DEEP LEARNING FOR AGRO TECH- PREVENTATION AND PROTECTION OF PLANT DISEASE

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Abstract.

The overwhelmingly pervasive industrialization and globalization have caused impediments in the agriculture sector. Agriculture is highly vulnerable to several parameters such as nutrition, environment, climate etc. On the other hand, demand for food continues to grow rapidly. Hence, the identification and diagnosis of plant disease is of primary concern in the field of agriculture. When plants and crops are affected by pests, it affects the agricultural production thereby the economy of our Nation. Usually, farmers or experts observe the plants with the naked eye for detection and identification of disease but this method may not be accurate, time taking, and expensive. The advent of emerging technologies like Image Processing, Machine Learning, Artificial Intelligence etc., to accurately identify the plant disease such that timely guidance can be given to farmers which not only ameliorates the huge loss of yield, time, money and quality of the product. Apparently, a mobile application which is a convenient approach for an untrained person to learn about the plant disease easily because most of the farmers now have access to the smartphone and the Internet. The proposed work also suggests the treatment to be given to the plant once the disease of the plant is diagnosed.

Keywords

Crop Disease Identification, Machine Learning, Deep Learning, Image classification, TensorFlow, Inception V3

1. Introduction

In our country, agriculture has always been the mainstay in the economy. Due to the growing concept of industrialization and globalization, the agriculture field is facing many hurdles. The amount of crops and agricultural lands that are been damaged due to adverse climate conditions is increasing every year and can't be neglected. On top of that, the awareness and the necessity of cultivation need to be instilled in the minds of the younger generation. The new kinds of disease are infecting crops, which has directly affected the production rate and farmers are often confused about the symptom of their plants. Nowadays, the identification and diagnosis of plant disease is the prime concern in the field of agriculture and accurately diagnosing crops disease is one of the most difficult tasks to perform as it is influenced by many parameters such as nutrition, environment, climate etc. But we are still using the old manual methodologies of identification which is done by the experts using outdated tools for analysis and the accurate prediction/identification is hard.

To enhance the quality and quantity of the agriculture production the framers need to adopt the new technology. Mostly diseases are seen on the leaves or stems of the plant and we can use the latest image processing and artificial intelligence techniques to identify those diseases and its protection. It is a non-invasive technique which provides consistent, reasonably accurate, less time consuming and cost effective solution for farmers to manage fertilizers and pesticides. Precise quantification of these visually observed diseases, pests, traits have not studied yet because of the complexity of visual patterns. Hence, there has been increasing demand for more specific and sophisticated image pattern understanding.

The growth in technology has been changing the lives of many people by playing the vital role and it can also be very useful in the field of agriculture. The emerging technology like Image Processing, Machine Learning, Artificial Intelligence etc., can be used to identify the plant disease, which can save us the huge loss of yield, time, money and quality of the product. A convenient tool is really desirable to help the farmers diagnose the disease as quickly as possible when the problem just appears. A mobile application is an apparently convenient approach for an untrained person to learn about plant disease because most of them now have access to the smartphone and the Internet.

In the current work, a novel approach to the development of plant disease identification model based on leaf image classification is proposed which employs the advanced feature extraction algorithms from Google's

TensorFlow model Inception V3 to train it over the extracted features. This trained model is highly portable and can be easily deployed on multiple platforms. The farmers can use the application to take images of plants leaves, flowers, and fruits of different types, and then those images are used to identify the affected area. The highly optimized Machine Learning algorithm harnesses hardware to full utilization and provides fast and enhances the accuracy of results from the neural network. The proposed work not only identifies the disease of the plant but also offers treatment for the infected plant.

The current work "***Identification of Plant Disease Using Tensorflow***", is a mobile application which uses latest artificial intelligence technology to identify the plant's disease. The farmers can use the application to take images of plants/leaves of different types, and then those images are used to identify the affected area. The different types of image-processing techniques are applied to process those images to identify the types of disease. The systems is complete hardware-independent and free to all farmers who have access to smartphones, making it very much convenient and easy to use.

The proposed work is more accurate and can have control over it such as training huge category of data sets. The current work can be extended to identify disease which can be given to AI that will manage ordering related pesticides/fertilizers or give farmer detailed crop health details. Therefore, the proposed work could provide total solution that can be given to a crop from planting to harvesting. The primary contributions of the current work are as follows.

1. To detect the infected region of plant leaf, flower and fruits and identify disease name using object detection techniques based on Google's TensorFlow model Inception V3, taking mobile application as a client.
2. To suggest the treatment to the infected plant.
3. To encourage farmers to use new technology and methodology for the early diagnosis of plant disease and save a huge amount of time and money.
4. To enhance the knowledge of the farmers regarding the type of infection which can affect their crops and plants.
5. To easily provide information about the disease to all people, garden enthusiasm etc.
6. To create a huge database of infected plant leaves found in India for the neural network training.
7. To develop neural network which is capable for accurately classifying images of plants diseases with an average confidence level of above 90%.
8. To promote the use of emerging technology based on Machine Learning, Artificial Intelligence, and Image Processing etc.
9. To encourage youth towards professional farming/agriculture in future by making agriculture more lucrative.

