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Prediction of Crop Disease with Solution Oriented E-Shopping Application

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***Abstract*—The proposed project is for prediction of crop diseases (For this project, Tomato) using classification algorithm in deep learning concept. A plant shows some symptoms of abnormality as a reaction to some pathogen or due to deficiency of sulfur. Some features such as wilting, size, rots, color, dryness, are major help to determine the plant's health condition. Prediction model deals with 'Transfer Learning using Inception V3' algorithm technique implemented with help of python to get the desired output. Machine learning is the branch of Artificial Intelligence to give the instructions to a particular system to perform an action automatically without or less guidance. Goal of this project is to give accurate early stage prediction about disease occurring in plant so that mortality rate of crop yields can be improved. Disease development depends on some conditions like- crop susceptibility to disease, viability of pathogen and environmental favorability for that crop yield. These three conditions need to be fulfilled for showing any signs of disease. This project represents full scale business structure idea such as, people can get 'correct' pesticides and fungicides from the smart web interface developed in project regarding specific crop yields. This is relative to E-commerce sites we are using everyday nowadays.**

Keywords*— *Transfer Learning, Web Interface, Inception V3, E-shopping, Deep Learning.

I. INTRODUCTION

As of 2020 we may have enough food for existing population but according to studies of UN, we will have shortage of food due to population blast till 2050. To achieve 'zero hunger' slogan, many initiatives were taken worldwide till now. This project is also small part to achieve that goal for benefit of society. This will help farmers yield more crops as death ratio of yield reduces because of disease. The project work deals with crop disease prediction using supervised classification algorithm of machine learning. We are considering Tomato for this project as it is one of the most demanding yields. A plant disease is a physiological abnormality. Visibility of symptoms are like rots, galls, dryness, leaf spots, and cankers etc. This proposed project will give near perfect prediction for certain type of disease at early stage so that necessary precautions can be taken.

Agriculture is business with moderate risk and reliable crop yield prediction is necessary for farmer rich country like India, these decisions related to agriculture business helps in risk management. Population and food production increasing rates has significant difference between them. The aim of meeting world's food demand for the blasting population around the world is going to become more important in recent years. Goal of this project is to give accurate early stage prediction about disease occurring in plant (Tomato) so that mortality rate of crop yields can be improved. Prediction could be used by crop managers or farmers to minimize losses when unfavorable condition may occur. Also, farmers that don't have knowledge of which pesticides to use or where to buy them could have been benefited by E-commerce web interface that connects pesticide manufacture directly to farmers thereby achieving complete elimination of 'Middle Man' concept who is making large amount of money by taking advantage of lesser knowledge and awareness of rural farmer about use of fungicides and pesticides, therefore this project can help farmers to detect and prevent crop yield loss. Ultimately could reduce suicides rates of them.

Proposed project model deployed using Flask server. CSS, HTML used for making simple prediction model web interface. E-commerce system was developed in python using Tinker framework. Plant datasets for prediction model were taken from Kaggle environment.

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II. LITERATURE SURVEY

One approach was presented [3] in 2011 to automatically grade the disease on plant leaves. According to this project, plant experts and pathologists mainly gave observations on basis of naked eye prediction of disease from symptoms that are visible and gave certain scale grade to the disease. But this manual grading is not only time consuming but also not feasible, therefore an image processing-based approach came forward to automatically grade the diseased plant leaves by using Fuzzy Logic had been proposed. The results are proved to be satisfactory and accurate when compared with manual diseases grading.

One survey report was published [2] in 2014, paper stated various different classification techniques that could possibly use for classification of crop diseases. Technique in machine learning where study objects are classified on basis of various different features is known as Classification. In this case, morphological features of plant leaves such as shape, size, texture, etc. are responsible for classification. There exists so many classification techniques such as Support Vector Machine, Artificial Neural network, k-Nearest Neighbour Classifier, Genetic Algorithm, Probabilistic Neural Network, Fuzzy logic, Principal Component Analysis, etc. Selecting classification technique is very difficult work because quality of outcome may differ for different kind of input data. This type of disease classification has wide applications in many fields such as biotechnological and agriculture research, etc.

