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Cropable- The Crop Protection App

Submitted in fulfillment for the J-Component of CSE – Human Computer Interaction

Project by: **GROUP-**

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1. Abstract:

According to estimates, every year 10% of global production, goes waste due to pests and crop pathogens. For instance, India is a leading producer of many crops, including wheat, rice, lentils, sugarcane, and cotton. But a majority of the farmers are unable to detect whether a crop is infected or not simply by looking at it. The emerging resistance of crop pathogens to fungicides and pesticides compels the discovery of new antifungal compounds, which over time are rendered useless as the pathogens again develop resistance to these compounds. Thus, the food security of any country is always at risk due to the vulnerability of the current agricultural systems to climate, pests, pathogens, and associated diseases. To solve this problem, we have developed Cropable, The Crop Protection App. In the proposed work, we have used Deep Convolution Neural Networks(CNN) models to detect the disease and further created a web app using flask. Cropable is an Artificially Intelligent Web Application that can help to identify whether the crop is infected or not. We also provide farmers with a treatment for the detected disease, which not only helps them in identifying a disease but also assists them in solving it.

2. Crop Disease: Nightmare of every farmer

Like every other living organism, plants are susceptible to diseases. Crop disease involves any harmful deviation or alteration from the normal functioning of the physiological processes. Therefore, diseased plants suffer disturbances from normal life processes and their vital functions.In an attempt to reach high yields and healthy crops, farmers throughout the world struggle to prevent and eradicate various diseases from their crops. Each crop is susceptible to particular diseases that affect the quality and final yield potential.Generally, it's estimated that various pests (insects, weeds, nematodes, animals, diseases) each year cause crop yield losses of 20-40%. More precisely, there is some data that maintains that crop diseases cause average yield losses of 42% for the most important food crops. In some cases, crop diseases destroy the whole crop production.For this reason, it's extremely important for farmers to find out all they can about the crop diseases so they can manage them properly.

Understanding the disease and the development process is the first step towards successful disease management. There are a few special conditions that are conducive for disease development. First, each crop is susceptible to some disease. Second, abiotic factors, namely weather, weaken the plant significantly. Therefore, the plant is vulnerable to the attack of the pathogen. So, the pathogen acts like a cherry on top. When all of the aforementioned factors (susceptible crop, abiotic stress, pathogen attack) are present together and at the same time, disease occurs.

3. Aim:

To solve this problem, we will be developing Cropable, The Crop Protection App. Our aim is to develop an Artificially Intelligent Web Application that can help to identify whether the crop is infected or not.We also intend to develop a solution based system- we provide treatment measures of the diseases predicted.

4. Objective:

The main purpose of this project is to empower farmers in India to improve quality of their crop. This project named “Cropable” detects the crop disease and recommends treatment accordingly. Using our application, the farmer can upload the image of the respective damaged crop our application will identify the disease and suggest treatment accordingly. Deep Learning Algorithm such as Convolutional Neural Networks (CNN) enables us to detect crop disease by image classifica- tion. Disease detection is performed in two steps where the first step is to detect the crop disease and the second step is to provide remedy for that particular disease. This application will help farmers improve the quality of their crops.

5. Introduction:

In India, agriculture is the main industry. In terms of global agricultural output, India comes in second. Farmers in India grow a wide range of different crops. The production of the crops is influenced by a number of variables, including the climate, the soil, various diseases, etc. The current method for identifying plant diseases relies solely on naked eye observation, which demands additional manpower, adequately outfitted labs, pricey gadgets, etc. Inadequate disease diagnosis can also result in inadequate pesticide application, which can lead to the development of long-term pathogen resistance and lower the crop’s ability to defend itself.

The agricultural business is looking for new and better ways to enhance food production as a result of the growing popu- lation, political unrest, and changing climatic circumstances.Many farmers are leaving agriculture for new occupations as a result of industrialisation and low productivity.

Leaf disease poses a significant threat to food security as well. Both the quality and crop output are compromised. It reduces harvest yields and diminishes product quality. Mi- croorganisms like insects, pests, fungi, bacteria, and viruses can transfer diseases to leaves. When they eat the

top and bottom of the leaf, the entire plant is affected. To prevent further agricultural losses, leaf diseases must be identified early. As a result, the economy is boosted by higher food output, which benefits farmers. Finding out how healthy the plant is is essential. Examining the afflicted leaves will reveal the ailment. On the surface of the leaf, irregularly formed black pigment patches appear, and if the area is damp, fungus can grow there. These spots start out little, but over time, they grow until they cover the entire leaf, which leads to deterioration. For the proper diagnosis of leaf diseases, a specific window of time must be given, i.e., at the early stages, before the basic operations of plants, such as pollen movement and fertilizer absorption, are jeopardized.

India's agriculture system till now is very dependent on natural factors. It's time we upgrade our systems by enhancing them in order to ease the work for our hard working farmers. The main aim of our project Cropable- The Crop Protection App is to empower our farmers by providing accurate crop disease detection and treatment measures. This will help them to increase their crop sale and quality of crops. By utilizing modern technology, which enables farmers to boost agricultural output, productivity, and quality at a very low cost, we must expand the use of agriculture. We must keep an eye on and regulate conditions like temperature, humidity, and light in order to produce crops with improved yield and quality. This paper is focused on Deep Convolutional Neural Net- work(CNN) models to be of service to farmers in terms of disease detection, and our app- Cropable is solution oriented, which gives out treatment measures as well at the same time.

