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VISTA

Deep Learning Based Diagnosis of Plant Disease using Convolution Neural Network

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A B S T R A C T

Agriculture plays an important role in development of Indian economy. Plant diseases are extremely crucial as they dramatically reduce agricultural productivity. Traditional method of identifying disease is done by physical analysis of plant and expert's opinion, which is difficult, time intensive, inconvenient and expensive in actual implementation. This system addresses the enhancement in traditional method. Mobile Technology has spread rapidly around the globe and it is more convenient and easily reaches out to the farmers. Hence Smart-Phone based identification of disease has become necessity.

The deep learning based process is being applied for analysis & detection of plant diseases. This image based system will detect disease from leaf images. Disease identification is implemented using Convolution Neural Network (CNN), which perform functions in multiple convolution and pooling layers. Large and heavy deep learning models will be converted into a smaller and mobile hardware supportive format by using TensorFlow Lite. It is proposed to develop mobile application which doesn't need internet connection and can apply deep learning on leaf image to detect the infected disease and would help to reduce the effect of disease on food supply by providing remedial solution.This will be very helpful for the farmer in monitoring plants, catch symptoms, recognize current infections, and will also guide how to remove the effect of disease.

Keywords : *Plant Disease, Deep Learning, Convolution Neural Network (CNN), Android Application.*

1. Introduction:

Agricultural field plays significant role in the economy of India. Plants are very important as they act as essential resources for human beings. In most of developing countries including India, farmers use traditional methods for farming. Plants are infected by various diseases and can be identified by observing symptoms. Plant disease problems continue to impact human's daily lives. These diseases are categorised as bacterial disease, fungal disease, or viral disease. It is a very demanding task to identify disease in the beginning stage of infection. It is observed that late

identifications of diseases in plants reduces the productivity of the farm and also degrade the quality of product that causes economic losses to the farmer which continues to adversely affect GDP of country at a very large scale. The traditional method of disease identification is based on physical analysis and expert opinion. This approach requires human resources having expertise and knowledge about this field.

Generally, Farmers are not having deep knowledge about these plant diseases and need to search for farm specialist. In rural areas, it is very hard to search for farm expert and to get expert opinion as per our need. It is also observed that due to a lack of knowledge about plant diseases, many farmers prefer pesticides to remove the effect of the disease. This improper use of pesticides adversely affects plant health, food productivity as well as human health. The increasingly rapid evolution of technology and automation, it would be very helpful for farmers to get an automated system that can identify disease infection plants automatically without having domain knowledge.

The aim of this study is to develop deep learning based semi-automated system to diagnoseplant diseases by analyzing leaf images. Deep learning is a subpart of machine learning which in turn subset of AI. The deep learning provides extended features compared to ML. An automatic feature extraction is available in DL for computer vision tasks, unlike traditional machine learning approaches. The main advantage of deep learning is that it does not require the domain knowledge. just like other previous researches, the proposed system will also detect the plant disease by analyzing plant leaf images. Diagnosing plant diseaseis image based semi-automated diagnostic system which will correctly predict the infected plant disease by utilizing deep learning techniques. It correctly identify whether the plant is infected by disease or not and if a plant is infected, it will also specify the type of infected disease [1-2].

Generally, Leaves, fruit, and steam are catch sights of disease symptoms of plant diseases. Leaf is considered for plant disease identification. A deep learning network for images can be developed by utilizing Convolution neural networks (CNN) [5,18]. Image features i.e. RGB values, vertical edges, horizontal edges, etc. are extracted with the help of Convolutional Neural Network. CNN is the best deep learning neural network for visual feature extraction [5,7,11,14]. First, CNN based networks can be trained by providing trained-dataset, which contains large amounts of healthy and diseased plants leaf images, and this trained CNN model can be tested to check the validity of model i.e. to anticipate the plant disease by leaf image. This image based Deep learning methods delivered excellent results for disease identification and classification, compared to traditional methods. After the identification of a disease or infected plant, it is necessary to take proper action to control it. So, it's also important to provide remedial suggestions for curing disease. Deep learning techniques which will be used to identify plant diseases without expertise knowledge from leaf image are more accurate and less time consuming compared to the traditional image processing techniques.

