Software Requirements Specification

For

Plant Disease Prediction System

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Prepared by

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INTRODUCTION

1.1. Purpose of the project

Agriculture is the chief source of livelihood in India. According to the Food and Agriculture Organization of The United Nations, 70 percent of India's rural households still depend chiefly on agriculture for their living, with 82 percent of farmers being marginal [1]. Plant and crop diseases are a noteworthy yield and quality constraint for Indian farmers. The crop pathogens can be fungal, viral, or bacterial and can damage the parts of the crops above or below the ground. Identifying those diseases is an ongoing challenge for Indian growers of crops like apple, potato, corn, pepper, etc. Not only farmers, but the people living in urban cities who prefer to grow fruits in their kitchen gardens also face the above-mentioned issue of their plants and trees getting diseased. Manually identifying plant diseases is not only hectic but also has high chances of being inaccurate. Misdiagnosing a crop disease can lead to loss of money and severe harm to the consumers of the crop. Computer vision models increase the efficiency but the great variation in symptoms due to the age of infected tissues, genetic variations, and light conditions decreases the accuracy of detection. Thus, the main purpose of this project is to develop a system capable of identifying crops and predicting their health.

1.2. Target Beneficiary

Growing crops plays a critical role in the entire life of a given economy as agriculture is the backbone of the economic system of India. The project's main target beneficiary is the plant/crop growers or farmers who manually identify the health of the crops. The other groups who would be benefited from the project are the people who grow plants, fruits and vegetables in the kitchen gardens of their homes and are not able to differentiate between a healthy and an infected plant.

1.3. Project Scope

The project's scope is to diminish the inaccuracy in diagnosing plant health. Manually classifying plant diseases is not only hectic but also has high chances of being imprecise. Misdiagnosing a crop disease can lead to loss of economy as the number of consumers would decrease. Thus, the project would help in eliminating the inaccuracy factor using Computer vision techniques. It would help anyone who grows plants or crops in maintaining the good health of their plants.

PROJECT DESCRIPTION

2.1 Reference Algorithm-

2.1.1 Convolution Neural Network (CNN)

Convolution Neural Networks or CNNs are most common neural networks that are used for the purpose of image classification. They contain different layers namely convolution layers, polling and padding layer, fully connected layer. Following is the explanation of function of each layer-

1. Convolution layer- The function of this layer is to extract the features from the image. Image of different objects can have different features, for example, image of cats will have four legs and tail, while an image of human will have two legs and two tails. So, the function of this layers is to recognise such features. Feature extraction is done with the help of filters. The original image matrix is multiplied with a particular matrix (called filter) in order to identify if a particular feature is present in the image. We can apply multiple filters in one convolution layer.

2. Padding – in convolution layer, as the filter matrix moves over the whole image, we find that the number of times, the values of the cells lying within the matrix is considered for the operation is more than the no. of times, the values of the cells in the corners or at the borders, are accounted for. This implies that the values at the corners or around the borders are not being given equal weightage. To overcome this, we add another row and column, of only 0, at all the sides of the image matrix.

3. Pooling layer – The main function of this layer is to reduce the size of image matrix and reduce the number of parameters and computation in the network. This is done by taking maximum value among all the values of say a 2 X 2 part of the matrix.

4. Fully connected layer – It is the last layer of CNN architecture and its function is to classify the images. This is essentially a Fully connected Simple Neural Network, consisting of two or three hidden layers and an output layer that performs the work of classification among a large no of categories.

In this project we will be using VGG16 architecture of CNN.

2.1.2 Residual Network (ResNet)-

More and more layers are being added to the deep learning architectures to solve more and more complex tasks which helps in improving the performance of classification and recognition tasks and also making them robust. But when we go on adding more layers to the neural network, it becomes very much difficult to train and the accuracy of the model starts saturating and then degrades also. This is called vanishing gradient problem. ResNet solves the problem of vanishing gradient.

In this network technique of skip connections is used. The skip connection skips training from a few layers and connects directly to the output. The approach behind this network is instead of layers learn the underlying mapping, we allow network fit the residual mapping.

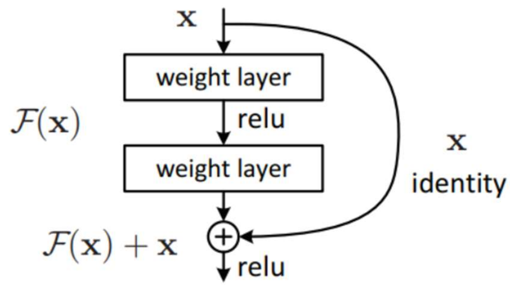

Fig 1: ResNet Architecture
Source: Deep Residual Learning for Image Recognition [3]

The advantage of adding this type of skip connection is that if any layer hurts the performance of architecture, then it will be skipped by regularization. So, this results in training very deep neural network without the problems caused by vanishing/exploding gradient.