6. Literature Survey:

Computer Vision image Enhancement for Plant Leaves Disease Detection

-By Dr. K. Thangadurai K. Padmavati (WCCCT) (2018)

This research paper has used the three fundamental concepts of Image processing- Use of Grayscale Images, Color Conversion & Histogram Equalization for detecting the Plant Leaves Disease. The algorithm implementing the cumulative histogram equalization includes- loading the analyzed grayscale image, generating a histogram, obtaining the cumulative distribution function, calculation the new values using the histogram equalization formula and then generating a new image using new values & obtaining a new histogram for the image, which has more clarity. The authors has implemented the functions and tested using MATLAB here. Since they have used cumulative histogram equalization, the grayscale images are easier to process and implement, since they have better quality. The concept of histogram equalization enhances the contrast of the images and provides a clear image to the human eyes. An app for the proposed algorithm can be created as further work, which also gives the farmer suggestions on how to cure the plant disease. The author could have also used better computing tools for ease.

Plant Leaf Disease and Classification based on CNN with LVQ Algorithm

-By Melike Sardogan & Adem Tuncer & Yunus Ozen (UBMK) (2018)

For training the networks, the output feature vector of the convolution component was input into the LVQ. The results of the experiments demonstrate that the proposed approach successfully detects four different forms of tomato leaf diseases.One of the benefits of deep learning is that it can automatically extract characteristics from pictures. During training, the neural network learns how to extract features. The common deep learning model is CNN, which is a multi-layer feed-forward neural network.Only a few leaves have been categorized incorrectly in each class, and it is clear which classes these inaccurate classifications have been folded in the table.

Plant Disease detection using image processing

-By Sachin D. Khirade & A. B. Patil (ICCUBEA) (2015)

The strategies for detecting plant infections using pictures of their leaves were investigated in this research. In addition, various segmentation and feature extraction algorithms for plant disease diagnosis were described in this work.The accurate detection and categorization of plant diseases is critical for effective crop cultivation, and image processing can help with this. Lower accuracy due to small dataset.

Processing Disease Detection on the Leaves of the Tomato Plants by Using Deep Learning

-By Halil Durmuú (IGAG) (2017)

The aim of this work is to detect diseases that occur on plants in tomato fields or in their greenhouses. For this purpose, deep learning was used to detect the various diseases on the leaves of tomato plants. For precise agricultural applications, such as spraying medicine to only affected area, it is necessary to determine the region where the plant diseases occur and spread. Operators, sensor networks, drones and mobile robots are used for detection in precision farming but the biggest disadvantage of these tools is that they cannot detect the field as an expert . So to solve this problem , deep learning techniques are used to detect diseases from the leaves of the tomato plants. Due to the small batch size of the training phase the accuracy of the model was low.

A Review on Machine Learning Classification Techniques for Plant Disease Detection

-By U. Shruthi; V. Nagaveni; B.K. Raghavendra (ICACCS) (2019)

A comparative study carried out on different types of machine learning classification techniques for recognition of plant disease is done in this review. The result shows that the CNN classifier detects more diseases with high accuracy. Higher accuracy of the CNN model compared to other existing statistical models and neural networks. Accurate models predict the disease in plants better and optimal fertilizer usage is then known.Different models such as naive bayes and decision trees may be used in further studies.

Leaf Disease Detection and Grading using Computer Vision Technology & Fuzzy Logic

-By Aakanksha Rastogi, Ritika Arora, Shanu Sharma (SPIN) (2015)

For exp. purpose, Maple and Hydrangea leaves are considered having two types of diseases, namely, Leaf Spot and Leaf Scorch. The proposed system has two phases:- Training and Testing Phase. This is advantageous in large fields of crops and help agricultural experts in identifying correct pesticide and its quantity to overcome the problem in an efficient and effective manner. The amount of diseases in plants has long been an issue of concern in the agriculture sector for crop quality management.

Plant disease Detection and Classification using CNN Model with Optimized Activation Function

-By S.Yegneshwar Yadhav, T.Senthilkumar, S.Jayanthy, J.Judeson Antony Kovilpillai (ICESC) (2020)

Here a CNN based model with a new activation and real time optimization is suggested. Further area affected by disease is calculated by using K – means clustering algorithm to estimate the optimum fertilizer usage.Here a CNN based model with a new activation and real time optimization is suggested. Further area affected by disease is calculated by using K – means clustering algorithm to estimate the optimum fertilizer usage.The activation function, ReLu, has a disadvantage that the derivative of the function is zero for negative values and leads to neuronal necrosis.

Copy-Move Forgery Detection by Using HSV Preprocessing and Keypoint Extraction

-By Prajwal Pralhad Panzade, Choudhary Shyam Prakash, Sushila Maheshkar (PDGC) (2016)

Image forensics plays vital role if the images are to be used as an evidence in an important judgments like in court of law. The paper proposes an approach to detect the copy-move forgery termed as Copy-Move Forgery Detection (CMFD). Then the key-points were extracted using SIFT and later matched. Thereafter, the keypoints are clustered and final detection is carried out based on it.The proposed method gives good results to images which are geometrically transformed and multi-cloned. The paper promotes a method based on SIFT feature transformation as keypoint based methods are more preferable over block based method due to low computational cost. In the matching key points step there is a possibility that some images with similar texture might not be detected or they may be falsely detected.

