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AN IOT BASED PLANT LEAF DISEASE DETECTION USING MACHINE LEARNING AND AUTO SPRAYING MECHANISM

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Abstract:

Our Indian agricultural farming takes part a major function in area of producing crops or yield of the crops. Most of the people rely on agriculture for their sustainance in the world since the agriculture is the base for the development of economy in a country. This field of land farming provides various employment and job opportunities to major percentage of the people. The healthy or the unhealthy condition of the plants plays an important role in order to earn better profit for the agricultural people. This can be achieved by the continuous observing the condition of the plant health which is needed at various stages of plant growth because to prevent several number of diseases that affects plants while growing. This existence of diseases and pests may affect the act of judging the crop cultivation and has the ability to minimize the yield of crop essentially. Nowadays the system depends on naked eyes monitoring which is considered be a time taking process. Hence, there is a need for the automatic identification of plant diseases that can be adopted to identify the plant disease maximum at the beginning itself. So many number of disease tracking strategies are introduced by the farmers at the continuous intervals of times in order to eradicate the plant diseases. This automated disease identification and prevention system has been introduced by merging the advantages of IOT agricultural land monitoring system and some of the Machine Learning algorithm. We can also use variousIOT sensing devices such as thermal reading sensor, moisture sensor including color sensors depends on the difference withthe leaves case of the plants where the values that depends on temperature sensor, humidity sensor and color parameters thatare used to detect the presence of plant diseases and prevented using the automatic medicine spraying process.

Keywords: Machine learning, SVM algorithm, Convolutional Neural Network, feature extraction, segmentation, disease identification, disease prevention, auto spraying, classifying disease, insecticides, fungicides

INTRODUCTION

Our Indian agricultural farming takes part a major function in area of producing crops or yield of the crops. Most of the people rely on agriculture for their sustainance in the world since the agriculture is the base for the development of economy in a country. This field of land farming provides various employment and job opportunities to major percentage of the people[1][2].

Thehealthy or the unhealthy condition of the plants plays an important role in order to earn better profit for the agricultural people. This can be achieved by the continuous observing the condition of the plant health which is needed at various stages of plantgrowth because to prevent several number of diseases that affects plants while growing. This existence of diseases and pestsmay affect the act of judging the crop cultivation and has the ability to minimize the yield of crop essentially[3][4].

Nowadays thesystem depends on naked eyes monitoring which is considered be a time taking process. Hence, there is a need for theautomatic identification of plant diseases that can be adopted to identify the plant disease maximum at the beginning itself[5]. Somany number of disease tracking strategies are introduced by the farmers at the continuous intervals of times in order to eradicate the plant diseases[6].

This automated disease identification and prevention system has been introduced by merging theadvantages of IOT agricultural land monitoring system and some of the Machine Learning algorithm[7][8][9].

We can also use variousIOT sensing devices such as thermal reading sensor, moisture sensor including color sensors depends on the difference withthe leaves case of the plants where the values that depends on temperature sensor, humidity sensor and color

parameters thatare used to detect the presence of plant diseases and prevented using the automatic medicine spraying process[10].

LEAF DISEASE SYMPTOMS:

The plants leaf majorly suffering from the micro organisms such as bacteria's, fungus and viruses. These symptoms of various types of diseases may be visibleto the naked eyes to the farmers from the disease affected plants. Symptoms may appears in the form of a identifiable changes in the colour, normal shape or the proper functioning of the plant such as

photosynthesis due to the diseases caused by these organisms. Hence, we can discuss those plant symptoms in a detail manner[11][12].

Various types of the fungal diseases may appear in the plants such as tiny, yellowish green lesions on young leaves are symptoms which normally seen as the dark foliages in the plants.These disease causing fungus may cause most serious disease in the various types of the vegetable plants. This fungal disease may even affect the flowers, vegetables, fruits, stem and the roots of the plant[13][14][15].

2 Related work (or) lnferenceFromtheSurvey:

In reference to the above plant disease prediction and prevention , we have conducted a survey on how these plant diseases occurs in a plant leaf under which circumstances, based on the available set of datasets with the help of the python programming language using the healthy and the unhealthy set of leaves[16].

In the early stages of the agricultural pest detection, mainly various types of supervised and unsupervised learning methodologies had been utilized in the purpose of the identification of the leaf infections[17][18]. There are some of the general steps that all the systems follows where pictures are gathered with the help of the modernized cameras and after these collected images are preprocessed by using some of the available preprocessing techniques[19].

