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CROP DISEASE DETECTION – MOBILE APPLICATION

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ABSTRACT
India being one of the major agricultural producing countries relies majorly on food production. The primary source of income in India is also through agriculture. Agriculture is also a primary source of employment, food and income for many citizens of India. There are many factors that are responsible for good agricultural production. Some of the factors include usage of fertilizers, amount of rainfall, proper distribution of rainfall, fertility of soil, quality of soil etc. The major issue which is faced by people is the crop diseases. Crop diseases also act as a major threat for small scale farmers because it may lead to destruction in their whole food supply. Sometimes farmers are not fully aware of the diseases which can lead to false determination of disease and improper solution of the problem. Farmers often tend to use wrong fertilizers or wrong amounts of fertilizers which may lead to crop failure. Farmers usually identify the disease through their naked eyes which eventually leads them to make wrong predictions about the disease. As a solution to this problem, this mobile application focuses on identifying the right disease and also to provide the solutions for the same. This mobile application can run in Android as well as iOS which make it more usable. It uses machine learning and deep learning for disease detection in the crops. Deep neural network and Convolutional neural network, parts of deep learning have been used to detect diseases.

Key words: Convolutional neural network, Crop Diseases, Deep neural network, Disease detection.

INTRODUCTION
Agriculture plays a vital role in developing countries like India, where the population directly or indirectly relies on agriculture because it provides the basic building block of human beings that is food. For better productivity, quality control is a must. Studies show that the quality of crops or food also decreases because of crop diseases. Crop diseases also interrupt some of the vital functions of the crop such as photosynthesis, pollination, germination, fertilization etc [8]. Crop diseases are caused by living agents or pathogens. The diseases vary season to season and also depend upon environmental conditions and the presence of pathogens [1]. The disease can be broadly classified as abiotic and biotic diseases [2]. Abiotic diseases are the diseases that are not caused by living agents and also can not spread from one plant to another. These are caused by external conditions and examples of abiotic diseases are soil compactions, nutritional deficiencies etc. Whereas biotic diseases are caused by pathogens and can also spread from one plant to another. It can also infect the plant tissues such as stem, roots, seeds etc. In this mobile application we are using deep learning by which we can determine the disease accurately. The model which we are using is the Convolutional neural network (CNN). It involves three simple steps which are; first you have to click a picture using the application. The second step involves a diagnosis report which will give the user a report stating the disease name and other important factors of the disease and also how to cure it. The third step is to get medicine accordingly for the crop.

1.1. Crop Disease Analysis
Crop diseases occur because of the presence of pathogens and there are some visible signs and symptoms

that the crop has got a disease. The symptoms include discoloration in the leaves, change in shape of leaves or crop and the change in the functions of the crop as it responds to the pathogens [3]. The pathogens can be of following types- fungal, viral, and bacterial and nematodes which can attack and damage the crops below as well as above the ground.

1.1.1. Fungal diseases

Fungi constitute a large number of plant pathogens and can lead to very serious plant diseases. It generally destroys the plant by killing its cells. The sources of fungal infections are soil, infected seeds, nearby crops and weeds [4]. The fungi can infect plants by direct or indirect contact as it can spread through wind, by contaminated water, animals, workers, seedlings etc. Some of the fungal disease signs are stem rust, leaf rust and Sclerotinia[3]. Some of the common fungal diseases include Downy mildews, Powdery mildews, and White blister.

1.1.2. Bacterial diseases

Pathogenic bacteria can cause some serious crop diseases. They do not enter the plant tissue directly but enter through some natural opening or wounds [5]. Crop wounds can be the result of either some insects or some other pathogens and can also occur because of tools during pruning and picking operations. Bacteria can multiply quickly when they find the right conditions to multiply. Some of the factors that can be responsible for the multiplication of bacterial pathogens include overwatering, under-watering, irregular watering, poor air circulation, poor soil health and also deficiency or excess of nutrients. The bacterial disease signs are difficult to observe from naked eyes. Some of the bacterial diseases include Black rot, Bacterial canker, Bacterial wilt and Bacterial spot.

1.1.3. Viral diseases

Viruses are immobile which means they cannot spread on their own and they need a living organism called vector or carrier to be spread from one plant to another plant [6]. These carriers include whiteflies, leafhoppers, aphids etc. Viruses can also be transmitted by insects, infected pollen, contact between plants, mites, nematodes etc. Some of the viral disease symptoms include mosaic leaf pattern, crinkled leaves and yellowed leaves. Some of the examples of viruses that cause the disease are Turnip mosaic virus, Cucumber mosaic and potato mosaic virus and carrot virus Y.