Plant Disease Detection Using CNN

-By Garima Shrestha, Deepshikha, Majolica Das & Naiwrita Dey (ASPCON) (2020)

Here, a CNN-based approach for detecting plant diseases is offered. In terms of time complexity and the extent of the infected region, a simulation research and analysis is performed on sample pictures. Image processing is used to accomplish this. The suggested approach is successfully implemented to train the system. With no overfitting, the accuracy rate on the test set is 88.80%. This work may be applied to the agricultural sector and utilized to assist people in tracking their house plants as well as farmers in keeping track of their crop.An app for the proposed algorithm can be created as further work.

Disease Detection Using Deep Learning.

-By Omkar Kulkarni (ICCUBEA) (2018)

The purpose of this research is to apply Deep CNN to both crop species classification and disease identification on images. The dataset covers 13 types of crop species and 26 types of diseases. Significant growth in accuracy is observed in initial stages of the processing and experimentation in InceptionV3 which get converged later on.Both MobileNet and InceptionV3 models shows steady growth with 99.04% and 99.45% accuracy respectively. Images having multiple orientation were not captured in a controlled environment and neither were they classified.There is still a scope for the the number of classes of crops and its diseases to increase.

7. Methodology:

7.1 Dataset Description

For this project we have used “tomato leaves “datasets to build our “Plant leaf disease detection” system. This dataset contains various categories of healthy and dis- eased plants. The diseases include Tomatomosaicvirus, Tar- get Spot, Bacterial spot , TomatoYellowLeafCurlVirus , Late blight , Leaf Mold , Early blight, Spider Mites Two- spotted spider mite , Tomato healthy , Septoria Leaf Spot. For the disease detection and its treatment, we have used “Tomato Leaf Disease detection using CNN” dataset from Kaggle, which contains 3 folders (train, test, Val). The “train” folder consists of different kinds of diseases. Each disease folder contains various images of each disease. The train and Val folder are used for training model.

In order to analyze data in a valid manner, it is necessary to perform data pre-processing. The process of encoding or transforming data in a way that the machine can easily parse makes up an important part of the process of building a neural network or deep learning network. This process begins with the data preprocessing stage. Mostly, it is necessary to make sure the data is readable by machine learning models and make sure it is accurate, complete, and has no duplicate, redundant, or missing data. It is essential that the updated data be free from inconsistencies and errors, and it must also be interpreted correctly. For a deep learning model to make accurate predictions/outcomes, it is crucial that the data is preprocessed.

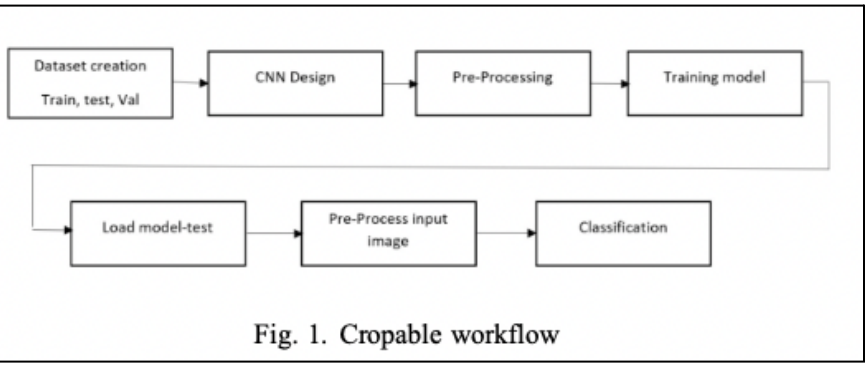


Fig. 1. Cropable workflow

We studied datasets of tomato leaves to create a system for identifying plant leaf illnesses, and in order to receive reliable suggestions, we cleaned the data before feeding it to the model. This dataset contains various categories of healthy and diseased plants. Sometimes, there is a possibility of overfitting the data for the categories whose numbers of images are large relative to others if the dataset is not balanced or the model doesn’t generalize well from training data to unseen data. Facing overfitting issues can become one of the trickiest obstacles in applied deep

learning models hence the very first step in tackling this problem is to actually know that your model is overfitting. In such a case, it becomes important to conduct cross-validation.

7.2 Data Processing

7.2.1 Data Augmentation

An augmenting technique is a method that uses modified data from an existing training set to artificially increase the set's size.In order to solve the over fitting problem, data augmentation may be used to produce more data from existing data. It helps to enhance the performance of the model by inflating the data we already have.

An inconsistent neural network may not be able to predict the accurate output. Hence, for a model to fit perfectly, we need enough accuracy of the trained data. For this project in the case of the disease detection app, we use image augmentation. To augment images when using TensorFlow or Keras as our DL framework we can draft our own augmentation pipelines or layers using tf. image or Use Keras preprocessing layers and ImageDataGenerator.

Using image augmentation, a small set of images can be augmented into a rich, diverse set of images for classifying images, detecting objects, or segmenting images. In image augmentation, the content of a base image is combined with the appearance of another image to produce new, high-quality images. For a more efficient training process, the newly created images can be used to pre-train the given neural network. For this process, we have considered a few factors such as the flipping, rotation, scaling, and translation of crop images.

7.2.2 Train- Test and Validation of Data

For the application of any neural network, models should be tested for accuracy. After applying data augmentation on an available dataset, we have divided our sample dataset into a training set and an independent test set, with the former being used for development and the latter for evaluation of the classification algorithm.