With the various type of input data, different techniques like Neural network, Decision tree, Naive Bayes and different plots like bar plot, box plot are plotted for comparison of their efficiency [1]. By performing the technique, it is concluded that, accuracy of given data has recorded accuracies 1) Neural Networks: 93 - 95 percentage 2) Naive Bayes:86 - 89 percentage 3) Decision tree: 92 percentage. Paper in 2018 also shows survey on different classification techniques that can be used for Grape leaf disease classification. Rupali Patil and Sayali Udgave describes k-mean clustering and extraction technique by which detection of Grape plant diseases could be possible. This project is recorded more accuracy as compared to the other feature detection methods. With this method, Red spot which is one of the fungal diseases is detected successfully [4].

The proposed methodology has aim to model a very accurate and reliable disease classifying model for crop yields. The system was divided into five primary steps: (1) Collecting sample images (2) Data preprocessing (3) Applying algorithms (4) Getting most probable disease grading (5) Appropriate pesticide or fungicide based on disease predicted by deep learning model.

In 2012, an article was published [5] which has a detailed description on definition of disease, types of diseases, their symptoms and causes of most commonly occurring plant diseases. One article was published by Michigan University [6] regarding the threats caused due to diseases. Various conditions for disease development had been discussed there. An overview of major disease-causing organisms and the effect of diseases caused by them was given.

In MATEC Web of Conferences of 2018 [7], Browser/Server (B/S) hidden client mode of web development is used to review online shopping system. User of system only needs one browser which is under the B/S model, and the browser interacts with database directly through Web Server for accessing necessary data, so due to B/S model having vast number of benefits, same model is used in this procedure. MVC (Model, View, and Controller) framework is implemented to integrate with network of E-shopping system, processing data access, and completing management of control layer. Finally, the system is able to complete basic requirements for online shopping and also becomes a good model for application of E-commerce.

III. SCHEMATIC DIAGRAM AND LOGIC OF PROJECT:

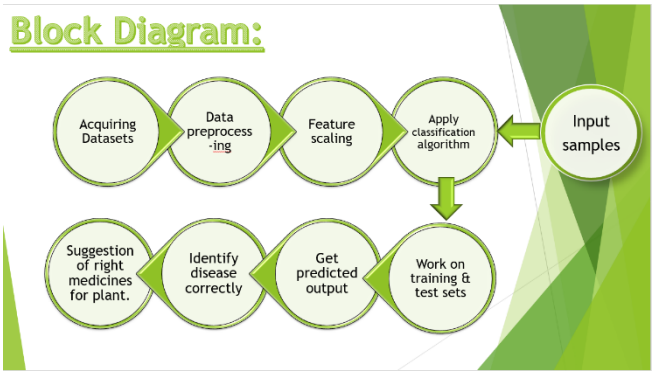

Fig. 1. Block diagram

1.Aquaring Datasets: Datasets of crop species had been collected from internet and manually. It has different varieties of diseases listed on datasets which can be split later into training and test sets.
2.Data Pre-processing: Process of collecting raw form of data and making it suitable to use for ML system is called 'Data Pre-processing'. It is basic and first step while creating machine learning model.
3.Feature Scaling: The technique to standardize all independent feature variables present in the raw data is called as 'Feature Scaling'. If feature scaling isn't applied, then a algorithm could do calculations on basis of rule greater values as higher in unit and can consider smaller values as the lower in unit, without knowing the actual respective unit of the values.
4.Application of Computational Algorithm: Inception V3 Classifier Algorithm.
5.Working on Training model: Training a model means learning (determining) best values for all the bias and the weights from test set examples. In supervised learning, an algorithm builds a system with aim to minimize loss of model by operating on many examples in training set and test set.
6.Get predicted output: Get most probable disease name at output of model.
7.Model Deployment: Deployment of the well built model is necessary step for reaching out to targeted audiences. Integration of system with frontend GUI (Graphical User

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Interface) helps making this model interactive with ease in operating for users. This is an essential step of system deployment. Also, helps in creating E-commerce based platform for changing world demands.

Fig.2 shows Data flow diagram of system.