2.1.3 UNet

UNet is an image segmentation architecture generally used for medical image segmentation. Convolutional Neural Networks gave decent results in easier image segmentation problems but it hasn't made any good progress on complex ones. In image segmentation, we not only need to convert feature map into a vector but also reconstruct an image from this vector.

Architecture of UNet-

The architecture looks like a ‘U’. This architecture consists of three sections: The contraction, the bottleneck, and the expansion section.

Contraction section

This section is made of many contraction blocks. Each block takes an input applies two 3X3 convolution layers followed by a 2X2 max pooling. The number of kernels or feature maps after each block doubles so that architecture can learn the complex structures effectively. Bottleneck section – This layer uses two 3X3 CNN layers followed by 2X2 up convolution layer.

Expansion section

This layer consists of several expansion blocks. Each block passes the input to two 3X3 CNN layers followed by a 2X2 up sampling layer. Also, after each block number of feature maps used by convolutional layer get half to maintain symmetry. However, every time the input is also get appended by feature maps of the corresponding contraction layer. This action would ensure that the features that are learned while contracting the image will be used to reconstruct it. The number of expansion blocks is as same as the number of contraction block. After that, the resultant mapping passes through another 3X3 CNN layer with the number of feature maps equal to the number of segments desired.

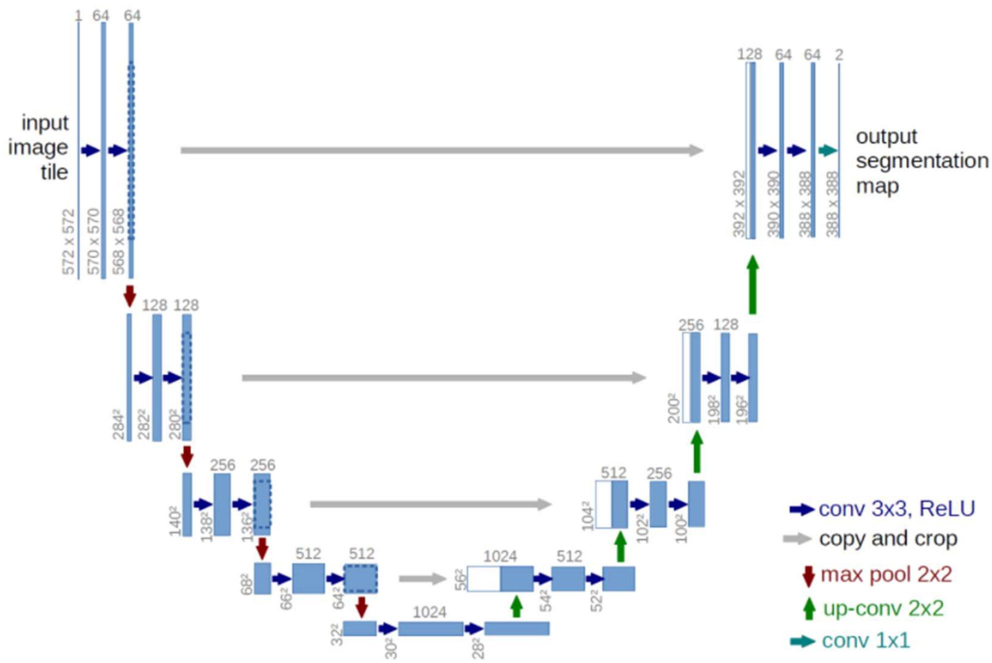

Fig 2: UNet Architecture
Source: UNet – Towards DataScience

2.2 Data

Data of several plants is collected from different online sources and merged into one data. The data consists of 11 different plants namely Apple, Cherry, Chilly, Coffee, Corn, Grapes, Peach, Bell pepper, Potato, Strawberry, and Tomato. Data contains train and test folders and each sub- folder contains separate files for healthy images of a particular plant and images of different diseases.