The training set enables the algorithm to learn the behaviors present in the data, and a testing set establishes whether the algorithm has the correct behavior. Here, we take a training set of 2/3rd and a testing set of 1/3rd of the original data set. For model validation, the data refers to the testing set. As part of our training process, we collect validation data from a different set than the training set in order to validate our model's performance. We separated the dates into a validation set to prevent overfitting, which occurs when the model becomes very effective at identifying samples in the training set but cannot generalize and make accurate classifications on data that it has never seen before.

7.3 Model Implementation

We have applied deep learning models to train the datasets after all three datasets have undergone data processing and augmentation for crop recommendation and plant disease detection. Convolutional layers, pooling layers, and activation functions—often known as Rectified Linear Units—are the three primary building blocks of CNNs (ReLUs).The distinctiveness of any architecture is determined by the number of layers employed, how they are arranged, and the addition of additional processing units.

We have created a content-based model that makes use of content-based filtering technology to suggest treatments for the identified condition.AlexNet on ImageNet ResNet, VGG, and Inception architectures are commonly used forms of architectures while DenseNet or ResNetXt are newer architecture forms. For plant disease detection we have implemented deep neural network models VGG16 and Sequential on the datasets of tomato. The features of the CNN model have been extracted from layers of CNN architecture.These features are then fed for the classification of the thirty-eight different categories of healthy and dis- eased crop images.CNN is basically a multi-layer structure model;each layer of the CNN model produces a response and extracts important features from the input image and then passes it to the next layer.

7.3.1 Recommendation system

We adopted a content-based approach for the recommendation system. examining solely the Content Description. This strategy advises taking into account prior decision. When creating a model, the model first determines which dataset pairings are similar to one another, and it then utilizes the items that are the most similar to create a list of suggestions. In this methodology, the term frequency-inverse document frequency has been used to establish similarity amongst agricultural datasets (TF-IDF). We have used the inverse document frequency to denote that we are examining the rarity of each element in the collection. It has aided in providing the rare in the dataset a better ranking. We created TF-IDF vectors for each element in the dataset after computing TF and IDF. We utilized cosine similarity to compare comparable vectors. For cosine, the angle between the vectors has been determined to assess how similar the entries are.

7.3.2 Plant Disease Detection system

The CNN model in our implementation has two convolutional layers and a Max-Pooling layer. Each convolutional layer is subjected to the ReLU activation function. We favor the ReLU function in this situation because it helps our input pictures become more nonlinear, which will produce accurate prediction. The Max-Pooling layer, which removes the maximum parameter from the input and discards the remainder, is applied in between the convolutional layers with

pool size (2, 2). We use the softmax activation function to ensure that the logits all add up to 1, meeting the requirements of probability density, in the output layer convolutional model.

Layers of CNN architecture have been used to extract the CNN model's characteristics, as shown in Fig 3. The output's form is represented by the dense unit in the output layer. Our model has a dense unit of 38 due to the fact that there are 38 different output categories. The input shape and target size for each network in the proposed CNN model are (64, 64, 3), (64, 64), and (64, 64), respectively. The categorical cross- entropy loss function is used to assess the model's performance in terms of loss and Adam optimizer. It is regarded as a collection of specific algorithms that are used to alter the neural network's properties, such as its weights and learning rate, in an effort to minimize loss.The batch size is 32 and each CNN has been fitted on 25 epochs. For the categorization of X-ray images, this CNN model uses eight pre trained deep convolutional neural networks that are completely integrated with keras-core as follows:

Sequential Model A simple stack of layers with precisely one input tensor and one output tensor for each layer makes the Sequential model ideal. Sequential models can include any number of layers; in this case, we passed two convolutional layers using the '.add ()' method and the ReLU activation function. This model may be customised to meet our needs.

