Plant Disease Detection using Deep Learning

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***Abstract* –The global rise in population has led to a shortage of raw materials and food supplies. The agricultural sector has become the primary and most vital source to overcome this particular constraint. However, the industry itself is facing the challenge of pests and various cropdiseases. Battling this has been the significant focus of the sector for decades. Still, due to the technology gap that existed earlier, there existed a constraint on identifying the diseased cropson a massive scale. Nevertheless, today, with the improvement of technologies such as drones, IoT devices, and higher processing speeds combined with data analysis and machine learning, the problem of identification can be resolved quickly. The proposed model using CNN was trained using images from plant village dataset and attained an accuracy of 94.87% in identifying the diseased plants with the help of image processing by Tensorflow.**

Keywords: Plant disease detection, Tensor flow, Green house, Convolution neural network, Data model, image to byte code

I. INTRODUCTION

Identification of the plant diseases is the key to preventing the losses in the yield and quantity of the agricultural product. The studies of the plant diseases mean the studies of visually observable patterns seen on the plant. Health monitoring and disease detection on plant is very critical for sustainable agriculture. It is very difficult to monitor the plant diseases manually. It requires tremendous amount of work, expertize in the plant diseases, and also require the excessive processing time. Hence, image processing and Machine learning techniques are used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification.

Crop growth is basically determined by the climate variables in the environment and by the amounts of water and fertilizers that can be supplied by irrigation. Therefore, crop growth can be managed by controlling these variables. This makes a greenhouse ideal for growing crops because it is enclosed; and these variables can be manipulated for optimal plant growth and development.

Having ideal climatic conditions present in the greenhouse might be optimal for plant growth but they also favor the proliferation of pests and diseases. This is the case with the disease caused by the fungus Botrytis cinerea(i.e. Botrytis), which thrives on humidity in the air. The lack of ventilation in Mediterranean greenhouses means that condensation in production processes under plastic is ever-present and, consequently, can cause severe damage.

II. LITERATURE SURVEY

Deep learning is an artificial intelligence(AI) function that imitates the working of the human brain in processing data and creating patterns for use in decision making. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as deep neural learning or deep neural network. Deep Learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

Deep learning uses artificial neural networks to perform sophisticated computations on large amounts of data. It is a type of machine learning that works based on the structure an function of the human brain. Deep learning algorithms train machines by learning from examples. Industries such as health care, ecommerce, entertainment, and advertising commonly use deep learning. There are many models available in Deep learning ,model selection plays vital role. Few examples are: LSTM,RNN,CNN etc. Deep learning has evolved over the past five years, and deep learning algorithms have become widely popular in many industries. Deep learning algorithms train machines by learning from examples. Industries such as health care, eCommerce, entertainment, and advertising commonly use deep learning. While deep learning algorithms feature self-learning representations, they depend upon ANNs that mirror the way the brain computes information. During the training process, algorithms use unknown elements in the input distribution to extract features, group objects, and discover useful data patterns. Much like training machines for selflearning, this occurs at multiple levels, using the algorithms to build the models.

Deep Learning is a branch of artificial intelligence that uses data to enable machines **to** learn to perform tasks on their own. This technology is already live and used in automatic email reply predictions, virtual assistants, facial recognition systems, and selfdriving cars. Breakthroughs in this technology are also making an impact in the health care sector. Using these types of advanced analytics, we can provide better information to health care. The ability to process large numbers of features makes deep learning very powerful when dealing with unstructured data. However, deep learning algorithms can be overkill for less complex problems because they require access to a vast amount of data to be effective. If the data is too simple or incomplete, it is very easy for a deep learning model to become overfitted and fail to generalize well to new data. As a result, deep learning models are not as effective as other techniques (such as boosted decision trees or linear models) for most practical business problems such as understanding customer churn, detecting fraudulent transactions and other cases with smaller datasets and fewer features. In certain cases like multiclass classification, deep learning can work for smaller, structured datasets.

The commercial crops have been segmented using grab-cut algorithm. Wavelet based feature extraction has been adopted using Mahalnobis distance and PNN as classifiers with an overall average accuracy of 84.825%.

The cereal crops have been segmented using k-means clustering and canny edge detector. Colour, shape, texture, colour texture and random transform features have been extracted. SVM and nearest neighbour classifiers used getting an overall average accuracy of 83.72%.A chilli plant leaf image and processed to determine the health status of the chilli plant. Their technique is ensuring that the Chemicals should apply to the diseased chilli plant only. They used the MATLAB for the feature extraction and image recognition. In this paper pre-processing is done using the.

Fourier filtering, edge detection and morphological operations. Computer vision extends the image processing paradigm for object classification. Here digital camera is used for the image Capturing and LABVIEW software tool to build the GUI[7].

The FPGA and DSP based system is developed and used for monitoring and control of plant diseases . The FPGA is used to get the field plant image or video data for monitoring and diagnosis.

The DSP TMS320DM642 is used to process and encode the video or image data. The nRF24L01 single chip 2.4 GHz radio transmitter is used for data transfer. It has two data compress and transmission method to meet user's different need and uses multi-channel wireless communication to lower the whole system cost.

III. METHODS OF DISEASE DETECTION

The process of plant disease detection system basically involves four phases as shown in Fig 3.1. The first phase involves acquisition of images either through digital camera and mobile phone or from web. The second phase segments the image into various numbers of clusters for which different techniques can be applied. Next phase contains feature extraction methods and the last phase is about the classification of diseases.