The proposed work employs Google's TensorFlow model Inception V3 to train it over the extracted features which works on tensors 'n Dimensional Vector' to extract features from the given values and add those to the nodes of the InceptionV3 Neural network to make it as a portable and light weight module to carry the trained neural network making it highly portable, to deploy it in variety of machines. The main advantage of InceptionV3 is that it is fast, efficient and the model trained in it can be deployed in any mobile device irrespective of their processing power in form of TensorFlow Lite or can be extended as an API.

The proposed work not only identifies the diseases of the plants through plant leaves but also considers flowers and fruits for better and proper diagnosis. This is possible because Inception V3 can be customized by adding more intermediate Neural networks which facilitates for more accurate and improvement in the identification of the plant disease. While existing Plantix App works on preset code and cannot take flowers and fruits in this concern.

The proposed model can be customized by adding more inner layers of Neural Networks. This will facilitate towards high accuracy for diagnosing the plant diseases by considering leaves, flowers, and fruits images.
The primary merit of the proposed work are as follows.

i. The percentage of accuracy of diagnosing plant diseases can be enhanced over the most popularly used Plantix application.

ii. The proposed work determines the health of the plant by considering images of leaf, flower and fruits whereas the available Plantix Application considers only leaf images.

iii. The proposed application can accurately detect the natural and synthetic plant while the existing Plantix application diagnoses the synthetic leaf images as well which is futile.

iv. Maximizes the farms productivity by accurately diagnosing the diseases by providing authentic treatment.

v. Protects the environment as it helps to reduce to expose chemicals to the plant for no reason.

vi. Easily accessible, reliable and easy to use system because of the accessibility of smartphones that can bring people more closer to the technology.

vii. Ease to use graphical user interface as a client, user don't need to have any kinds of knowledge regarding agriculture and farming.

viii. Anyone can be the user without any restriction.

ix. Saves time and money of farmers.

The current approach can be implemented in all forms of agricultural sectors. The system has the capabilities of identifying the disease of the leaf, stem, fruits and it can be very helpful for the farmers to manage crop diseases. A photo of disease affected plants taken from the mobile application will be used to identify the types of the problem by using object detection using the latest technology like Image Processing, Machine Learning, and Artificial Intelligence etc. With identification and detection of the disease, the system will automatically find the shape of affected areas to quantify affected area by diseases and to determine the colour of the affected area. The farmers can use it to identify the plant diseases in an early stage, which will be a beneficial to save huge amount of yield.

The rest of the paper is configured as follows: in Section 2, the available work on the pertinent area is discussed. In Section 3, the proposed approach for identification of the plant disease in presented. The experimental results are the discussed in Section 4. The outline of the proposed plant disease identification are drawn in Section 5.

2.0 Review of Literature

Plethora of work exits in identification of plant diseases. Here we present the review of the pertinent area of plant disease classification and the methods used to classify the plant images.

Fadzilah Siraj, Muhammad Ashraq Salahuddin and Shahrul Azmi Mohd Yusof proposed the system for classification of Malaysian blooming plant. In their study on the application of Neural Networks (NN) on image processing particularly for understanding plant image features. For predictive analysis, two techniques were employed viz., NN and logistic regression. The study concluded that NN attains higher percentage of accuracy among the two techniques. Later, Otsu's method was applied in order to compute a global threshold. The image is converted to RGB color space again. In color extraction, the images were transformed from RGB color space to HSV color space then the image texture is calculated based on gray-level co-occurrence matrix (GLCM) to obtain the contrast, correlation, energy and homogeneity of the image. The prediction accuracy of logistic regression is 26.8% based on 1800 samples of Malaysian plant images. The observation of the study was that NN has shown higher average prediction results over logistic regression. However, their work cannot recognize the plant type, it could only recognize plant features so future studies were focused on the development of plant model system which can recognize Malaysian blooming plant by extending the dataset built with varieties of image samples can be captured from different plants in order to better recognize their types.

Yuita Arum Sari and Nanik Suciati proposed Plant Classification using Combined a* b* Color and Fractal based Texture Feature. This research proposed a new method of plant classification system using combination of color and texture features. The first phase is getting the crown of the plant, which is localized from a plant image by using pillbox filtering and OTSU's thresholding. The color features are extracted by removing L channel in L*a*b* color space, and taking only a* and b* channel, because of ignoring different lighting condition in plant image. The texture features are extracted by Segmentation-based Fractal Texture Analysis (SFTA). Classification is done using kNN classifier that is used to assess similarity among image plants. Cosine measure outperforms to all distance measures under k = 9. The authors observed that combined a*b* features and texture could improve the performance when using cosine measure than using L* color channel when combined with texture feature. The plant classification achieves the best result with accuracy 73.63%. Comparing the colour feature extraction, the accuracy of texture feature is better to stand alone, and help the performance to achieve the accuracy when all

features combined with combined a*b*colour and texture feature. Beside the distance, choosing of k value in kNN method is quite critical. The authors concluded that, the accuracy will be poor if the colour feature extraction is independently used for classifying plant. Removing L degraded colour feature performance when the feature classifies is stand-alone. The proposed model is sufficient to overcome the image plant classification in different lighting condition and color in the same class.