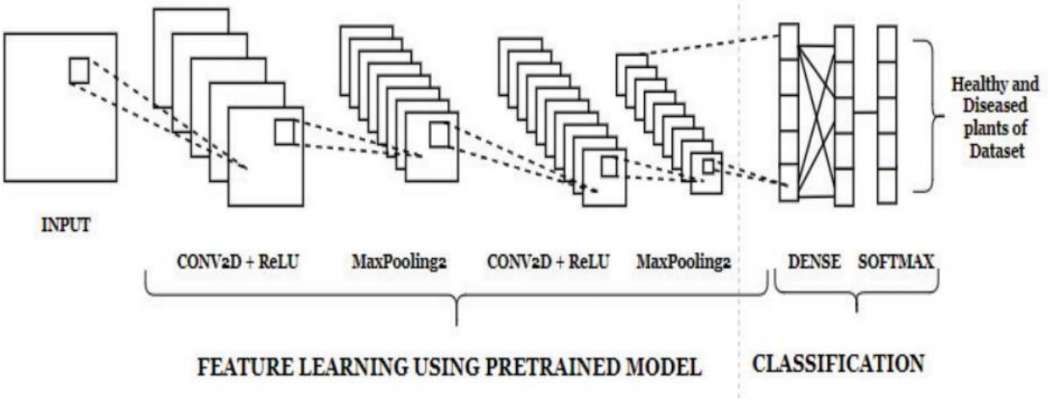
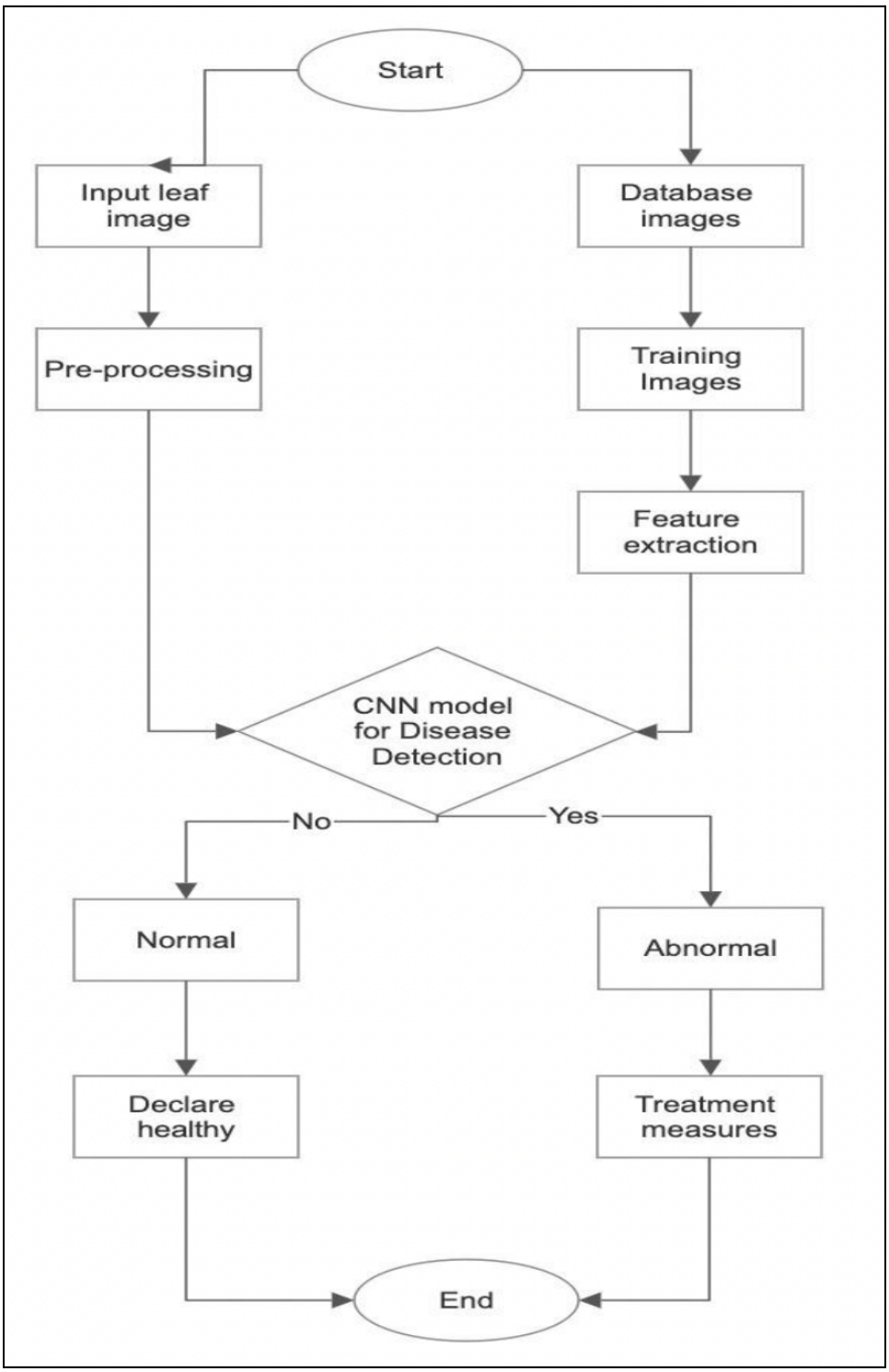


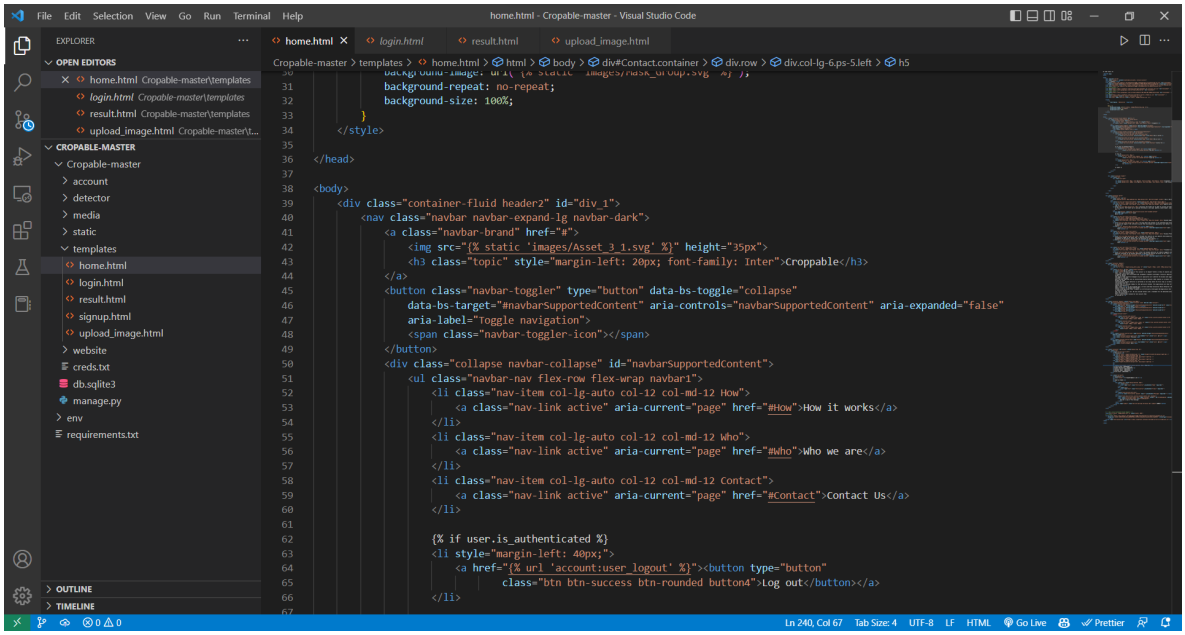
Fig. 3. Proposed Architecture for Crop Disease Detection