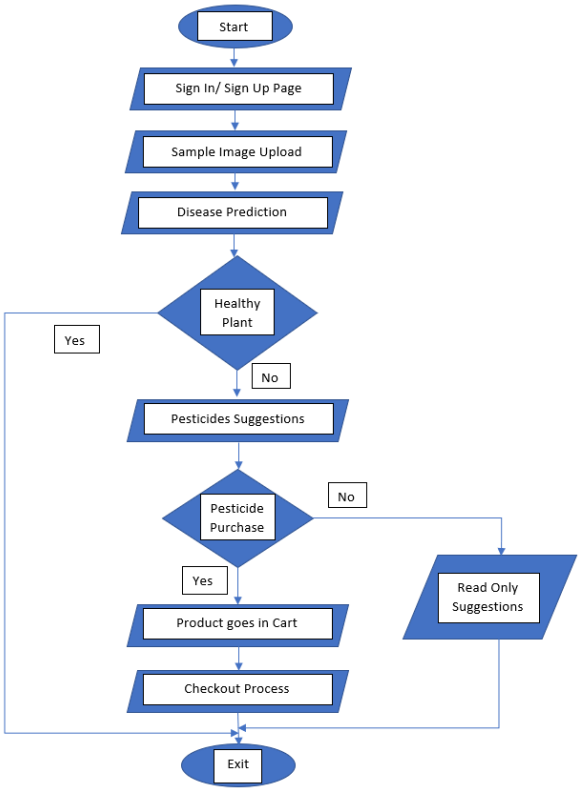

Fig.2. Data flow diagram of the system

IV. METHODOLOGY

A. Classification Algorithm

An Inception V3 is a convolutional neural network structure for processing of image detection and object detection. This first started as a module for Googlenet. Initially this algorithm is introduced only for ImageNet Recognition Challenge but afterwards it became third edition of Google Convolutional Neural Network's Inception V3 algorithm. It can be used along with Transfer Learning Technique. Inception helps classification of images in the world of computer vision.

Architecture:

Fig.3: Architecture of Inception V3 Model

1. Convolutional Layer: This layer is the principal layer that is used to extricate the different features starting with those input pictures. In this layer, those logical operation of convolution may be performed between the information picture and filter matrix of a specific size MxM. By placing those filter on input image, the dot product is performed between some part of the information picture and filter matrix of a specific size (MxM). The output is called as 'Feature Map'. Feature Map gives information about the images. For example: edges and corners of pictures. Later, this feature map becomes input for other layers to learn other different features of the input data image.

2. Pooling Layer: In most cases, a Convolutional Layer is followed by a Pooling Layer. The primary aim of this layer is to decrease the size of the convolved feature map to reduce the computational costs. This is performed by decreasing the connections between layers and independently operates on each feature map. Depending upon method used, there are several types of Pooling operations. In Max Pooling, the largest element is taken from feature map. Average Pooling calculates the average of the elements in a predefined sized Image section. The total sum of the elements in the predefined section is computed in Sum Pooling. The Pooling Layer usually serves as a bridge between the Convolutional Layer and the FC Layer.

3. Fully Connected Layer: The Fully Connected (FC) layer consists of the weights and biases along with the neurons and is used to connect the neurons between two different layers. These layers are usually placed before the output layer and form the last few layers of a Neural Networks Architecture. In this, the input image from the previous layers were flattened and fed to the FC layer. The flattened vector then