Plantix application in India have grown popularity in identification of plant diseases that employs Google's TensorFlow model Inception V3 and it is Cloud based application.

The existing system is cloud based and is of less accuracy as it could not distinguish between synthetic leaf and natural leaf. In few cases it is observed that the available work is unable to classify the plant when any leaf image is uploaded. Moreover, the image given by the farmer is zoomed by the exiting application for identifying the disease of the leaf in the process they miss the layout of the leaf which adds to the inability in identifying the plant. This is because the Plantix application uses two Neural Networks 1) Object Detection 2) Plant disease detection. So, when the synthetic leaf image is given to the application it first passes object detection test that it is a leaf and then the leaf disease detection neural network which is deployed over the Cloud classifies it as a Plant leaf which is either healthy or infected with disease. The neural network used in the proposed work is Inception V3 which is similar to Cloud implementation over that we have added our own customization where more branches of Neural Networks. This will facilitate towards high accuracy by considering leaves, flowers, and fruits images. Moreover, when the leaf prediction is very less the proposed system will discard the image and the farmer will be asked to reupload the image. This ensures that correct treatment for the plant will be provided to the farmer. Sandeep Kumar , Rajeev Ratan , and J. V. Desai presented a study on Cotton Disease Detection Using TensorFlow.

3. The Proposed Approach

The proposed system will employ the advanced feature extraction algorithms from Google's Tensor Flow model Inception V3 and train it over the extracted features, this trained model is highly portable and can be easily deployed on multiple platforms.

The proposed approach facilitates to easily modify values and reconfigure the application or retrain the neural network to increase the accuracy. While the available Plantix application used cloud infrastructure for training and deploying and it cannot be manipulated. The input image from the mobile API will be transferred to Cloud and processed according to the preset code using cognitive services of the Cloud and gives the output.

In the available system, the user/farmer uploads the sample images to the Cloud and then tags them and Cloud trains it and files are generated for the corresponding output. This is the drawback of the existing system. Whereas the proposed model has unlimited training data and will support for decision making besides it enables to identify a wide range of diseases and crops. The plant disease identification process is depicted in Figure 1, and comprises of three-step process namely:

- Image capture & selection
- Image Submission
- Image Classification
- Treatment
- Image Capture & Selection

Image Capture & Selection

Leaf image is captured through a clear camera. Multiple snapshots are to be taken for choosing the appropriate affected area. A clear image is chosen such that the leaf is clearly visible. In case of some image cropping problem, the images from the dataset can be chosen which was created earlier.

Image Classification

Cropped image is given to the neural network using the software application; Receive notification: Once image sent to the neural network, pattern matching is performed with the available datasets using pattern matching algorithm, and the dialogue box appears displaying result.

Treatment

Once the plant disease is diagnosed, the information regarding the disease identified is passed to Treatment module. The treatment module send the information of disease identified to the database for treatment. The database contains all possible treatments of diseases which is taken from Agrinomists.