This model was trained using the input shape of (64, 64, 3). VGG16 Model The 16-layered convolutional neural network model known as the pretrained model VGG16 was created by K. Simonyan and A. Zisserman from the University of Oxford in 2014. 11 kernel-sized filters were used in this pretrained model, five of which were applied in the first layer and many 3x3 kernel-sized filters sequentially. This model features a 224 x 224 fixed input size, a stride of up to 1, and a padding of 1 pixel.

8. Architectural Diagram:



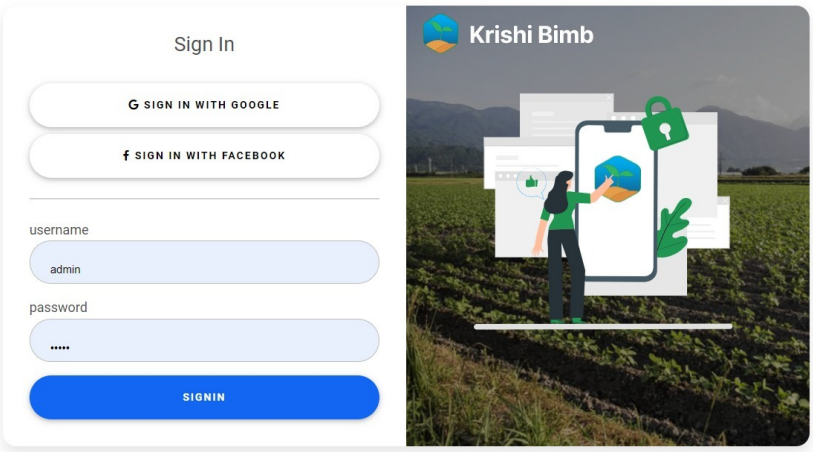
9. Code snapshots:



Further code can be seen here:
https://github.com/Anannya09/Cropable

10. Web App snapshots:

SIGN IN:



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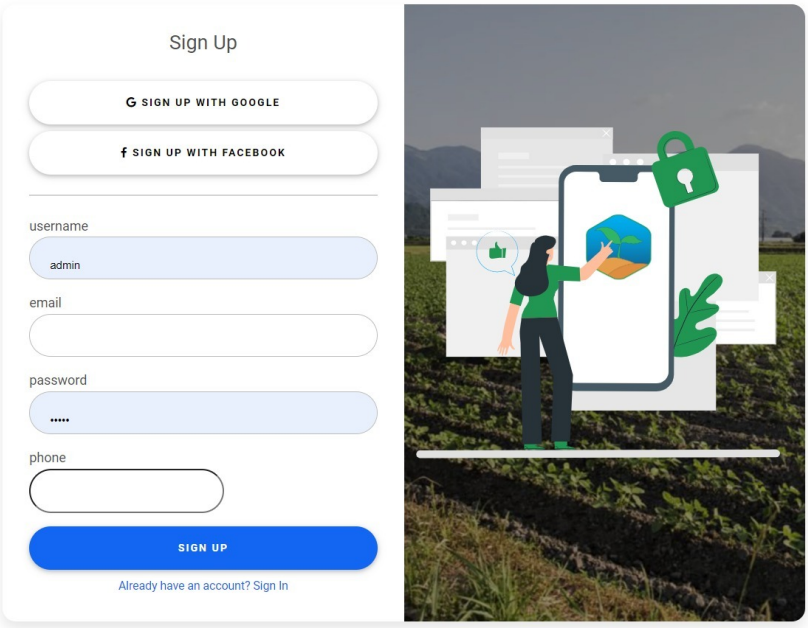