Further the people who are known to be the experts, they extract the features from the above preprocessed pictures and those features are provided as inputs to the classifying system. Here, the accuracy of the classification depends on the type of the technique used for feature extraction[20]. But it is quite complex and the time consuming process.

In these days, the Convolutional Neural Networks or the CNN model posses a major role in the process of the image segmentation and the classification because to improve the classification accuracy[21][22]. The CNN networks can automatically learn the features and be classified within the less amount of the time. Here are the some of the recent trends and discussions by utilizing Convolutional Neural network and the machine learning techniques for the farming applications[23][24].

In the referenced papers, various authors proposed various CNN network models to identify and classify the various or the distinct number of infections affected because of the tomato leaves, apple leaves, cucumber leaves, grape leaves, potato leaves and other leaves also. There are three commonly occurring diseases are bacterial diseases, viral and the fungalinfections. All their different diseases are captured separately and stored as the images, whenever required, they are provided as the input to the designed CNN model , processed and finally evaluated whether the leaf is the healthy leaf or not[25].

3 Algorithm:

The objective of this algorithm is to recognize abnormalities that occur on plants in their greenhouses or natural environment The objective of this algorithm is to recognize abnormalities that occur on plants in their greenhouses or natural environment. The Machine learning algorithms are the engines of machine learning, meaning it's the algorithms that turn a data set into a model that depends on the kind of problem we are solving, the computing resources available, and the nature of the data. The objective

of this algorithm is to recognize abnormalities that occur on plants in their greenhouses or natural environment. The algorithm was contrasted with other machine learning models for accuracy. The accuracy can be increased when trained with vast number of images and by using other local features together with the global features.

Algorithm In Brief - SVM(SupportVectorMachine):

Supportvector machines(SVM)were the kindof supervisedML algorithmsthat is mainly usedfor both classification or regression challenges in the real world problems which analyzes the datausedfor classification. However it is mostly used for the classification problems. Support vector machine can also solve linear and non-linear problems and work well for many real world practical problems .

Support vectors are simply the co-ordinates of the individual observation.A support vector machine takes the data points and outputs the hyperplane which is in two dimensions or it's simply a line that best separates the tags.

This is the decision boundary: anything that falls to one side of it we will classify as blue and anything that falls to the other end is specified as red color.

Itcansolverealworldproblemsandworkwellformanypracticalproblemssincetheidea ofSVMissimple. This simplicity is shown below in figure 3.1.

Figure3.1LeafDiseaseClassification

In developing the successful SVM forecaster, feature extraction is the very important and the first step. The features are determined as shown in the following figure 3.2:

Figure3.2FeatureExtraction

AdvantagesofSVMAlgorithm:

1. HighAccuracyrates.
2. Fullyautomated.
3. Securitylevelcanbeimproved.
4. ReductioninComputationalComplexity.
5. CodeanbewritteninPython.

4 COMMONLYOCCURRINGPLANTDISEASES:

a) BACTERIALDISEASESYMPTOMS:

Thediseaseisnamed "bacterialleaftinypointsontheleaves" as shown in the below figure 4.1.Varioustypesofthebacterialdiseases may appear in the plants such as tiny, yellowish green lesions on the budding leaves are symptomsthat are normally observed as the dark foliages in the plants. These disease causing bacterias may causemost serious disease in the various types of the vegetable plants.These diseases

an be treatedusingvarioustypesofpestcontrolchemicalsthatarementionedin theupcomingsolutionsforthetreatmentofthediseases.

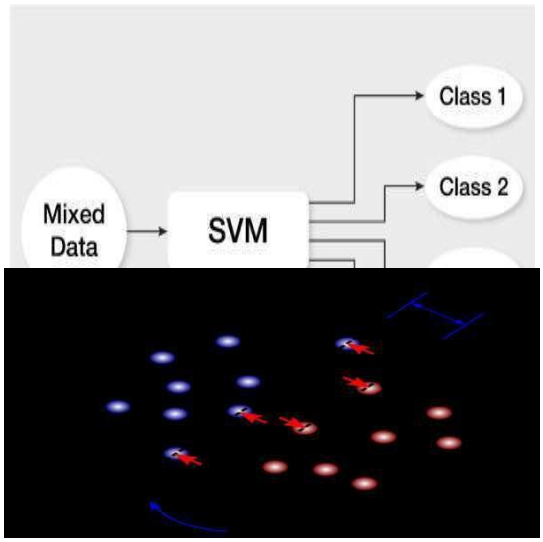


Figure4.1BacterialLeafdisease

b) VIRALDISEASESYMPTOMS:

Many of the viruses that causes the viral diseases may be identified by the farmers through thenaked eyes by the farmers. But when it is not treated properly while the disease affects the plantswhich may leads to serious damages to the entire agricultural field. These viruses can be foundnot only in the leaves but also in the stems, fruits, vegetables even in the roots and flowers. Themodernagriculturalpracticesmaybeusedt otreattheseviraldiseasesasmuchaspossible. Some of the viral diseases are shown in the below figure 4.2

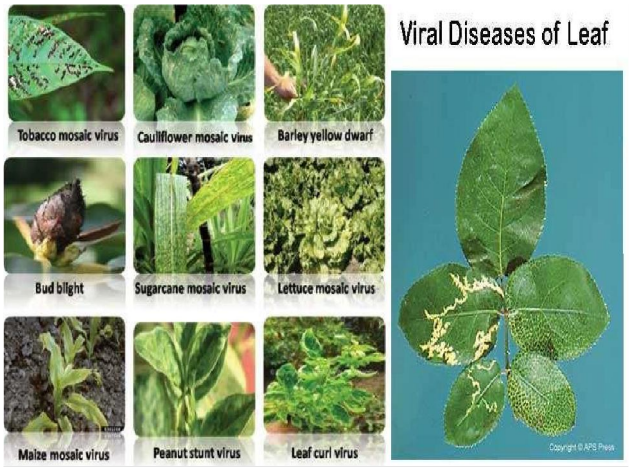


Figure4.2ViralLeafdiseases

c) *FUNGALDISEASESYMPTOMS:*

Varioustypes ofthe fungal diseases mayappear in the plants such as tiny, yellow is hgreen lesions leaf's which are the symptomsthatnormallyobserved by the dark foliages in the plants. These disease causing fungus may cause most serious disease in the various types of the vegetable plants.Thisfungaldiseasemayevenaf fecttheflowers,vegetables,fruits,ste mandtherootsoftheplants as represented in the below figure 4.3.

Figure4.3FungalLeafdiseases

TypesOfInfectiousDiseases And Chemicals To Prevent:

There are number of very commonly occurring plant diseases, symptoms and the preventive measures to be taken to take care of the plants from these diseases are discussed below in detail with the help of the different points and also the table.

1) LOCALIZED SYMPTOMS are congested to a specialized part of an organ or parts of plant(example,leafspotsandanthracnoseaffectedbyvariedorganisms).
2) SYSTEMIC SYMPTOMS arethe organisms that spreads from a affected part (example,.downymildews).
3) ENDEMICSYMPTOMScan be found in a specific state or region. This infections mayexistineitheror otherformina particularregion.
4) EPIDEMICOR EPIPHYTOTICsymptoms occurs in huge area, but periodically can alsobefoundcommonlyinthelocalregions.
5) NON-INFECTIOUS (ABIOTIC) symptoms where these are nutritional imbalancing of theplantsforexamplethecommonlyoccurringKairadiseaseofriceduetoZincnutrition,uncomfortableecosystemexamplecropwilt.
6) POLYCYCLICSYMPTOMSmay have quite the plants during a crop yielding months.Exampleis:potatoblight.
7) MONOCYCLIC SYMPTOMSS may rise of the analogous of improvement in money thanksto interests i.e. these infections that might had existing generation on the yielding season. forexample,wheatsmut.
8) SPORADIC SYMPTOMSwere the one that occurs at common intervals during a mediumtohighriskformi.e.,plantblights,leafwilt.
9) PANDEMICSYMPTOMSleadstohugeloss.