For this purpose, the proposed android application will provide a handy camera integration to allow the farmer to easily click an image of the plant leaf which he wishes to diagnose and can get an accurate result. This captured image will be processed by deep learning model which will be already integrated in mobile application. It will be able to detect any disease on the plant leaves. Further, it will give information about the type of plant and recommendations about remedies which guides the user for action too. This will be very helpful for the farmer in monitoring plants, catch symptoms in an early stage, identify type of infections, and will also guide how to remove the effect of disease.

1.1 Diseased Plant Leaf Images :

When plants get affected by diseases, symptoms of disease infection get appear on leaf of plant. Type of disease can be identifying by observing plant leaf. Figure 1 shows the sample leaf images of the disease infected plants of various species.

Fig. 1 Infected Plant Leaves

2. Problem Definition :

Plant diseases have turned into a predicament as it can cause a substantial reduction in both the quality and quantity of agricultural productivity. Automatic diagnosis of plant diseases is needed to improve the agricultural productivity by detecting the symptoms of diseases as soon as they appear on the leaf [14]. The proposed system is a smart phone based automatic analysis and diagnosis of plant leaf diseases. This dissertation proposes a process of applying deep learning technique for analyzing, classifying & identifying plant diseases. This image based model will be able to identify several diseases from the image of their leaf. Disease identification will be implemented using Convolution Neural Network (CNN)[1,2,18]. CNN performs two main functions of convolution and pooling. Two datasets will be used to perform plant disease identification. The dataset will comprise of raw images. The one dataset images will be used to train the CNN model and another dataset will be used for the final finding of this proposed work. The TensorFlow Lite will be used to convert large deep learning models to small and mobile hardware supportive format. It is proposed to develop a mobile application that will apply deep learning on the image of leaf for identification of disease and it would also help to develop solutions for the detected disease to reduce the effect of disease on food supply.

3. Literature Review :

There has been a significant research using image

processing for classifying the plants and identifying disease of a plant. Various Machine Learning and Deep Learning strategies are used by researchers to perform this task.

Deep Learning based plant disease classification models makes use of various CNN models. Different applications are implemented using various available CNN models, such as AlexNet [1], Google Net [2], modified GoogleNet [2], LeNet [3], Caffe [4,5] and Deconvolutional Network [4], and VGG Net [6]. Most of the applications have been implemented using the ResNet models including Paying more Attention [8], Large-Scale Plant Classification [9], and Imagenet classification by ResNet-50 [10].

Leaf based CNN's system was presented, which automatically identify the plants disease [11]. Powerful neural network was developed by to classify three distinct legume specie by considering structural patterns on leave's veins [12]. The comparison between two CNN architecture with 26 plant disease detection is performed with open database, which is composed of 14 different plants leaf images. Their favorable results having accuracy rate of up to 99.35% [13]. A methodology for the detection of diseaseinfection based on plant leaves images using a dataset available on the Internet. This dataset consist of 5 different plants and 13 diseases. Depending on the testing data, disease prediction accuracy rate of the models were ranges between 91% and 98% [14].

The system has been proposed that can automatically identify and perform diagnosis of detected plant diseases. It is very helpful for agronomist who needs to apply diagnoses by visual observation of infected plant leaves [12,13,15]. Apple Leaf Diseases Classifier was proposed with Alex Precursor and Cascade Inception architecture combination for classification of leaf diseases. That research paper also gives a good comparison between their model and the other models like SVM, Back Propagation (BP) Neural Network, AlexNet, GoogleNet, Resnet-20, and VGGNet-16. Comparison between these models are based on performance, accuracy, convergence rate, and the computational resources required. Apple disease dataset containing 1053 images were used to test all these criteria. This Apple Leaf Disease Classifier gave an accuracy of 97.62% [1]. The use of a combination of CNN models i.e. the combination of original GoogleNet and a modified version of GoogleNet is used for classification of images into 8 different classes. These images were belongs to Flavia dataset. These two networks compared on basis of accuracy and performance and, It also observed that the modified version of GoogleNet performed marginally better compared to standard GoogleNet[2].

The achievement of pattern recognition techniques using CNN models based on 3 distinct types of dataset in plant identification was examined. These 3 datasets were having all images of either plants, leaves or fruits. It concludes that the performance of CNN is considerably better than conventional methods. Finally, CNN models are developed for identification of tomato plant diseases with satisfying accurate rate [16].

The plant disease detection system was developed using CNN on plant village dataset by splitting dataset as 80% for training purpose and 20% for testing and gives 95% accuracy [17].