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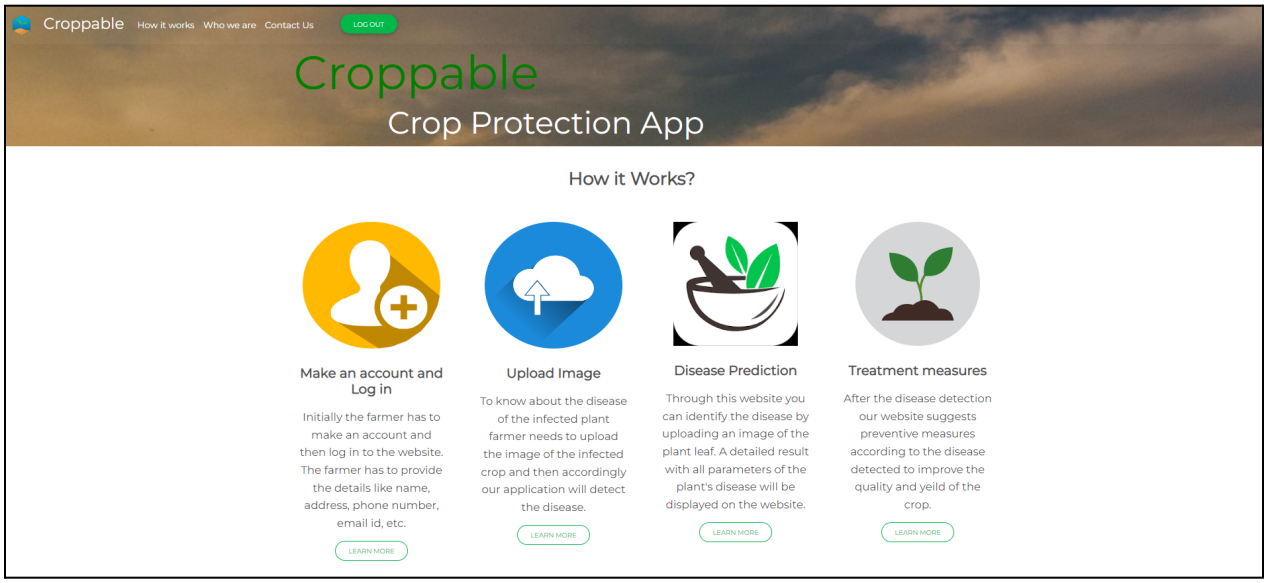

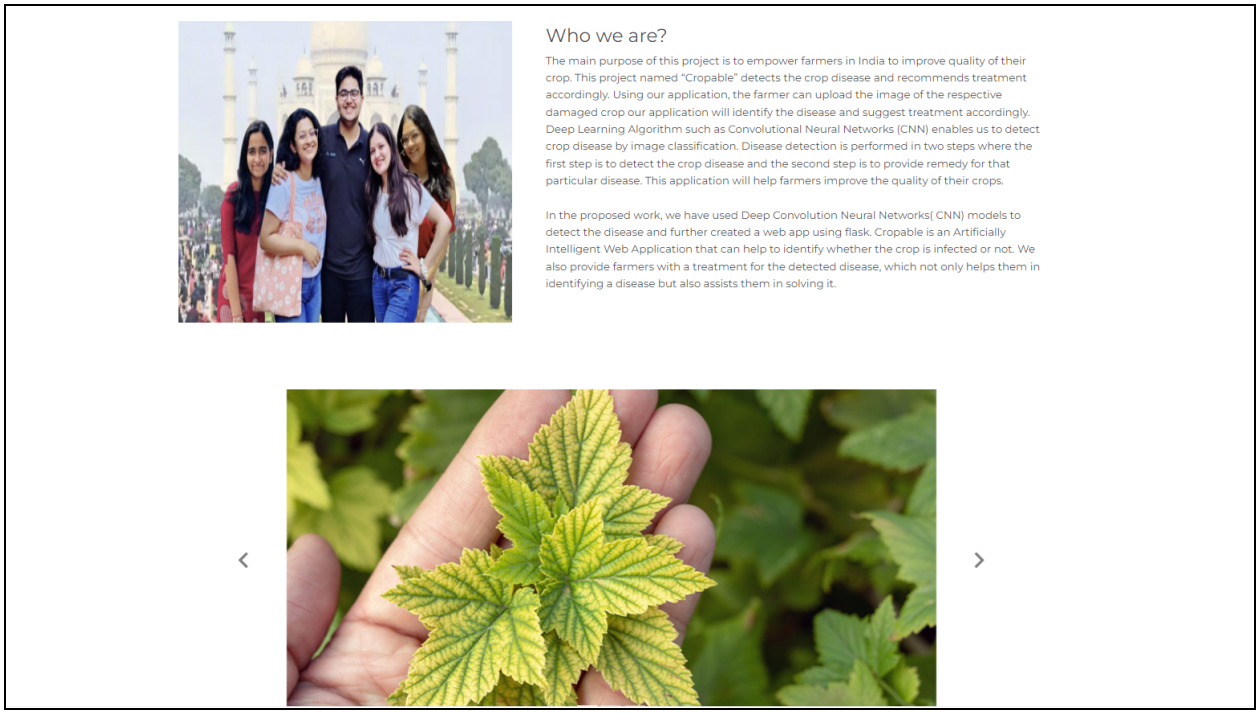
Who we are?
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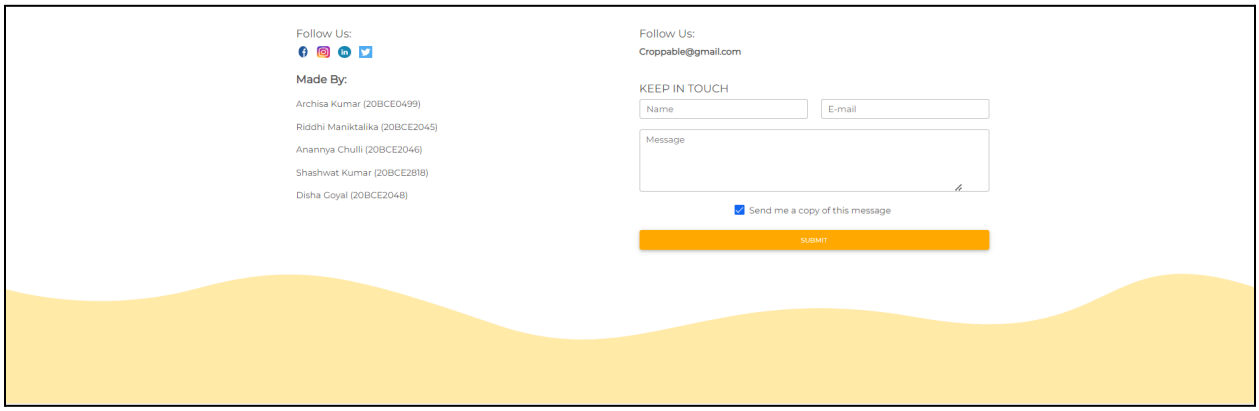
In the proposed work, we have used Deep Convolution Neural Networks(CNN) models to detect the disease and further created a web app using flask. Cropable is an Artificially Intelligent Web Application that can help to identify whether the crop is infected or not. We also provide farmers with a treatment for the detected disease, which not only helps them in identifying a disease but also assists them in solving it.