5 GENERAL SYMPTOMS OF PLANTDISEASES:

S.NO	Name of the Disease	Type of the Disease	About Disease	Example
1.	**Mildew**:	**Fungal Disease**	these are the commonly occurring disease in the plants during the winter seasons of the climatic conditions	
2.	**Plant Rusts**:	**Fungal and Bacterial Disease**	These are the commonly occurring bacterial disease that are found	

			similar to that how a iron rod gets rutsed due to the varible climatic conditions.	
3.	**Leaf Smuts**:	**Fungal Disease**	This disease is found in the areas where the agricultural field is dense rich since the sunlight does not enter inside the ground that much easier.	
4.	**Scab leaves**:	**Fungal Disease**	This disease is found in the leaves during the crop yielding period.	
5.	**Plant Blotch**:	**Fungal disease**	Due to the over usage of the fertilizer s, the these viral disease affects the plants.	
6.	**Tar leaf spots**:	**Fungal Disease**	It is seen by the naked eyes by the farmers since it looks the big size	

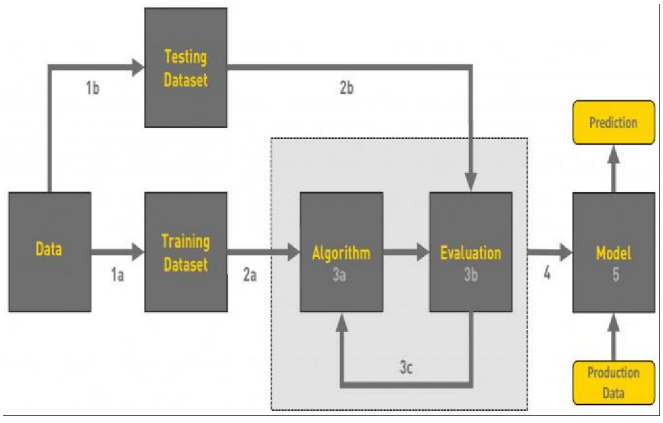
			lesions when the human burn into the fire.	
7.	**Chloro sis**:	**Viral Disease**	This is one of the commonly occurringviral disease that can appear as the brownis spots in the plant.	

6

PROPOSED METHODOLOGY:

In our Proposed methodology "Disease detection with Auto-Spraying Mechanism (DD-ASM)", after the plant disease is detected or identified, an auto spraying mechanism is implemented which is resposible for providing the medicines for their respective diseases. Though there are different traditional methods for identification of plant leaf disease, the key to decrease agriculture loss is detection and cure of plant disease. In our proposed method we are using the Support Vector Machine algorithm which is used to classify the features in efficient manner. Also, by our method, the infected or diseased parts of the plant leaf can be segregated and the respective solution is provided to cure that part of plant.The accuracy can be increased when trained with vast number of images and by using other local features together with the global features.

CONVOLUTIONAL NEURAL NETWORKS:



In leaf disease detection, various classifiers are used to classify the disease of data. The classification is based on healthy and affected/diseased leaf or other parts of plant.

The Detection and Prevention to these infections of a herb will be the major requirement of the farming and cultivating people. So these diseases should be identified and treated in the early stages as soon as possible, so that it results in prevention or protection of the other plants from this risk factor.

• The primary aim of our project will be motivated to manufacture an automated device that implements both detection or finding and prevention of these diseases that occurs to the plants of the agricultural fields. This system will be effective and very useful for the farmers purposely older people who work in the agricultural lands.

• To identify and determine the unhealthy parts of the plant leaves using image features.

• Test for the leaf infection.

• The examined information should be forwarded to the farmer for the prevention of other plants from the infection.

• Develop an new application with the help of android development and embed with the IoT.

A. Problem Detection:

A major cause in the EXISTING system was that these bacterial, fungal, viral diseases are mostly judged by their naked eyes of farmers based on their experience. Many times, these diseases may be either identified or diagnosed wrong. A cause of infection may be have a visibility effects of disease on the plant. Thus infections also include a identifiable transformation in the color, shapes or functions or an texture of the plant leaf because it reflects to the micro organsims. Leaves wilting may be a common infection that is a result by the fungal plant pathogens Verticilliumalbo-atrum and V. dahliae.

B. Identification of Plant Infections:

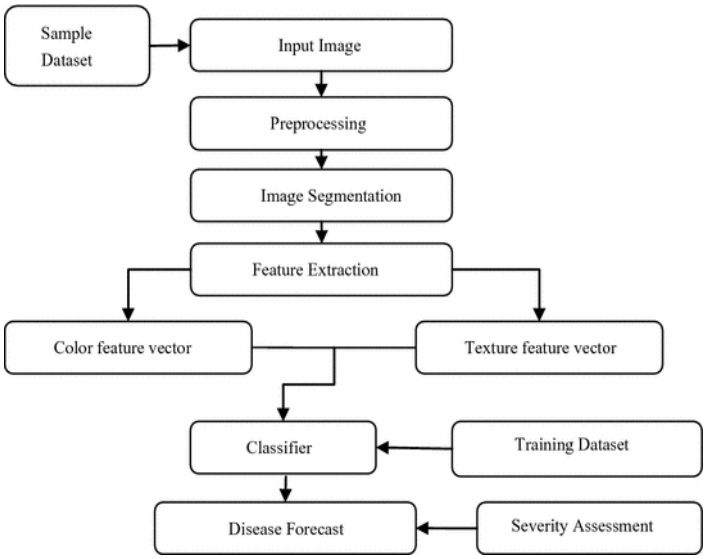
Infections that are seen on herbs are detected based on the colourpoints , streaks on leaves, stems and seeds. So disease progresses is identified based on the the visual infections because they may increases.