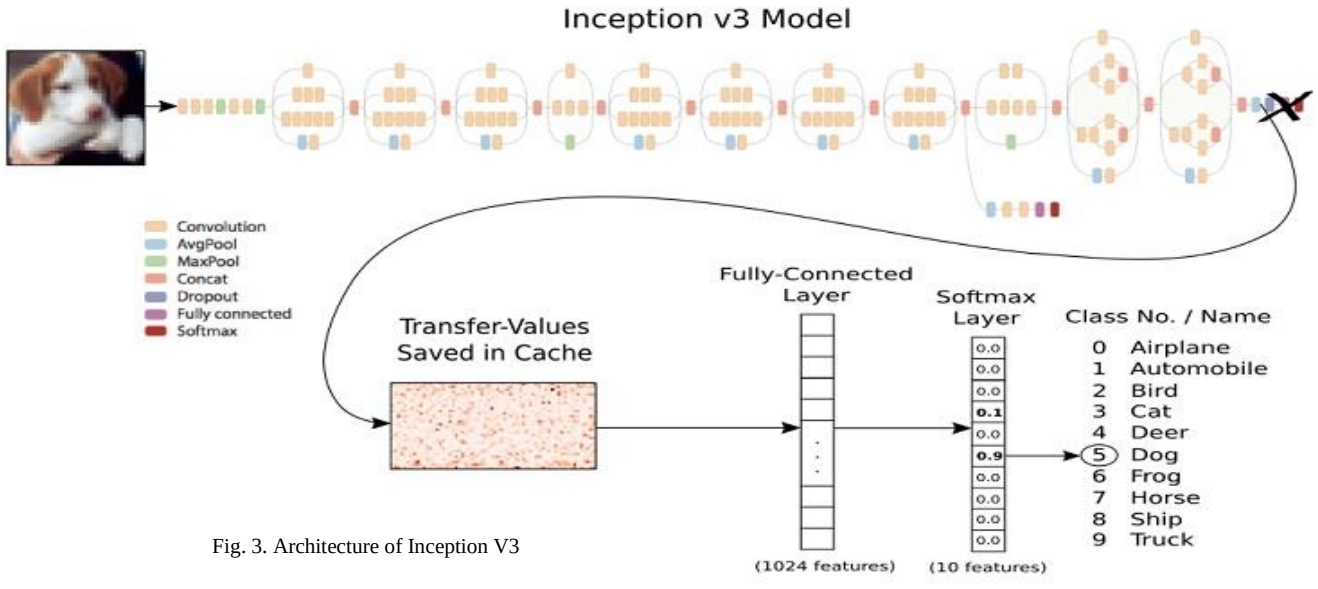

Fig. 3. Architecture of Inception V3

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undergoes few more FC layers where the mathematical functions operations usually take place. In this stage, the classification process begins to take place.

4. Activation Functions: Finally, one of the most important parameters of the CNN model is the activation function. They are used to learn and approximate any kind of continuous and complex relationship between variables of the network. In simple words, it decides which information of the model should fire in the forward direction and which ones should not at the end of the network. It adds non-linearity to the network. There are several commonly used activation functions such as the ReLU, Softmax, tanH and the Sigmoid functions. Each of these functions have a specific usage. For a binary classification CNN model, sigmoid and softmax functions are preferred for a multi-class classification.[8]

B. Transfer Learning Technique

Machine learning technique in which system trained on one particular task is again used for a second related task is known as Transfer Learning. It is an accumulation that allows fast progress and increase in performance while running the second task.

Instructions for using Transfer Learning:

1. Selecting Source Task: It involves selection related predictive demonstrating issue with a plenitude for information the place, where there will be exact relationship in the output data, input data, or ideas discovered throughout those mapping starting from input data to output data.
2. Development of Source Model: Aim is to develop a good and effective performing model for the first task. The model has to be better than a basic model so that some characteristic learning will be performed.
3. Reuse of Model: The model fitted on the source task again will be used as the start point for a model presently running i.e. on the second task. All parts, weights, bias could be used depending upon requirement and algorithm used.
4. Tune the Model: This is optional step. The model might need to be update or adapt on the output-input pair as per data available/require for the model to be executed. [10]

Benefits of Transfer Learning:

Jude Shavlik and Lisa Torrey [9][10] gave three possible advantages that could be achieved using transfer learning:

1. The initial feature extraction (before reusing the system) on the base model is higher than what it usually could be. It could give you Higher Start.
2. The improvement rate of prediction of system during training of the base model is more than what it usually could be. It could give you Higher Slope.
3. The converged prediction accuracy and speed of the trained model is better than what it usually could be. It could give you Higher Asymptote. Figure below shows all affecting three factors in the form of graph.