Contact Us: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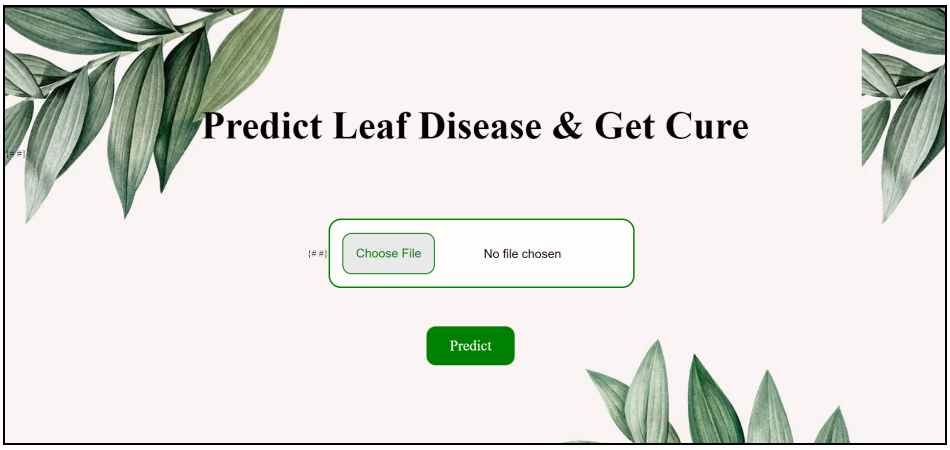
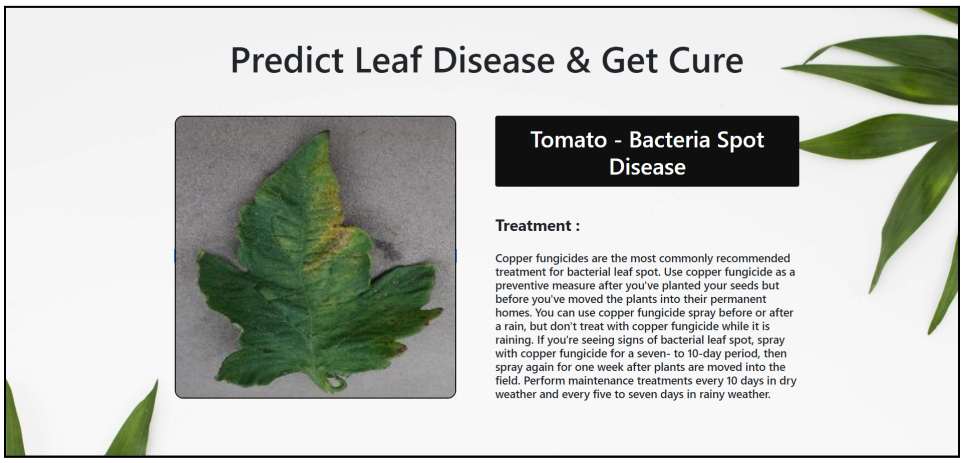


Final Output:



11. Conclusion:

The project, Cropable, harnesses the power of Artificial intelligence and Machine Learning to help owners and farmers of gardens, plantations, or anyone who is interested in finding out the disease and its corresponding remedies. Through the project we aim to develop an interface which is simple and eas- ily understandable for the user. The project will be developed in compliance with Norman's heuristics and Schneiderman's 8 Golden Rules. This product will be an app-based business solution used to monitor crop health. The software would improve the efficiency of crop harvesting and would help the farmers to keep track of crop health. The software would be only accessible by the farmers. The software provides a dynamic dashboard for farmers to keep reminders to water the crop and the prediction system helps the crop to be disease- free, this avoids the loss of farmers.

12. Research Paper update

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6th - 7th November, 2022
EVENT ACCEPTANCE LETTER

Paper Title: **Cropable-TheCropDiseaseDetectionWebApp**

Author's Name: **ShashwatKumar**

Co-author's Name:
ArchisaKumar,DishaGoyal,AnannyaChuli,RiddhiManiktalia,DeepaK

Paper ID: **RW-ICSTEMMELBO-061122-16204**

We are happy to inform you that your Paper has been selected for **ICSTEM** on **6th - 7th November, 2022** at **Melbourne, Australia** after peer review process which will be organized by **Researchworld** and in association with **PET** for presentation (oral presentation) at the Conference. Conference Proceeding having ISBN *(International Standard Book Numbe*r) and certificates of paper presentation will be given.