ARCHITECTURALDIAGRAM:

Plant leaf disease detection includes some basic step of image processing to detect & classify plant leaf disease.

1) Image acquisition
2) Image pre-processing
3) Image segmentation
4) Feature extraction
5) Training the designed model
6) Classification
7) leaf disease detection
8) Testing the model
9) Evaluation

Theoverallarchitectureofourplantdiseasedetectionsystemisrepresentedbelow figure 6.1:



The testing and training are the two important processes of a machine learning project. Whenever a model is designed using the machine learning algorithm the model should be first trained using all the number of datasets available. And in the similar way, the trained system is tested with some number of datasets that are already trained using the datasets. The steps or process of the testing and training is shown below:

1) Data is the images that can be given as the inputto the systemto processthe images and classifyasthehealthyortheunhealthyleafofthplant.
2) The training of dataset is the one that "teaches" an algorithm to recognize patterns in a dataset,fromthepreviousetofdatas.
3) The next step is thetesting of the collected dataset by the means of the process of a test (orvalidation)in order ntoexaminethemodel.
4) Evaluation is an important process in the testing and training of the dataset of the machine ofthe proposed system. Once the system is trained then the input data sets are given and the systemisevaluatedbasedonthetraining.
5) Predicting is an important reading strategy that allows the students who are doing the projectthatmayhappensbasedontheprevious knowledgeofthe dataset.

ProblemIdentification:

The problem in existing system is that the diseases are mostly judged by experience of farmers.Manytimesthe diseaseiseitherdetectedor diagnosedwrong.

IdentificationOfPlantDiseases:

Diseasesin plants are identifiedbasedon the symptomssuch as color spots on leaves,streakson leaves, stem and seeds. As disease progresses it is indicated by the visual symptoms as theyincrease.In leaf disease identification, different number of variable classifiers were engaged to findvarious numbers of diseases of datasets. This classification mechanism depends on healthy andunhealthyleafbasedonthevariousclassifieralgorithmsandotherpointsoftheherb. The below figure or the diagram shows the identification of the diseased image using the naked eyes. But after giving this image into the system, it

processes many steps as represented in the below figure 6.3:

Figure 6.3 Disease Identification

7 MODULEDESCRIPTION:

a. *Image Acquisition :*The first stage of any vision system is the image acquisition as shown in the below figure 7.1. Image acquisition involves the steps to obtain the plant leaf and captured the high quality images through the camera. InImageacquisition,theinputdatasarebeinggatheredImages are acquired from the internet or agriculture field. The efficiency of the concept depends upon the quality of database images. This image is in RGB (Red, Green, and Blue) form.

b. *Image Pre-Processing :*Image pre-processing involves the steps of image enhancement, RGB to Lab conversion, filtering etc. Here, image enhancement is carried out for increasing the contrast. Image smoothing is done using the

filtering techniques. There are different types of filtering techniques available in image processing like median filter, average filter, Gaussian filter etc. Inimagepreprocessing,theacquiredimageisprocessedandconvertedintotheRGBscale images as shown in the following figure 7.2

figure 7.2 *Image Pre-Processing*

c)Image Segmentation :

Image segmentation means partitioning of image into various parts of same features or having some similarity. The segmentation can be done using various methods like otsu' method, k-means clustering, converting RGB image into HIS model etc. The K-means clustering is used for classification of object based on a set of features into K number of classes. The classification of object is done by

minimizing the sum of the squares of the distance between the object and the corresponding cluster. In image Segmentation figure 7.3, the image is split into different parts having similar features calledimagegesture

.