4. Methodology :

The powerful Deep learning technique reduces the problem of feature engineering of conventional machine learning approach. The deep learning is based on the artificial neural networks (ANN). To implement a neural networks one of the most standard libraries is TensorFlow. It is used to classify text and images too. TensorFlow contains all libraries require to develop artificial neural networks.

Proposed system consist of following steps:

Step 1 :Building and creating a deep learning model (Convolutional Neural Network) using TensorFlow with Keras.

Step 2 : Deploying the model to an Android application using TFLite.

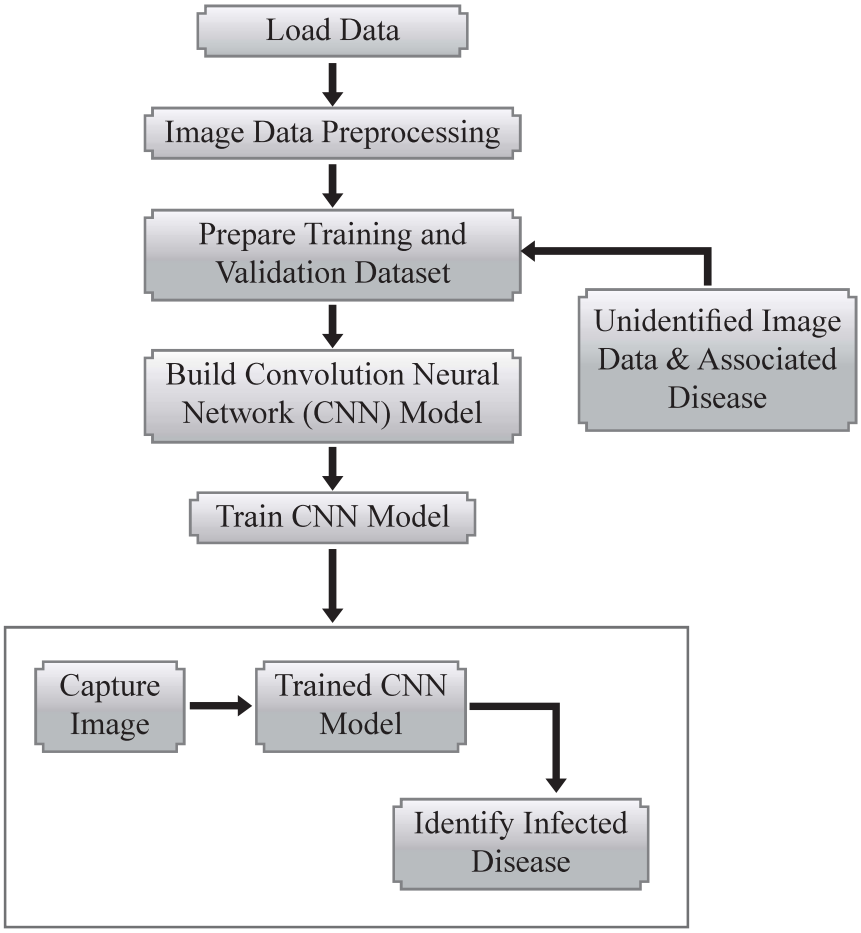

Fig. 2 Flowchart of Proposed Methodology

The proposed system will use convolution networks for image classification of the disease classes. Figure-2, shows the flowchart of proposed system to depict the step by step procedure to implement the proposed system. TensorFlow Lite format will be used to optimized and convert the model to be used in a memory and time-efficient manner on android application. Large and heavy deep learning models will be converted into a smaller and mobile hardware supportive format by using TensorFlow Lite. To avoid the need of internet connectivity, all databases will be store locally in application. User only need to select image from gallery or to capture image of plant leaf and app will help with rest of the process.

4.1 Convolution Neural Network (CNN) :

Convolution Neural Networks (CNNs) will perform the recognition of plant diseases. ANN can be evaluated to CNN to give better results through images. All images (related to anything) contains similar recurrent patterns of a specific thing. The functions of CNN are performed by 2 important steps i.e. Convolution and Pooling. Outline of pattern in an image will be identify by Convolution function and dimensions of an images will be diminishes by Pooling function. Jupyter notebook and Keras API of Tensor Flow will be used for training the model. Keras is a deep learning API for building and training models, which runs on top of TensorFlow.

The application will be build using TensorFlow Lite technology to improve the memory and time efficiency of the application. Used AI technology will process the image within seconds and can diagnose the disease without affecting other running processes onthe device. The builded application has been deployed on mobile device and will be ready for identification of disease by capturing image of leaf by camera or selecting image from gallery as shown in Fig. 3.