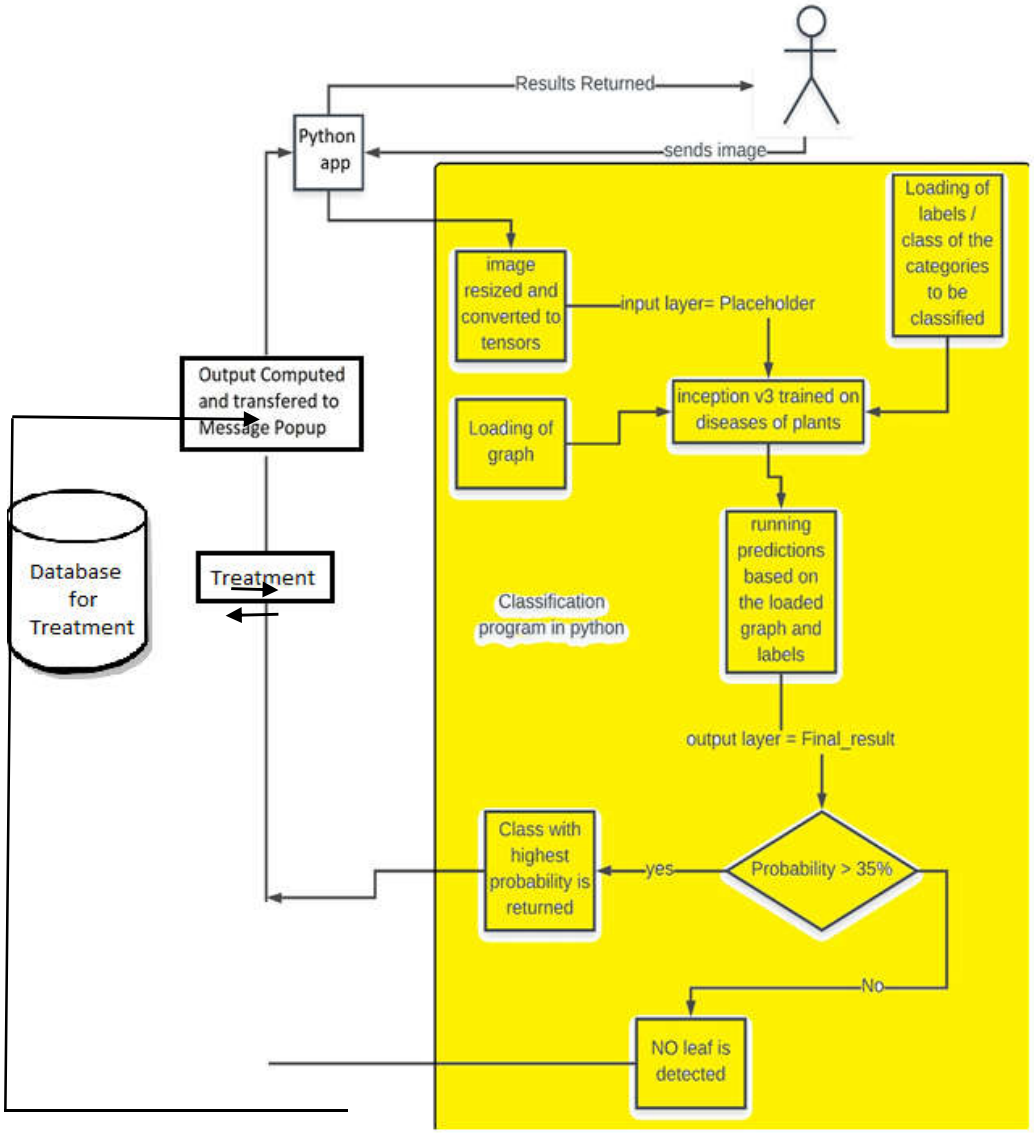


Figure 1. Plant leaf Identification Model

Training of Inception V3 Neural Network over the Given Dataset

For detecting various plant leaf diseases, the image processing techniques namely image acquisition, image segmentation, preprocessing feature extraction and classification of image are introduced.

Image Acquisition

Leaf image is uploaded using files. To find the exact disease affected, the RGB color of the cropped image is must be clearly visible. This is achieved with the help of a camera. Later the user has to enter the image in the software application and press classify button.

Image Preprocessing

The basic idea of the procedure is to upgrade the picture information and enhance the image properties. Image pre-processing is basic for showing, putting away and transmission off picture. It brings about image improvement in leaf picture using RGB shading position. The preprocessed images are resized to tensor size of 299*299 in-

order to get the most data out of the image in terms of tensors directly instead of saving the preprocessed in order to minimize the storage wastage of the training. Figure 2 presents the pre-processing image saved as Tensor.

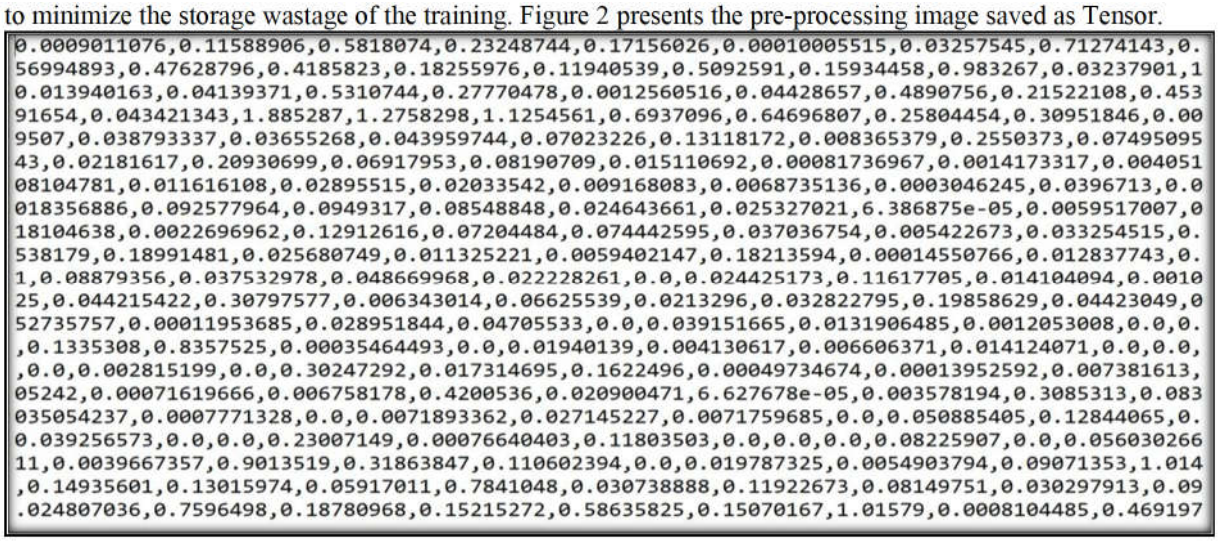


Figure 2. Pre-Processing Image saved as Tensor

Image Segmentation

The preprocessing technique is utilized by the TensorFlow to extract the features of the given leaf image using feature extraction provided as an inbuilt library in TensorFlow. The preprocessed image is then plotted as a graph by the TensorFlow in order to train the InceptionV3 Neural network from the extracted features from the given preprocessed tensors extracted from the provided leaf images.