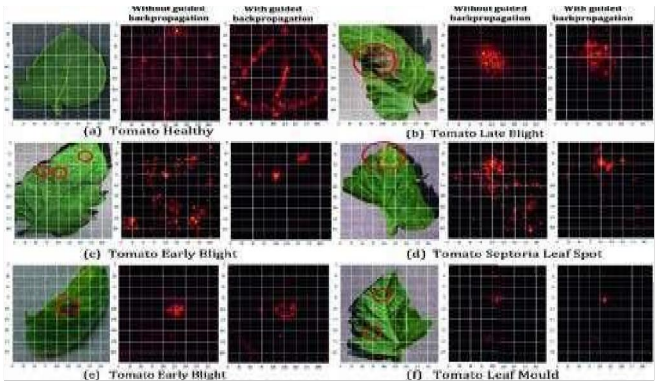


Figure 7.3ImageSegmentation

D.Feature Extraction :

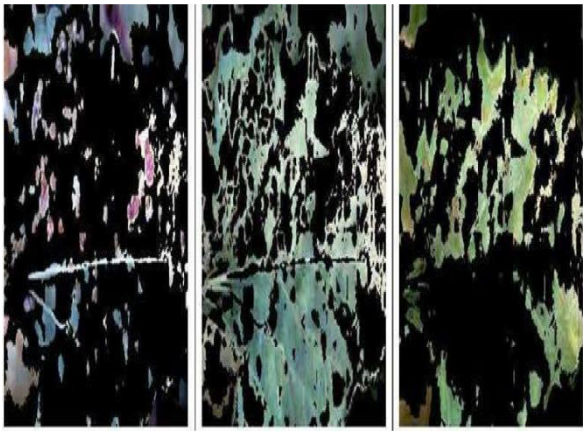
Features are parts or patterns of an image that help to identify the proportions. ColourGradientHistogram:This is the commonly used methodology that mainly focusses on the primary colour gradientssuch as RED, BLUE, GREEN values of the images that is being observed from the datasets oftheplantleaves.

E.Training the model:

The important process of the machine learning process is the training and testing the designed AI system with better performance and the expected output from the trained system. In order to train the AI model through the machine learning algorithms required or specified set of processes should be carried out that involves the acquiring training data with the help of the particular algorithm, validation of the model and implementation to verify and validate with the real time use.

F. Classification & Detection of Diseases :

Finally, classifiers are used for the training and testing of the datasets. These classifiers may support vector machine (SVM), k-nearest



neighbour, neural network, fuzzy logic based etc. These methods are used to classify and detect the leaf diseases. The classification playsan importantrole in theimage separationpart.Here we use a famoussupervisedmachinelearningclassificationalgorithmcalledsupportvectormachines. It is shown in the following figure 7.4

Figure7.4Classificationofhealthyandunhealthyleaf

G. Testing the input data:

Once the model is trained with the right(chosen) algorithm, the system is exposed to the outside environment. But testing the designed model with AI model or AI framework is somewhat complex. Though, it follows many steps used during the functional testing mechanisms such as learning from the various resources or the data sources, input data conditioning, machine learning and analytics, visualization and finally the feedback about the output from the system.

H. Evaluation of the output:

The important process in the machine learning is the evaluation of the output. This may be carried out by having the comparison of the our system i.e the designed system output with the other systems output by comparing the three

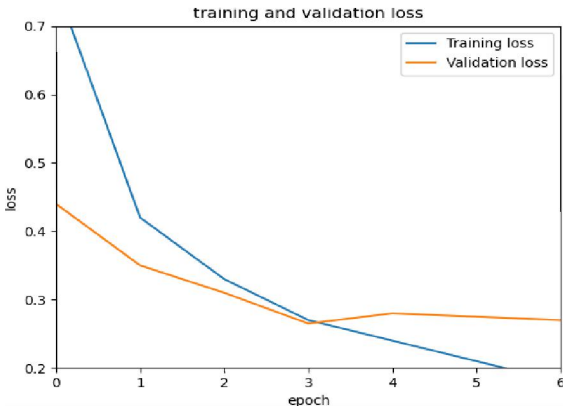
major metrics such as the accuracy, precision and recall where the accuracy of the system plays the vital role than other metrics. Here accuracy is defined as the percentage or the measurement of the number of correct predictions for the test data.