Fig 3: Some Data Samples

Screen shot of dataset directory-

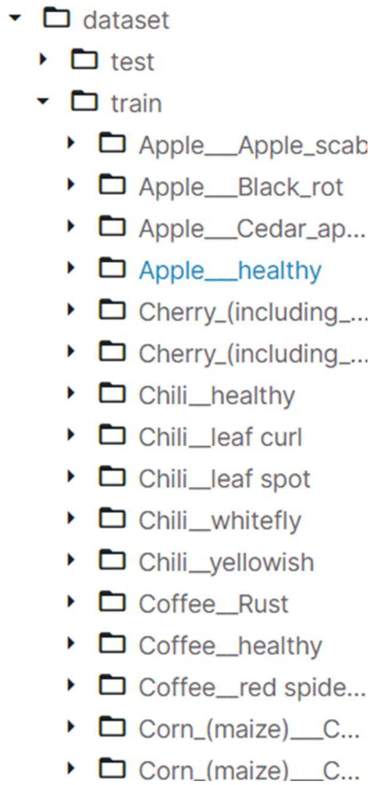

Fig 4: Data Directory

2.3 SWOT Analysis

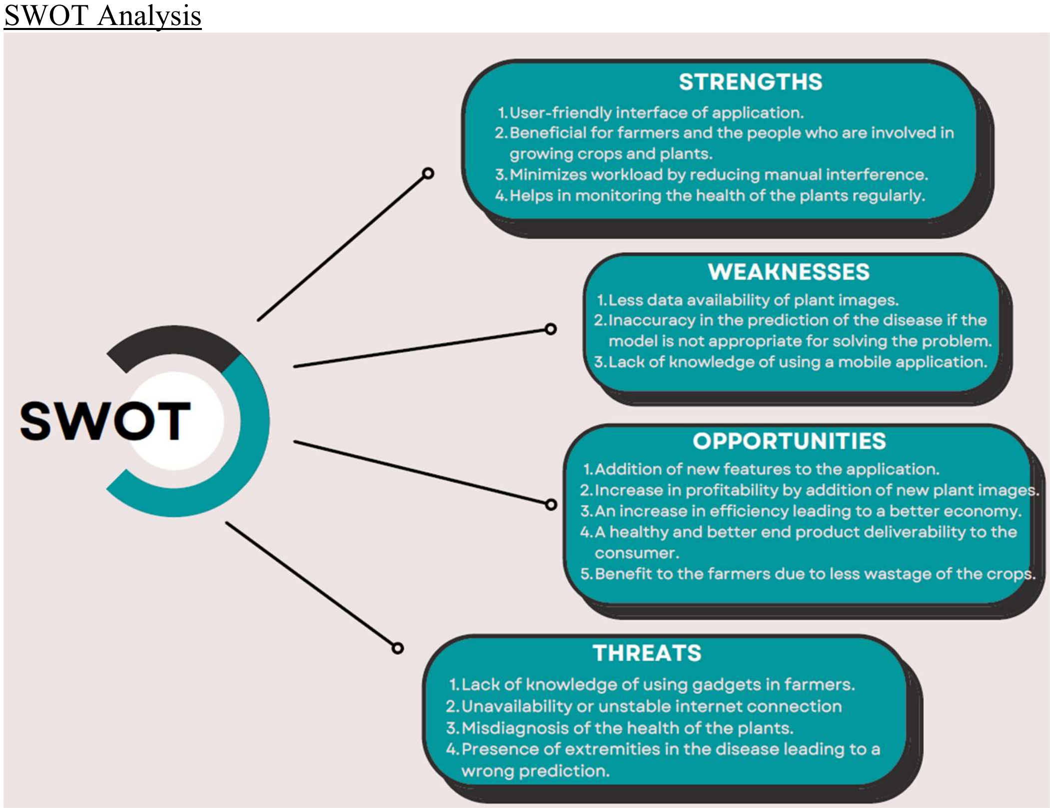

Fig 5: SWOT Analysis

2.4 Project Features-

- The AI model will be deployed on Heroku and connected with the mobile application through an API which will be developed using FastAPI.
- If a picture of the plant is found to have some disease, the application will send a notification to the user after a few days for capturing the photo of the plant again. So, the application will monitor if the intensity of disease is decreasing or not.
- If internet connectivity is available app will predict through the model deployed in Heroku, else app can also work without internet also.

2.5 User Classes-

- The project will be helpful for people who grow plant at their home.
- The project will be helpful for farmers who don't have much knowledge of different diseases of plants.