DESCRIPTION OF THE PROBLEM

India's economy relies largely on agricultural production and not only the economy, about 70% of the population relies upon agriculture and 82% of which are small scale and marginal farmers [9]. Apart from this, the population of India indirectly also relies upon agriculture as it gives the basic building block-food, to the people of the country.

For this, the production of crops and the quality of crops should be good enough so that the needs of the people can be fulfilled. The major problem that farmers face is crop diseases. The farmers usually detect the diseases by their naked eyes which lead to making wrong predictions about the disease which in turn leads to using wrong fertilizers which can cause a lot of damage to the crops.

BRIEF DESCRIPTION OF INNOVATIVE SOLUTION

We focus on identifying the disease with utmost accuracy. This application is made so that it can be available to all the farmers in all the corners of the country. The steps are so simple yet so efficient for the detection of diseases. Firstly the user has to click a picture of the affected portion of the crop using the application only. Based on the picture clicked a detailed report will be generated by the application. The user can read the report and can identify the disease. The report also contains the preventive measures and the right amount of fertilizers that can be used to cure the disease.

LITERATURE REVIEW

Plant Disease Detection using Image Processing by Mr. V Suresh et al[9], categorized the whole process of disease detection into four stages. The first stage includes acquisition of images either through mobile

phones or through web, then comes the second stage which contains segmentation of image into various clusters by applying one or more techniques. In the next stage various features extraction methods can be used and in the last and final stage the classification of disease is done. They used several classifiers and one of them is the SVM classifier for classification of disease because it is simple, easy to use and robust technique.

An Overview of the Research on Plant Leaves Disease detection using Image Processing Techniques by Ms. Kiran et al[8], used five steps for identifying the disease in plants. The processing scheme consisted of image acquisition through digital camera or web, then image pre-processing included image segmentation and image enhancement where the affected areas are segmented, feature extraction and classification. In the final step the disease on plant leaves is identified. In image preprocessing the RGB images are converted into color space representation. For classification of disease several neural network classifiers are used such as K-nearest neighbor, Radial basis function, Artificial neural networks and Support Vector Machine (SVM).

Apart from the research papers we also referred some blogs and articles regarding the development of this application software. One of the articles which we found very fruitful was by Srinivas Chilukuri from ZS New York A.I. Center of Excellence [10] where he mentioned the essential process of deep learning methods applied in this application like vertical and horizontal flip, Lighting Standardization and Zoom and Crop. We were also guided by this article for Convolutional Neural Network (CNN). This article was basically focused on wheat crops.

TECHNOLOGIES USED IN THE DEVELOPMENT OF APPLICATION

5.1. Data Set Used

Huge data set has to be used in order to train the machine for processing the image and detecting the disease in the crop produced. We need high accuracy as we have to find the disease and cure for the disease in the plant. In order to achieve the particular goal we are taking the data set for the cotton, tomato and other various disease prone crops from the “kaggle” which is a very well known site for the machine learning training data set provider. These images from the data set contain some basic diseases to which crops are generally prone to.

Image Processing- When using Image Data Generator the images in validation and in training dataset are resized or re-scaled, as they are rotated by 40%, whereas the width and height of the image is changed by 20%, also the shear and zoom ranges are put up to 20% and at very last the image is flipped horizontally. The image size is then reduced to 150px * 150px and the batch size is 32.