8 Experimental Results and Discussion:

Though there are different traditional methods for identification of plant leaf disease, the key to decrease agriculture loss is detection and cure of plant disease. This study shows the key features and the importance of the plant disease recognition, identification, prevention these days. In our proposed method we are using the Support Vector Machine algorithm which is used to classify the features in efficient manner. Also, in this work we have used the convolution neural network model for the testing, training and validating the input provided by the user to the system and by our method, the infected or diseased parts of the plant leaf can be segregated and the respective solution is provided to cure that part of plant.

The below mentioned are the some of the village datasets available for our project work which are used for testing and training the neural network model.

The accuracy of the system can be increased when trained with vast number of images and by using other local features together with the global features. Here we have used 10 the total number of epochs in which 20% of the images from the plant dataset of the village awere used to test the accuracy of this model. In every class, 20% of the images were randomly selected for testing purpose. The testing dataset gives more than 96% accuracy which means, if 100 images are inputted then 95 images were classified correctly. When the training dataset is increased and the epochs, the epochs the accuracy is also increased and finally at the 6th epoch, the designed network model gives the highest accuracy.

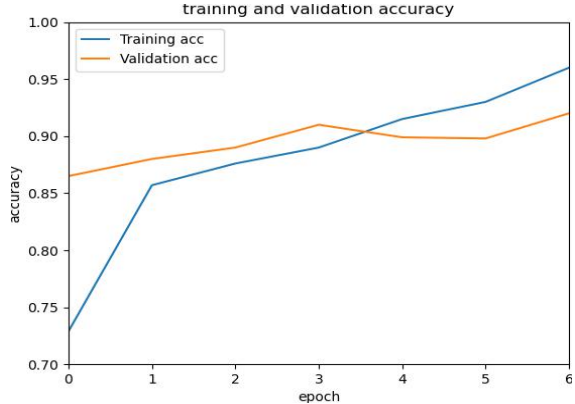


The accuracy and the loss for both training and validation graphs generated by the model are shown below. With Every sickness having differing side effects, from the leaves, stem and root of the plant. This method may help the agriculturists in IDENTIFYING AND CURING of the infection in the leaf in plausible and precise path, in brief time traverse.

Training and validation Accuracy:

The below web page that contains the GUI for the leaf disease detection using OpenCV where a button is available named “browse image” for uploading the image from the available Village datasets.

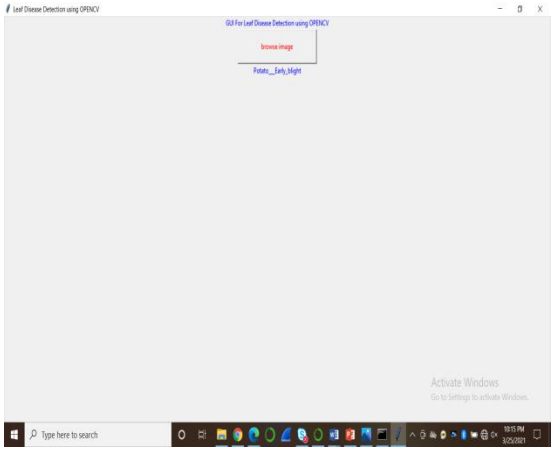
The pictures may be downloaded and



uploaded form the web and even the images that are captured by the normal camera also.

Name of the Method	% of Accuracy
Proposed Method (SVM & CNN)	96%
Supervised algorithm and Fuzzy sets	95.17%
Feed Forward Neural Network	94.89%
K means and Neural network	93%
ANN	91%

The colour images are considered and the images should be in the .jpg format. Once the image is succesfully uploaded, then the below will be the result showing the predictions of leaf disease affected to that plant or the health status of the leaf as an output.



Plant Health Prediction

9 Comparative Work:

The various comparative studies of our project with the different number of the machine algorithms are listed below in the form of the tabular represenetation. Further the performance evaluation are compared based on the algorithm specification with the performance evaluation.

10Conclusion

Agricultural farming is one of the most important sectors that provides a large number of human employment opportunities to many people and to the Indian economy. In order to yield food crops and natural plant products and also to have a raise in the economy of any country, there must be a prediction of diseases in the crops is very much important and need these days. The proposed system Disease detection with Auto-Spraying Mechanism (DD-ASM) the designed CNN model is used to classify the different plant diseases obtained from the Plant Village dataset. Also our proposed CNN model provides a very good solution to predict the various types of the plant diseases in the early stage itself. Also the additional benefit of our system is that once the disease is detected, it can be prevented based on the auto spraying mechanism. The pesticides, fungicides, insecticides are auto sprayed on the respective plant leaves with the corresponding chemicals.

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