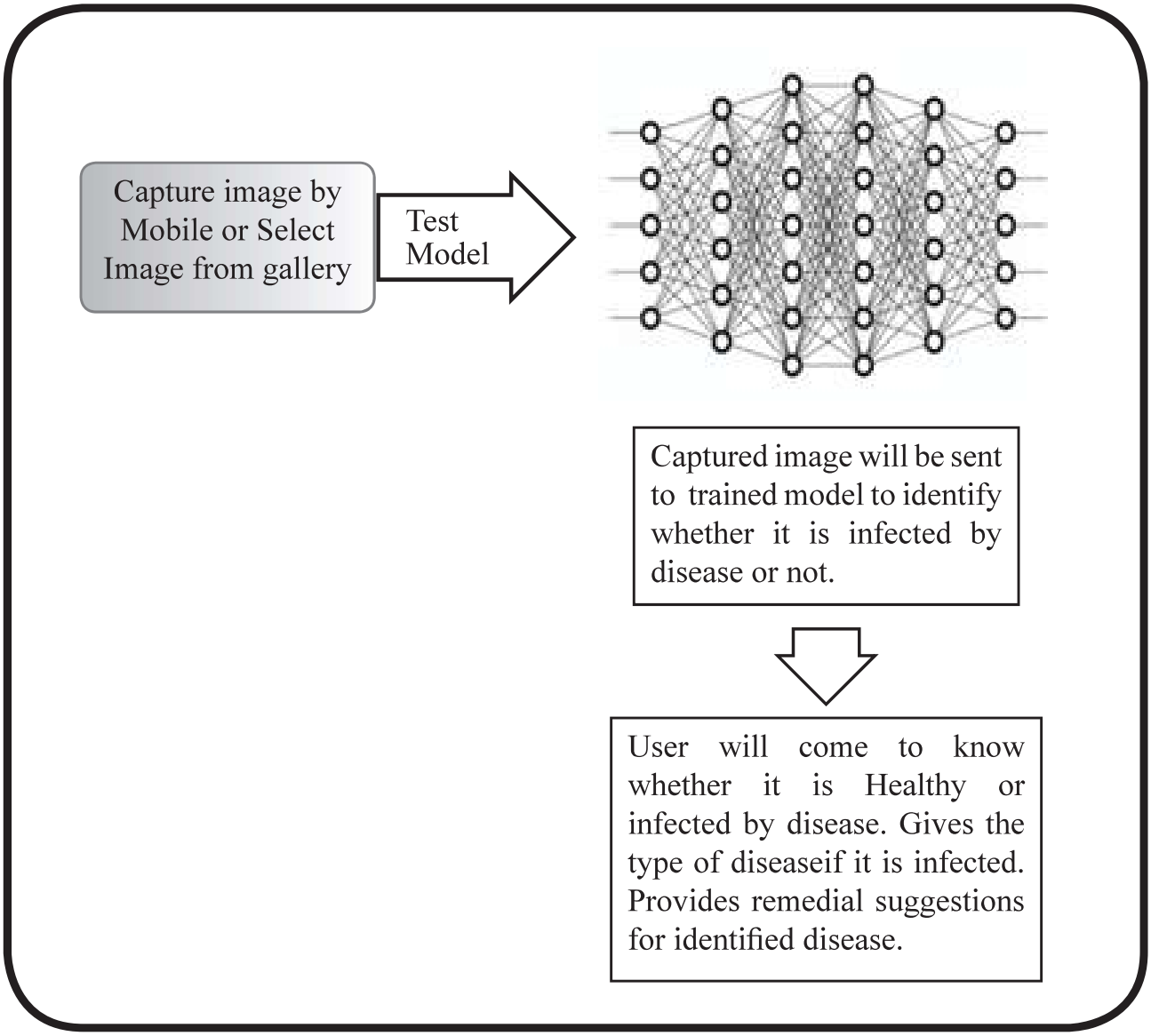

Fig. 3 Working of CNN Model

4.2 Advantages of CNN:

1. The main advantage of CNN is that it automatically detects the important features of image compared to other models.
2. CNN is also computationally well planned. It perform function in two important steps i.e. convolution operation and pooling operations. It is universally popular as run on any type of device.
3. It is very robust and systematic model which performs automatic feature extraction to achieve greater accuracy.