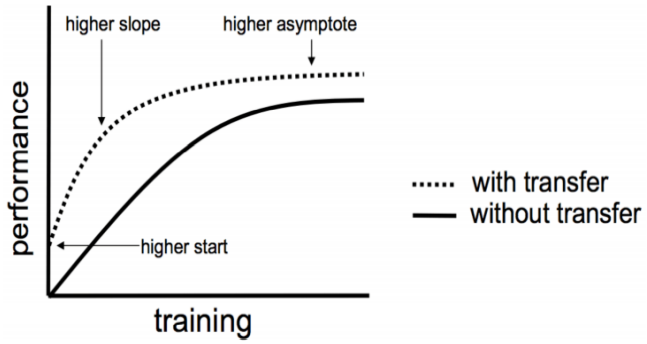

Fig. 4. Three ways in which transfer might improve learning.

SQL Lite server is used as database in making GUI. Tinker framework library in python is used as building structure for GUI and 'Flask' server is used for the deployment of the disease prediction system. Visual studio and Anaconda environments are used as base. According to relationship between all working functional modules, a relational entity diagram is designed to serve the needs of customer using site. Entity Relationship Diagram is given in Fig.4.

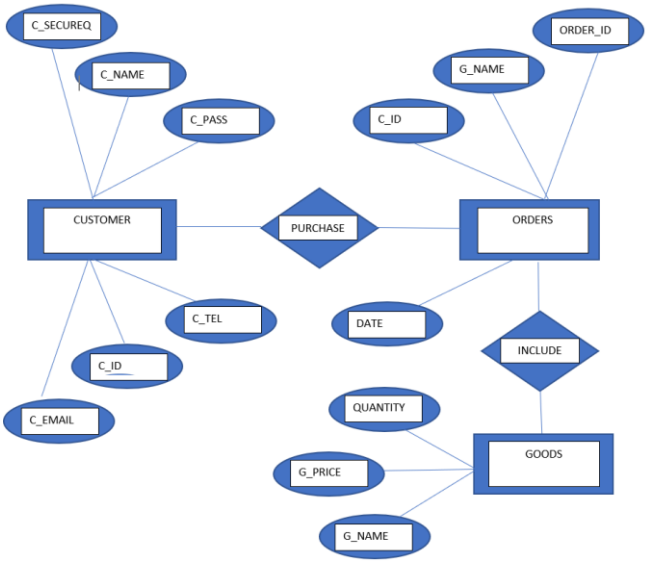

Fig. 5. Entity Relationship Diagram

V. HARDWARE AND SOFTWARE REQUIREMENTS

A. Hardware Requirements

Most basic set of requirements defined by any software application or operating system is physical computer i.e. hardware. Hardware specifications for this project are:

- Minimum 4 Gigabyte (GB) RAM (possession of graphic card is also beneficial)
- Minimum 8 Megapixel (MP) resolution camera
- Any USB cable (transfer of images)
- 40 MB Memory space (approximate value)

B. Software Requirements

These involved all software pre requisites and packages need to be installed on computer to provide optimal functioning of any application. Software requirements required for this project are:

- Python 3.6
- Anaconda3
- Visual Studio Code
- SQL Lite Studio

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- Google Colab (if processing power of hardware system is low)

VI. SYSTEM EVALUATION

Raw datasets are manually divided into training sets and test sets with splitting ratio 0.8 and 0.2 respectively with six probable different outcomes (i.e. specific diseases associated with Tomato crop yield). All pictures that are undergoing are resized into 264*264. Google Colab is used for training of data due to high GPU (Graphical Processing Unit) power and 'Tesla T4' which is famous server to be used among data scientists is also used here for its processing power. 25 Epochs are iterated during entire training of model and 97 percent accuracy rate is achieved during same. Here are result of accuracy and data which is lost during process:

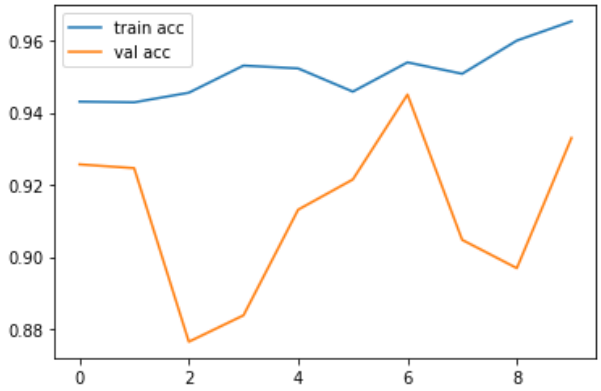

Fig. 6. Accuracy of system

Model is deployed with help of Flask server (many other E-commerce organizations use services like Microsoft Azure, AWS, etc. which are paid unlike Flask) along with simple interface to upload input image (which must be of size 264*264) and most probable output will be predicted by system and shown in form of text. All outputs except 'Healthy Plant' will lead to E-commerce site known as 'Krushisupport.com' and all suggested fungicides or pesticides according to type of disease are available to be bought.

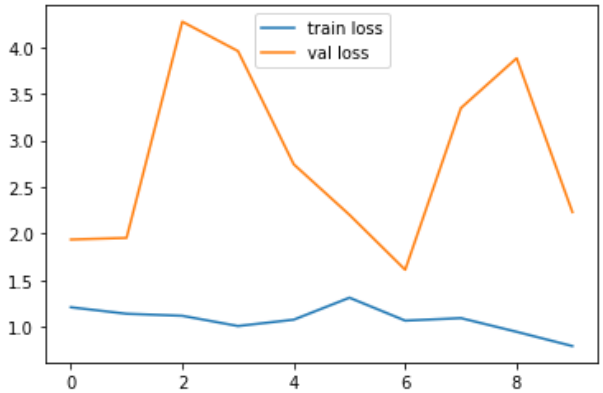

Fig. 7. Loss of system

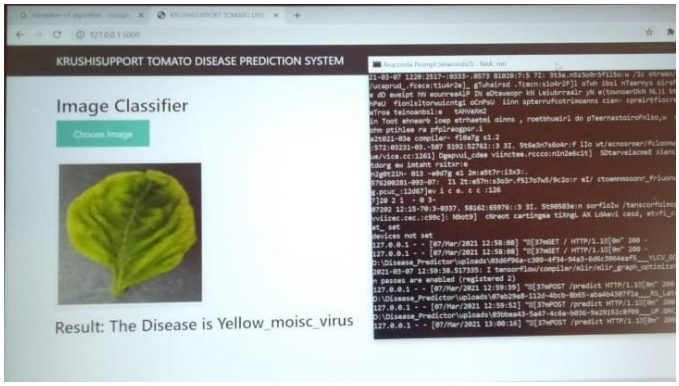

Fig. 8. Successful prediction of one of the disease affected Tomato plant

Fig. 9. E-shopping application for pesticide and fungicide suggestion and purchase

VII. CONCLUSION

To predict the disease for 'Tomato' crop yield, dataset of diseased leaves are taken from Kaggle environment in 6 type of attributes (6 different diseases). Prediction of disease for Tomato crop yield is achieved (Fig. 8) with accuracy of 97 percentage with help of classification algorithm in machine learning concept. Web application (Fig. 9) for smart suggestion and direct purchase of related pesticide is developed to get quick and right solution for respective plant disease. Model using Inception V3 algorithm using Transfer learning along with accuracy and loss of data plots given in fig.6 and fig.7 respectively. This small scale E-commerce system could help decrease in pricing of pesticides and helps farmers getting more profit which surely lead to decrease in the suicide rates between them.

Future Action:

- In future, one possibility is spreading the use of model by training it for distorted images captured from distance and on wider land areas, which could be achieved by using planes or drones with advanced object detection algorithms and very high definition camera.
- Same system could be used for different crops if datasets attributes are similar to tomato family of plant or on any plant with slight changes in architecture of system.
- Online shopping website for farming essentials, where farmers get solution according to our system predictions along with other necessary things for farmers like Agricultural equipment, organic seeds, etc. without any mediator involved.

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- This will help creating datasets for further use of technology in the era where 'Data is Gold.'
- With further research on this topic, helpful impact on the sustainable development can be achieved thereby improving crop yield quality for next generations.

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