Feature Extraction

The leaf image consists of different lesion shape and lesion color because of several types of leafs such as Paddy, Wheat, Jowar, and Turmeric. Features such as shape, color play a major role in leaf identification. Shape can be identified by measuring the breadth and height of the leaf image to measure the object pixel count. The pixels are then used to distinguish RGB values for calculating the Grey- Level Co-occurrence Matrix (GLCM). The method proposed by Pujari J D et al., is adopted in the extraction of RGB features. The foremost step is the separation of RGB components from the original colored images. The next step is the computation of mean, standard deviation, variance, and skewness from the separated RGB components.

Image Classification

The given image is pre-processed and saved in the form of tensors. These tensors are then passed to the InceptionV3 in the input layer and then using the decision tree hierarchy in the InceptionV3 model as hidden layer the decision is made according to the weights and the leaf is classified in the final layer. There are multiple epochs of training done to reach the higher accuracy of the trained neural network and the InceptionV3 CNN should not be overfitted or underfitted with the images which may lead to higher accuracy but low reliability of the neural network to classify image.

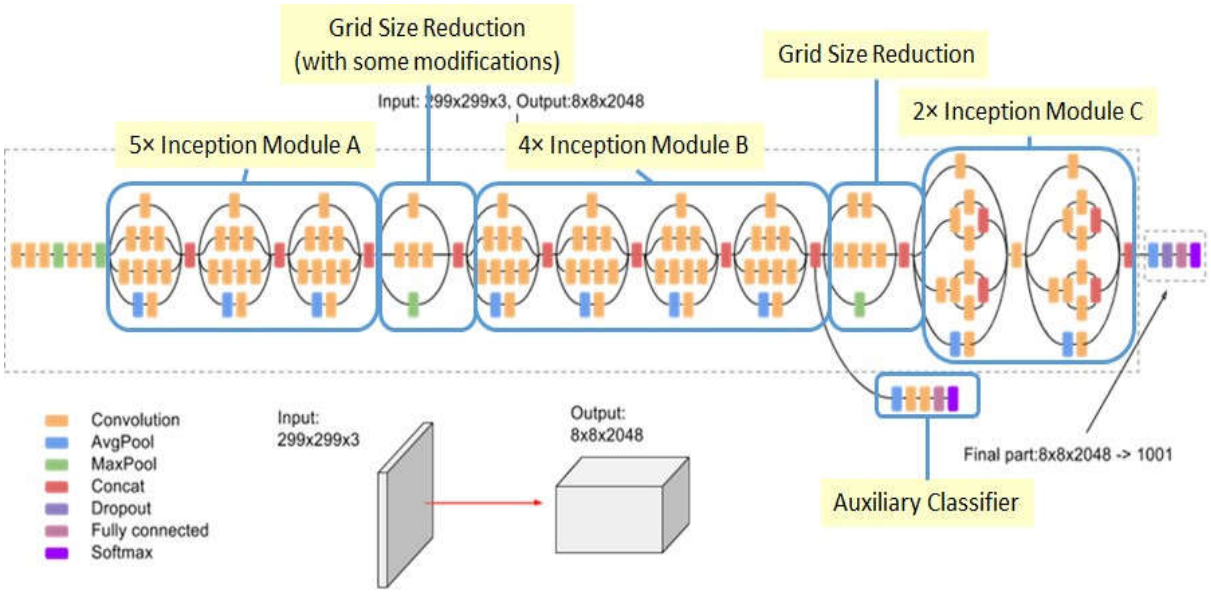


Figure 3. InceptionV3

4. Experimental Results and Discussions

Requirements

The list of requirements for developing the model for plant disease identification using TensorFlow is further described in detail. The complete requirements is divided into several necessary stages in subsections below, starting with gathering images dataset for classification process, labelling and training using conventional neural networks.

Dataset

Appropriate datasets are required at all stages of object recognition research, starting from training phase to evaluating the performance of recognition algorithms. All the images of disease and plant name collected for datasets will be from various sources. Images in the dataset were grouped into different classes which represented plant diseases which could be visually determined from leaves. In order to distinguish healthy leaves from diseased ones, one more class was added in the dataset. It contains only images of healthy leaves. An extra class in the dataset with background images was beneficial to get more accurate classification.

Image Pre-processing and Labelling

Images collected from the various sources will be in various formats along with different resolutions and quality. In order to get better feature extraction, final images intended to be used as dataset for deep neural network classifier were preprocessed in order to gain consistency. Preprocessing images commonly involves removing low-frequency background noise, normalizing the intensity of the individual particles images, removing reflections, and masking portions of images. Image preprocessing is the technique of enhancing data which involves cropping of all the images manually, making the square around the leaves, in order to highlight the region of interest. It is essential to use accurately classified images for the training and validation dataset. Only in that way may an appropriate and reliable detecting model can be developed.

Conventional Neural Network Training

Training the deep convolutional neural network for making an image classification model from a dataset was proposed. TensorFlow is an open source software library for numerical computation using data flow graphs. Nodes in the graph represent mathematical operations, while the graph edges represent the multidimensional data arrays (tensors) communicated between them. The flexible architecture allows you to deploy computation to one or more CPUs or GPUs in a desktop, server, or mobile device with a single API. TensorFlow was originally developed by researchers and engineers working on the Google Brain Team within Google's Machine Intelligence research organization for the purposes of conducting machine learning and deep neural networks research, but,

the system is general enough to be applicable in a wide variety of other domains as well. They have wide applications in image and video recognition, recommender systems and natural language processing. Convolutional neural networks (CNNs) consist of multiple layers of respective fields. These are small neuron collections which process portions of the input image. The outputs of these collections are then tiled so that their input regions can overlap, to obtain a higher-resolution representation of the original image; this is repeated for every such layer. Convolutional networks may include local or global pooling layers, which combine the outputs of neuron clusters.