5. Result :

The expected result of proposed system will be as shown in figure 4. The first screen of mobile application view will be used to capture image by using integrated camera or select it fromgallery. In second screen deep learning model will be applied to identify whether the leaf is infected or healthy and if it is infected, it will show the type of disease along with its confidence score. Remedies of identified disease will be shown as per the third screen along with symptoms and causes of disease.

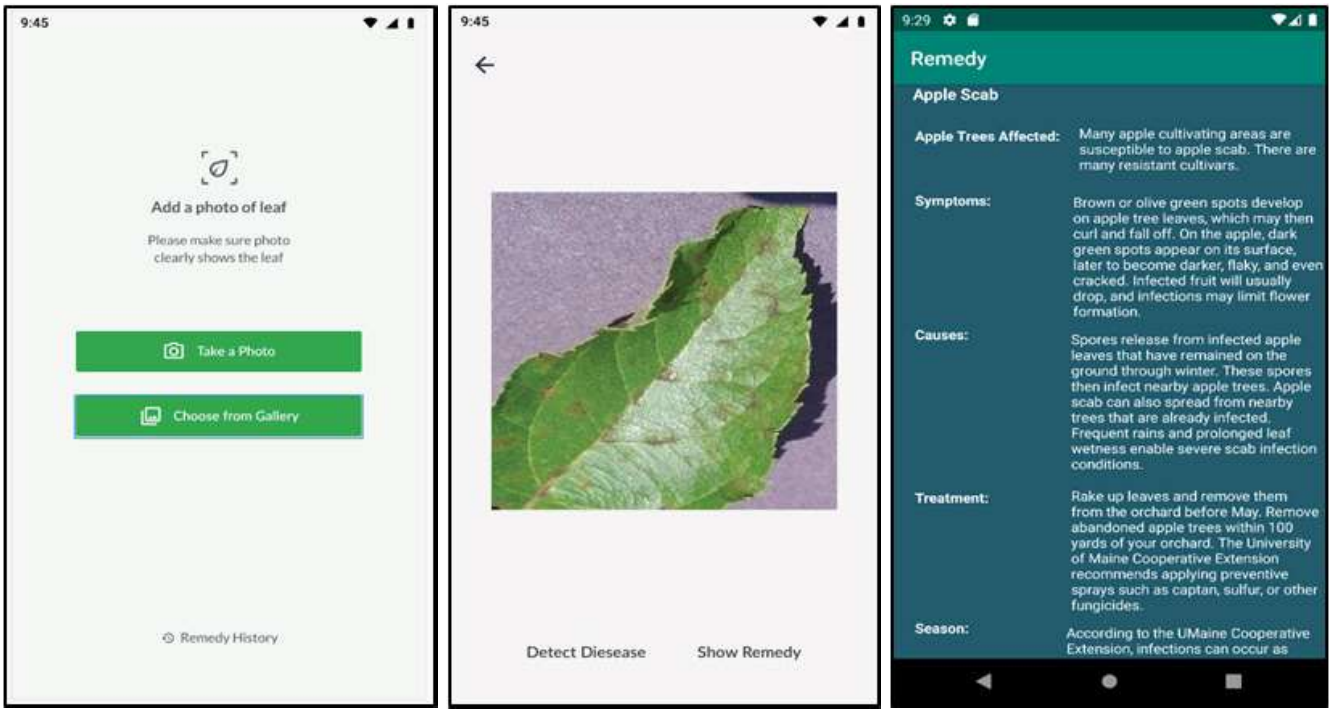

Fig. 4 Mobile Application View

6. Summary :

In rural areas for accurate advice or expert opinion on plant diseases, it is very hard to search for farm expert and to get expert opinion as per our need.

Therefore it is useful to provide mobile application by computerized Convolutional Neural Network (CNN) technology. The functions of CNN are performed by 2 important steps i.e. Convolution and Pooling. Outline of pattern in an image will be identify by Convolution function and dimensions of an images will be diminishes by Pooling function. CNN model will get train using a training dataset. Testing will be performed on a trained CNN model using test images or by capturing images using the camera.

This study proposes to achieve following goals:

1. Study to develop an application to acquire the images which are practical enough for a normal user's usage.
2. Analyzing the parameter like time and memory-efficient deep learning model.
3. Designing computer methodology for identifying symptoms that would give strong confidence and guide to diagnose a hidden disease at an early stage.
4. Guide the user by providing information on how to cure the disease detected.

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