2.6 Design diagrams-

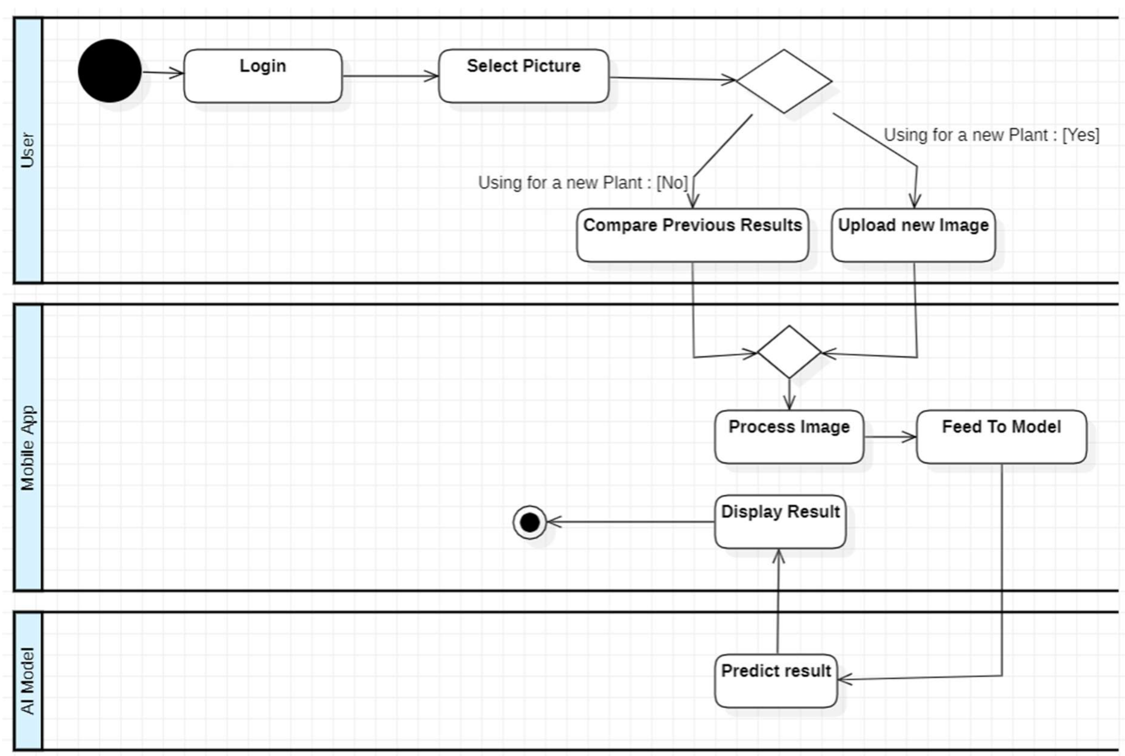

Fig 6: Swimlane Diagram

2.7 Assumption and Dependencies-

- Only half of the permutations are reachable.
- Only half of the edge orientations are reachable.
- Only one third of the corner orientations are reachable.

SYSTEM REQUIREMENTS

3.1. User Interface

The application will have a user friendly GUI which will be developed in Android Studio.

The User interface will show the options to select image, then predict results & show the predictions in an innovative format. The application will also have a feature, using which the user can compare the intensity of disease over a time period of 3-4 days.

Few features of the UI are as follows: -

- If in case a user is unsure about what a particular option is about, they can press the help button and the explanations of all the available buttons or options will be displayed.
- If a user at any point wishes to exit the application, they can do that by pressing the exit button.
- The UI is equipped with exceptional handling, so that in case of a wrong input the application won't crash.
- The UI will have texts formatted properly, making it easier for the user to understand.

3.2. Software Interface

Modules inside the application are communicating through simple arguments being passed to them while function calls. On the other hand application will be using standard TCP/IP connection for communicating with the API.

3.3. Database Interface

The database management system will be managed using Google Firebase as it provides login/authentication features with a real time database & integration with Google Analytics. It also provides fast & reliable hosting.

3.4. Protocols

Communication with Firebase uses standard TCP/IP protocol for listening to the queries and returning the output generated from the query.

NON-FUNCTIONAL REQUIREMENTS

4.1 Performance Requirements

- RAM: 2 GB
- OS: Android
- Active Internet Connection

4.2 Software Quality Attributes

Our program will follow the following quality attributes:

a. Availability - The Application will be available to predict disease in plants/crops at any time with good precision.
b. Performance – The application will be performance efficient, will only require little memory & it will provide fast execution.
c. Usability - The application will be designed with ease of use so that anyone with an Android Device can use it for disease prediction using images of crop/plant.
d. Functionality - The application will be able to find the disease of the crop with actual requirements & specifications.

REFERENCES

[1] "India at a Glance" – Food & Agriculture Organization of the United States

[2] Vijai Singh, A.K. Misra, Detection of plant leaf diseases using image segmentation and soft computing techniques, Information Processing in Agriculture, Volume 4 Issue 1, 2017, Pages 41-49, ISSN 2214-3173, doi: 10.1016/j.inpa.2016.10.005.

[3]. Kaiming He, Xiangyu Zhang, Shaoqing Ren, Jian Sun: Deep Residual Learning for Image Recognition, Dec 2015, DOI: https://arxiv.org/abs/1512.03385