The proposed system uses the transfer learning feature of inception v3 model by Google's TensorFlow module to extract the features as a graph from the images which is feed as an input to the neural network in the training process. After the training is completed the Neural Network state is saved as a graph file with extension ".pb" and this file consists of all features of the trained neural network regarding the class to which the entered image to be classified as these kinds of models are easily deployed in form of mobile TensorFlow lite model or as an API on the Cloud platform such as Google Cloud Platform, Microsoft's Azure, Amazon Web Service, IBM Cloud, etc. using an ML Engine available on those cloud platforms.

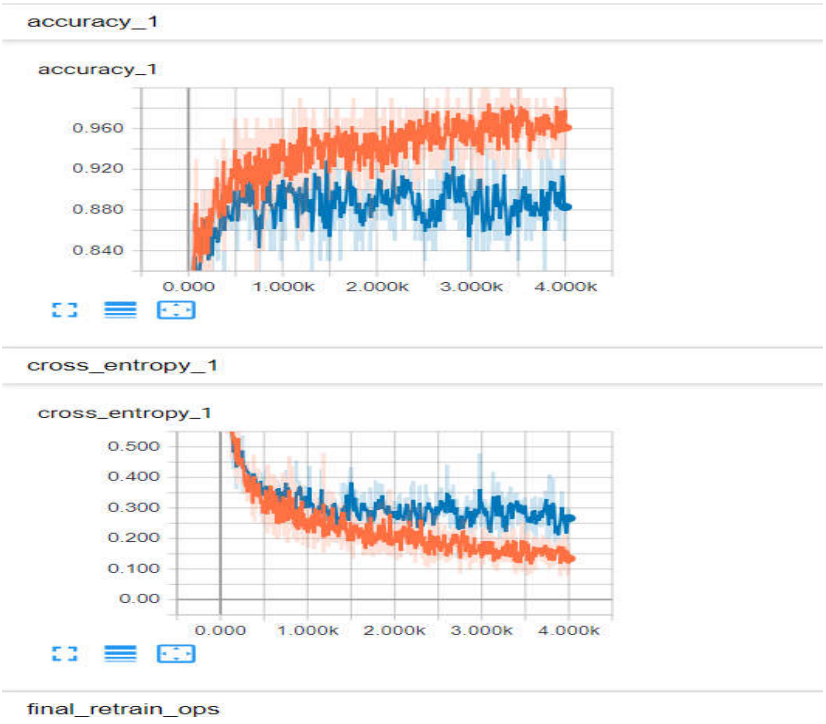


Fig 5.3: Scalars Tensorboard

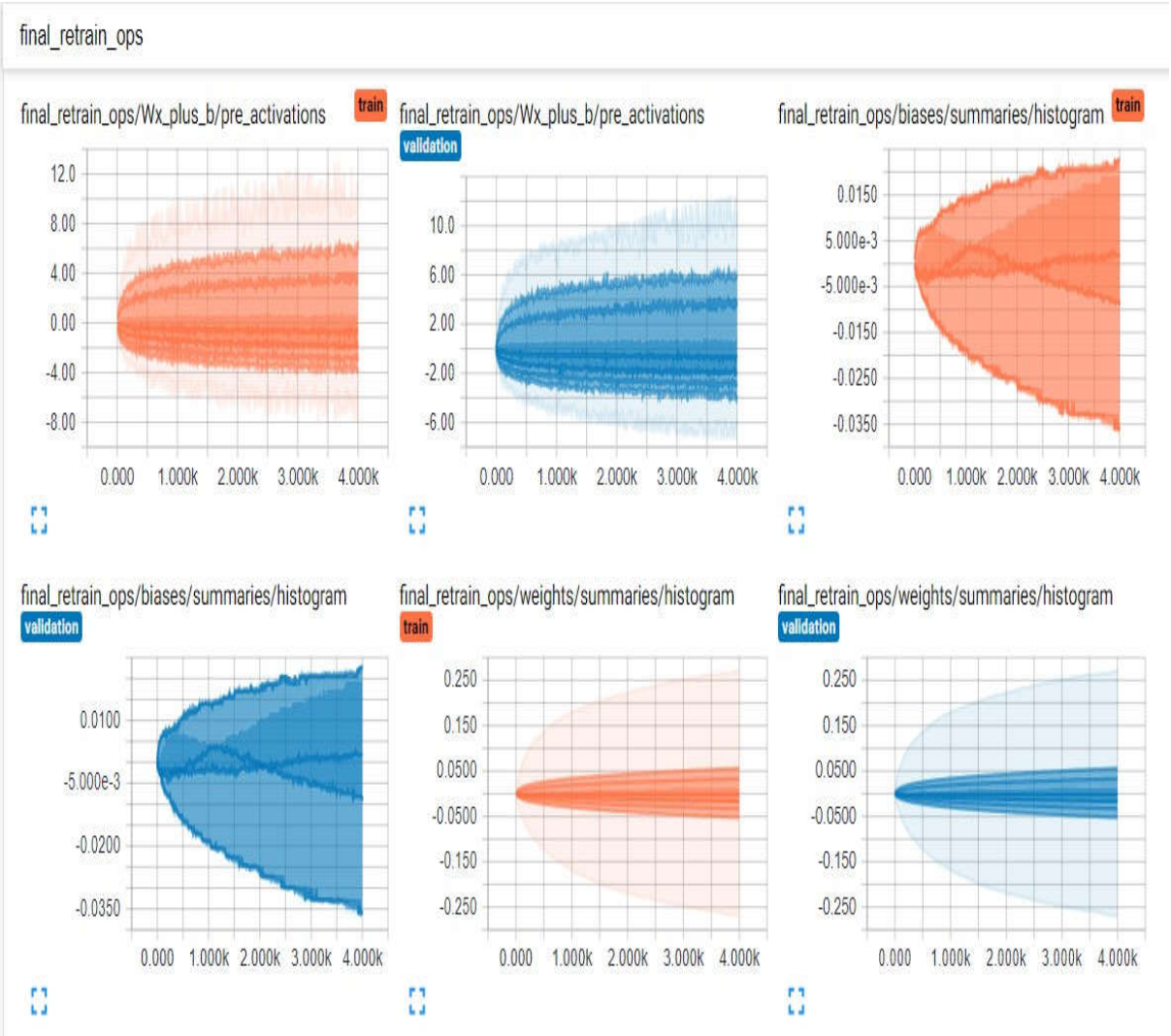
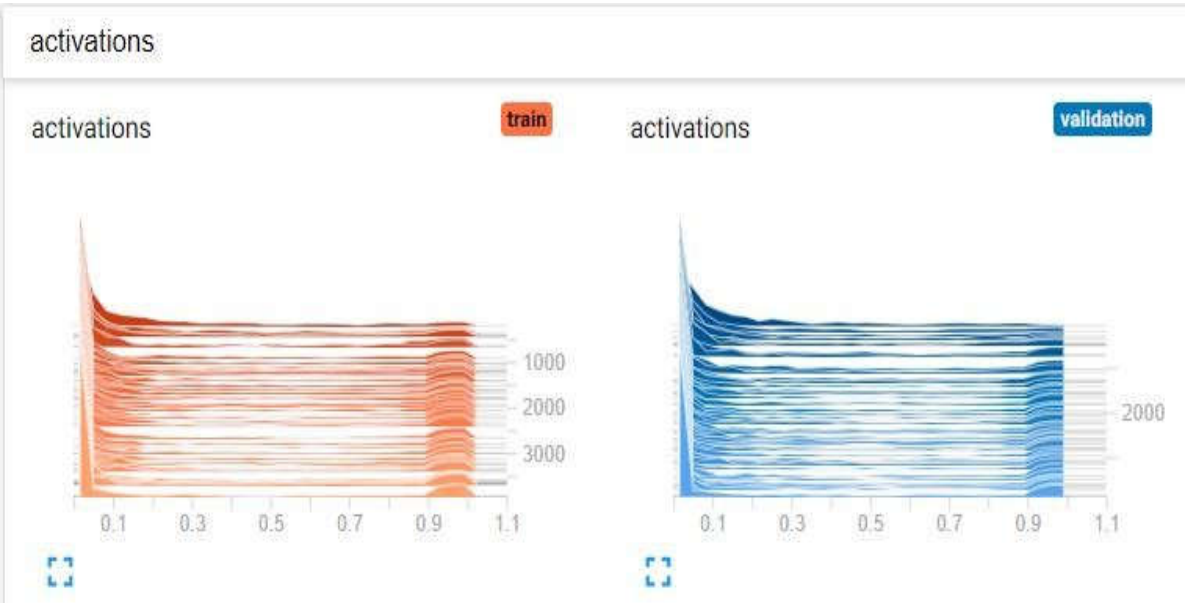