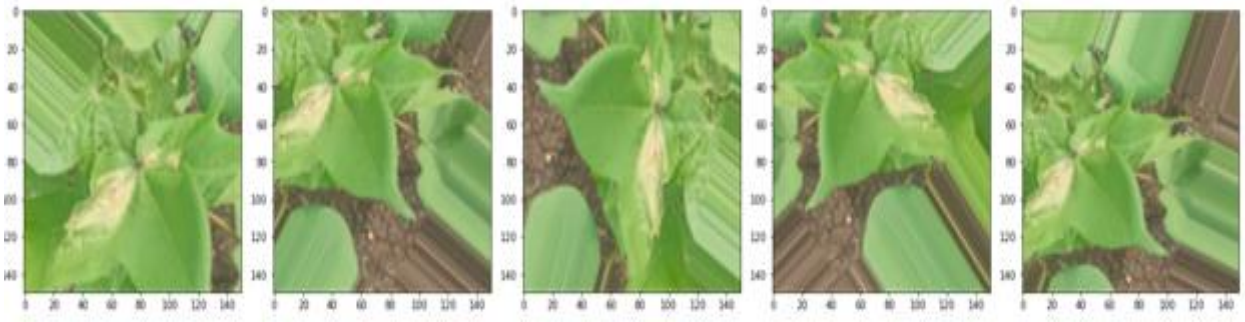

Fig-5.1 Image Processing

5.2. Machine Learning - (Neural Network)

In this kind of application in which we process images for the classification of diseases we use the deep learning model which is named as “Convolutional Neural Network”(CNN). With the different CNN- based deep neural networks developed we achieve a significant result on the ImageNet Challenger, which is the most significant image classification and segmentation challenge in the image processing field. This system is widely used in medical classification task but here we are going to use it for the crop disease classification task. It is an excellent feature extractor, and hence we can utilize it to classify crop images and can avoid complicated and expensive feature of engineering.

For building our own model, 4 convolution layers of filter size 64,128 and 256 are taken and 4 max pooling layers with size 2 are taken. In this at first convolution layer is placed which is then followed by max pooling layer and are placed in this sequence one after another.
To train the model mentioned a total of 500 epochs were taken which resulted in an accuracy of 92.074% with a loss of 0.666%. The accuracy and loss graphs are shown below:

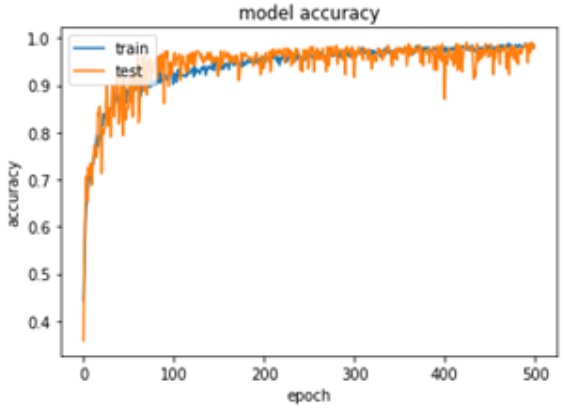

Fig- 5.2.1 Accuracy Model Graph

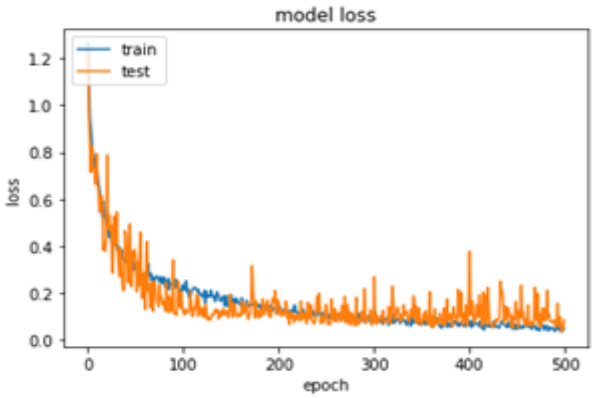

Fig- 5.2.2 Loss Model Graph

5.3. Use of Flutter in Implementing the process

Flutter framework is used for the development of the mobile application which can be used for the detection of the disease in the crop. We are using the flutter framework and dart language for its implementation so that it can be used both in Android OS and apple oriented smart phones i.e. in iOS. So the main motive of putting the above discussed software is that most of the farmers will not have the computers or laptops for implementing the software but will surely have smart phones or can afford smart phones to implement this in their day today life.
For the model to communicate with applications it has to be converted to “TensorFlow lite version” or “tflite version”. In this flutter application the user can select from available crops for which he wants to know about the disease and other things like pesticide and fertilizer quantity, and weedicides or other information which he will be provided with which will lead to sustainable and good crop production . The user will click the image of the crop plant or crop leaf from his/her camera available in the device or will insert the image of crop from his/her gallery for which the disease, if present, is to be detected. He/she can also select the crop available in the application to get information about the cultivation of the particular crop. The image inserted from the user is loaded into the model, the model checks for the disease and if present, the user is provided the solution for the same by the application.

