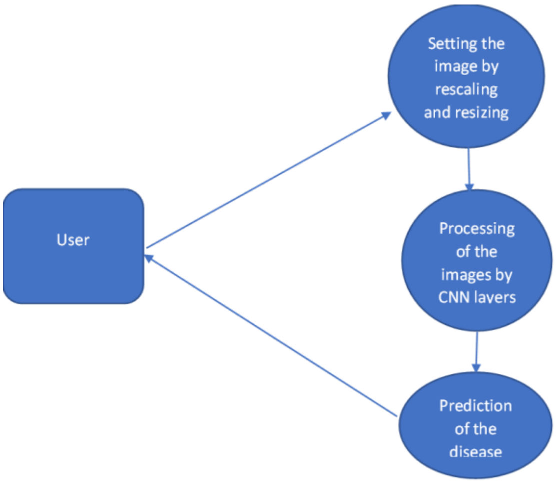


Fig 4.5: Level 2 Data flow diagram

VI. RESULT ANALYSIS

The PlantVillage dataset was collected from the Mendley website and used in this suggested system project; the dataset consisted of photos of damaged and healthy tomato leaf images. We discovered that there were no missing values in the dataset after further investigation. The information was subsequently investigated to learn more about the diverse tomato leaf species and illnesses. There were 10 distinct varieties tomato plant leaf diseases in the sample(9 diseased and 1 healthy). There are a total of 11620 tomato leaf images in the training dataset.

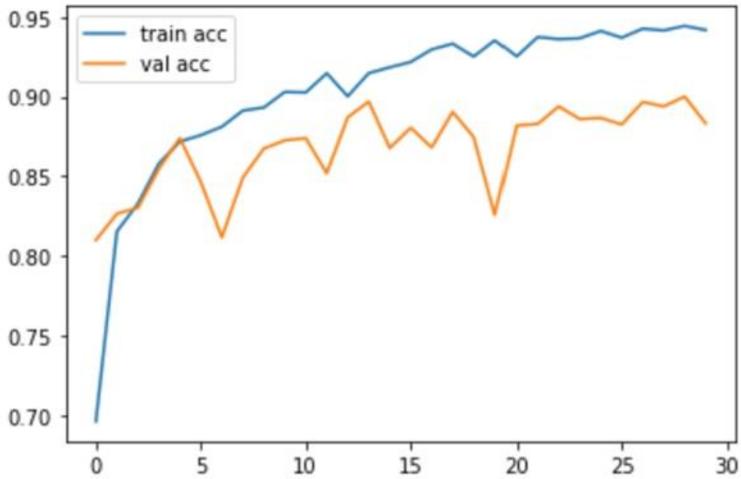


Figure 6.1: Accuracy Graph-Accuracy vs epochs

The figure 6.1 shows the accuracy graph. The two curves are depicted in the graph below, with the blue curve indicating training accuracy. The orange curve depicts the validation accuracy. The Training accuracy obtained is around 94.17 percent. The validation accuracy obtained is around 88.32%

VII. ACKNOWLEDGMENT

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