Fig 5.4: Distributions TensorFlow



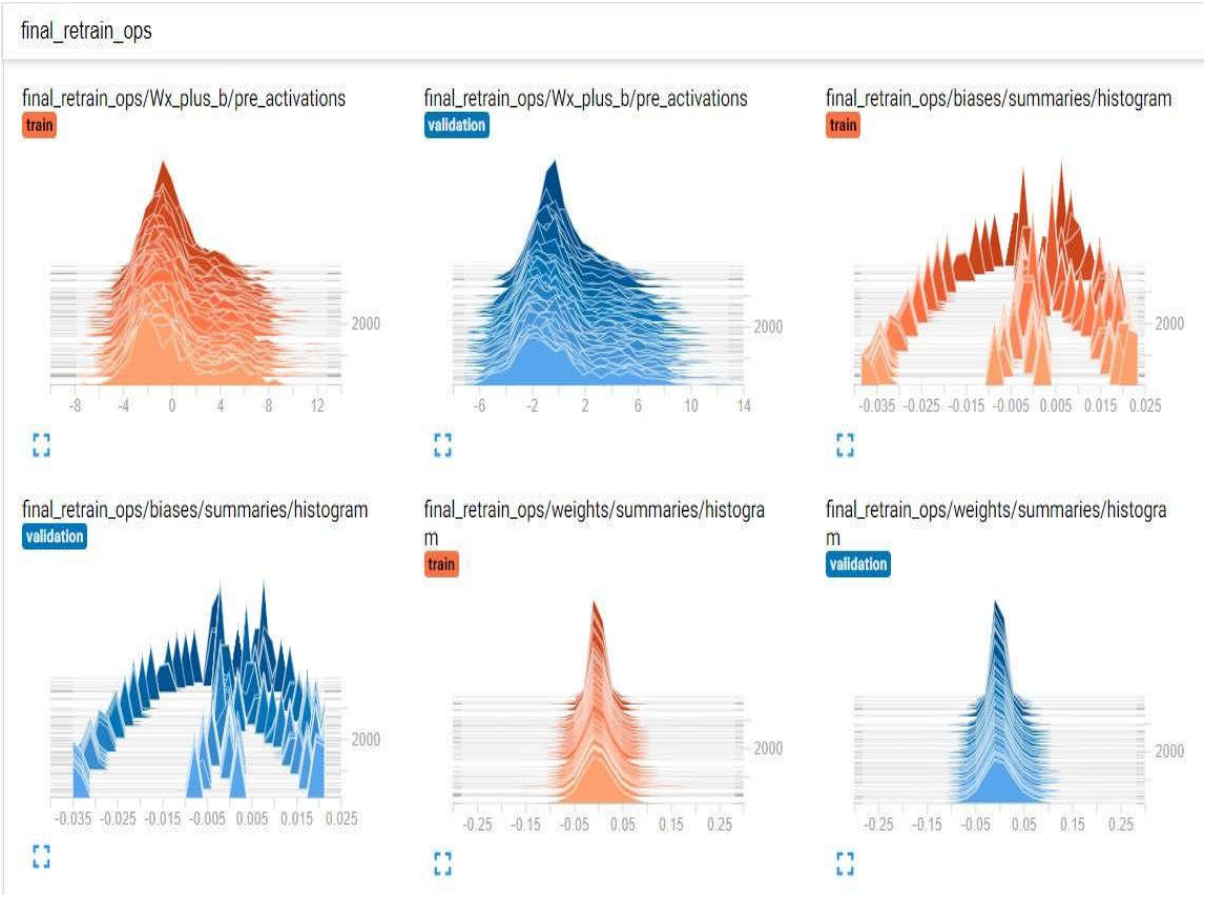


Figure 5.5 Histograms Tensorboard

(a) **(b)**

Figure 6. (a)Demonstration of mobile application that detects plant disease and (b) suggested treatment

5. Conclusions

The proposed method to identify plant leaf diseases can be very supportive for the farmers. The plant leaf disease identification system can recognize the plant disease with highest precision and accuracy and aids the new farmer to recognize its disease without any actual knowledge about flowers. The proposed system uses the transfer learning feature of Inception V3 model by Google's TensorFlow module to extract the features as a graph from the images which is feed as an input to the neural network in the training process. The emerging technology like Image Processing, Machine Learning, and Artificial Intelligence can be used to identify the plant diseases, which can save huge loss of yield, time, money and quality of the product. A mobile application is an apparently convenient approach for an untrained person to learn about plant disease because most of the farmers now have access to smartphone and internet. System can identify the affected part of a plant spot by using image processing technique.

References

F. Siraj, M. A. Salahuddin and S. A. M. Yusof, "Digital Image Classification for Malaysian Blooming Flower," *2010 Second International Conference on Computational Intelligence, Modelling and Simulation*, Bali, Indonesia, 2010, pp. 33-38, doi: 10.1109/CIMSiM.2010.92.

YA Sari, N Suciati, Flower classification using combined a* b* color and fractal-based texture feature, International Journal of Hybrid Information Technology, Vol.7, No.2, pp.357-368, 2014.

Jagadeesh D.Pujari, Rajesh Yakkundimath and Abdulmunaf. Syedhusain Byadgi, SVM and ANN Based Classification of Plant Diseases Using Feature Reduction Technique, International Journal of Interactive Multimedia and Artificial Intelligence, Vol. 3, No. 7, 2016, DOI: 10.9781/ijimai.2016.371.

Sandeep Kumar , Rajeev Ratan , and J. V. Desai, Cotton Disease Detection Using TensorFlow Machine Learning Technique, Advances in Multimedia, 2022, https://doi.org/10.1155/ 2022/1812025

Advances in image processing for detection of - Semantic Scholar. https://pdfs.semanticscholar.org/0a10/96ca51b4b8067865211b42c0bec4c9969f34.pdf. | Accessed 12 Dec. 2018.

AI takes root, helping farmers identify diseased plants - Google Blog https://www.blog.google/technology/ai/ai-takes-root-helping-farmers-identity-diseased-plants/ | Accessed 15 Dec. 2018.

PlantVillage - Penn State. https://plantvillage.psu.edu/ | Accessed 15 Dec. 2018.