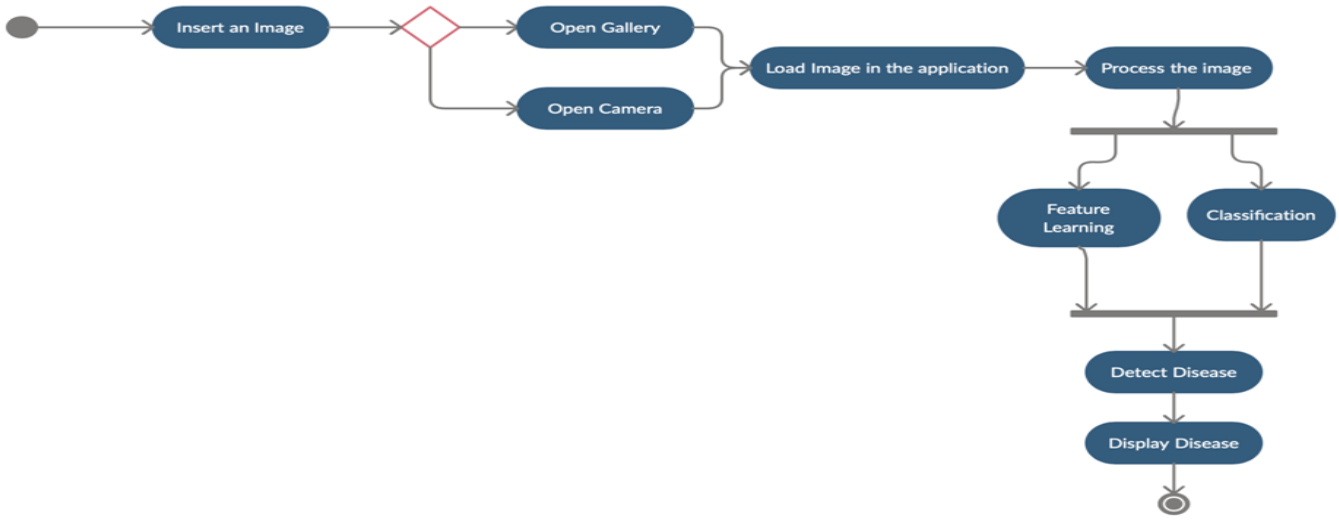

Fig- 5.3 Flow of Application

5.4. Software Development Model

The software development model we will be using in our project is Prototyping Model. The prototyping model is a system's development method in which a prototype or we can say a demo model is developed, then its testing is performed and after that we work back on some necessary changes and the cycle goes on unless we reach to the satisfactory conclusion of the application or software. Once the software works as it is expected to work it can be sent for the complete development or can be developed as the final product.
The prototyping model in software development is further classified into four major forms -

- Rapid Throwaway Prototyping
- Evolutionary Prototyping
- Incremental Prototyping
- Extreme Prototyping

In the above application development we used Incremental Prototyping method which says that the final product is divided into different small prototypes and are being developed individually. As soon as all the pieces are developed completely and are tested successfully then they are finally combined and are merged into one single platform in their predefined order.
Just like in this application development the software application is divided into three

- Machine learning module,
- Deep learning that is convolutional neural network (cnn) module for image classification
- Flutter application designing module.

After the complete development of all these three modules we combine them in a predefined order and it works in a flow as one android application for crop disease detection.

DATA FLOW

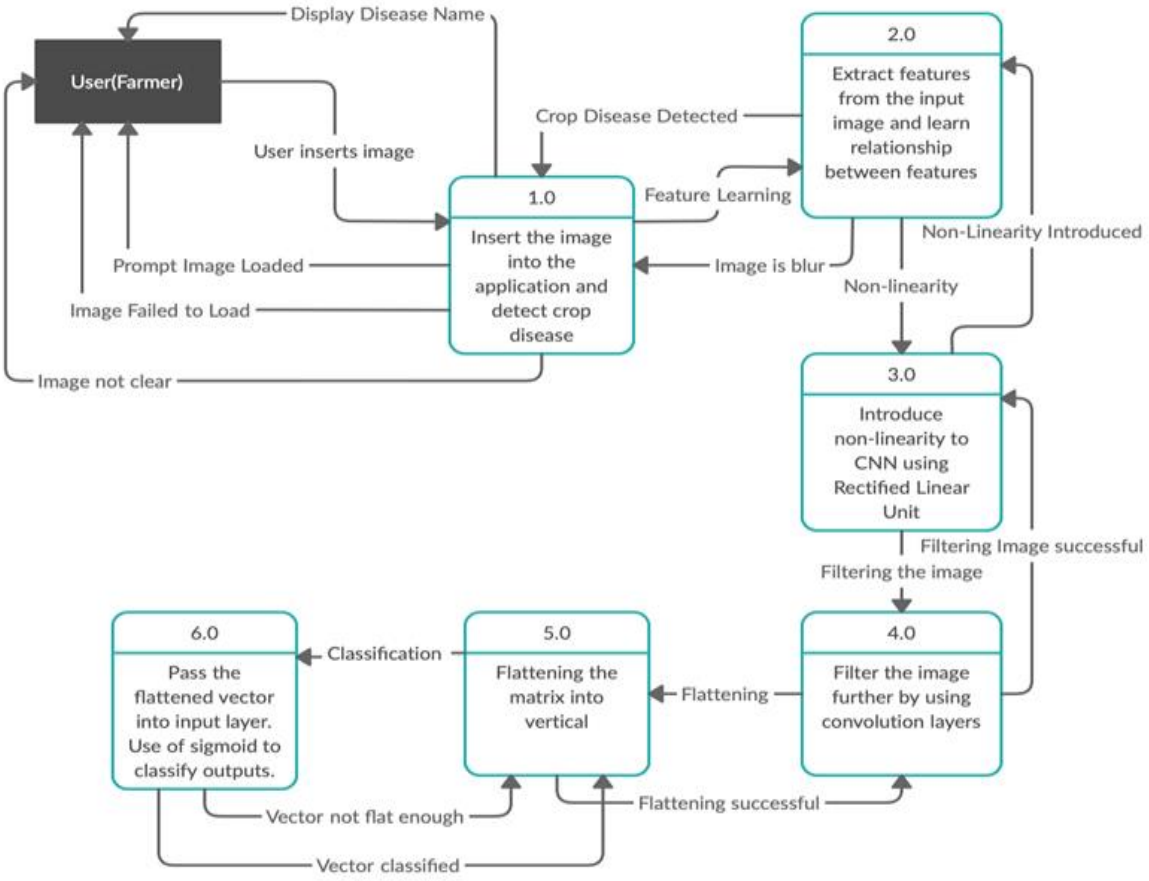

Fig-6.1 Data Flow

The above diagram basically defines the work flow or we can say the data flow of the application that is shown in the following steps:

- At first the target user that is our farmer will register him/her in the application and then will give the image of the selected plant in the application.
- As the user inserts the image into the application it starts processing the image by extracting the features from the input image and learns the relationship between the features.
- If the image sent by the user is blur it toasts that the input image is blurred and asks to try again with a new one. If the image is clear it moves ahead to detect the disease and is sent through CNN and is introduced to non linearity using rectified linear units.
- After the above process image is filtered and is sent for the flattening of the image, after flattening the matrix into vertical then it is sent for classification.
- Here it passes the flattened vector into the input layer and uses sigmoid to classify outputs. This process continues for some moment unless proper results are derived.
- Then the image results are sent back to the start where the user or farmer inputs the image with the name of the classified disease and other details found in the selected plant.
- At final results the name of the disease is displayed.

APPLICATIONS

- This project aims to be a useful tool for the farmers to detect the disease with utmost accuracy so that the right fertilizer with the right amount can be used to cure the crop disease.
- It is not a platform dependent application that means it can be used in any smart phone be it android or iOS and we are also providing it as a web application so that the disease detection system can be used effectively

FUTURE SCOPE

Crop monitoring is an effective idea as it will let the farmer organize the things better and certain activities such as watering the crops and giving the fertilizers at the right time and in the right amount can be effectively done using crop monitoring. It may be also responsible for predicting the rough weather that could also hinder the plant growth.

CONCLUSION

Using this article one can easily understand the use of Machine Learning & Deep Learning in developing the application for crop disease detection. We have written this article to provide the basic knowledge about the use above mentioned techniques in field of agriculture and used flutter framework to provide handy application to the farmers so that they can easily have the access to the technology and can use for the betterment of the crop production and can find the cure of the disease in the selected crop. This article reference will lead to the development of application with an accuracy of 92.074% with a loss of 0.666%.

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