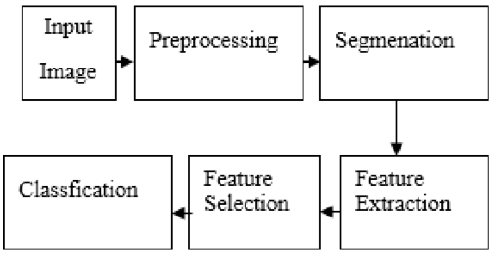


Fig.3.1 Phases of plant disease detection system

Image Acquisition

In this phase, images of plant leaves are gathered using digital media like camera, mobile phones etc. with desired resolution and size. The images can also be taken from web.

The formation of database of images is completely dependent on the application system developer. The image database is responsible for better efficiency of the classifier in the last phase of the detection system.

Image Segmentation

This phase aims at simplifying the representation of an image such that it becomes more meaningful and easier to
Analyze. As the premise of feature extraction, this phase is also the fundamental approach of image processing.

There are various methods using which images can be segmented such as k-means clustering, Otsu's algorithm and thresholding etc. The k-means clustering classifies objects or pixels based on a set of features into K number of classes. The classification is done by minimizing the sum of squares of distances between the objects and their corresponding clusters.

Feature Extraction

Hence, in this step the features from this area of interest need to be extracted. These features are needed to determine the meaning of a sample image.

Features can be based on colour, shape, and texture. Recently, most of the researchers are intending to use texture features for detection of plant diseases. There are various methods of feature extraction that can be employed for developing the system such as gray-level co-occurrence matrix (GLCM), color cooccurrence method, spatial grey-level dependence matrix, and histogram based feature extraction. The GLCM method is a statistical method for texture classification.

Classification

The classification phase implies to determine if the input image is healthy or diseased. If the image is found to be diseased, some existing works have further classified it into a number of diseases. For classification, a software routine is required to be written in MATLAB, also referred to as classifier.

A number of classifiers have been used in the past few years by researchers such as k-nearest neighbour (KNN), support vector machines (SVM), artificial neural network(ANN), back propagation neural network (BPNN), Naïve Bayes and Decision tree classifiers.

The most commonly used classifier is found to be SVM. Every classifier has its advantages and disadvantages, SVM is simple to use and robust technique.

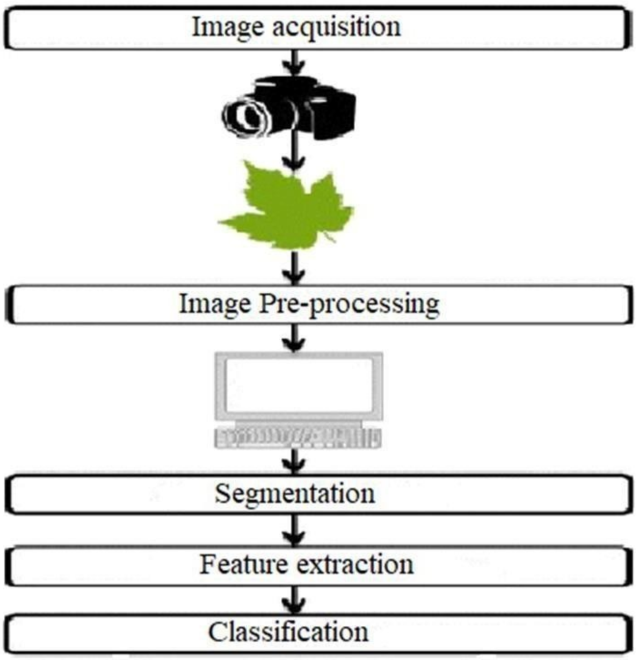
IV. OVERVIEW OF PLANT DISEASE

Plant diseases are generally caused by infectious agents such as fungi, bacteria, and viruses. Signs of plant disease are observable evidence of infection and symptoms are the visible effects of these kinds of disease. Fungal infections cause signs like visible spores, mildew, or mold and the basic symptoms are like leaf spot and yellowing.

Fungal diseases are plant infections caused by fungi. Fungi can be single or multicellular, but either way infect plants by stealing nutrients and breaking down tissue. Fungal diseases are the most common infection in plants. There are some characteristic symptoms, or observable effects of the disease, in plants.

Fungi infections can be recognized by symptoms like spots on plant leaves, yellowing of leaves, and birds-eye spots on berries. With some fungal diseases, the organism itself can actually be viewed on the leaves appear as a growth and as a mold,

These may a malformations on stems or the underside of leaves. These direct observations of the disease-causing organism are called signs of infection Bacteria are single-celled, prokaryotic organisms. Bacteria are everywhere and many can be beneficial, but some can cause disease both in humans and plants.



The signs of bacteria are often harder to detect than fungi, since bacteria are microscopic. Upon cutting an infected stem, a milky white substance may appear, called bacterial ooze. This is one sign of a bacterial infection. Other signs include water-soaked lesions, which are wet spots on leaves that ooze bacteria.

Eventually, as the disease progresses, the lesions enlarge and form reddish-brown spots on the leaves. A common symptom of bacterial infection is leaf spots or fruit spots. Unlike fungal spots, these are often contained by veins on the leaf.

Viruses are infectious particles that are too small to be detected by a light microscope. They invade host cells and hijack host machinery to force the host to make millions of copies of the virus.

Viral diseases don't show any signs in plants since viruses themselves cannot be seen even with a light microscope. However, there are symptoms that the trained eye can observe. A mosaic leaf pattern, yellowed, or crinkled leaves are all
characteristic of viral infection. This classic pattern of discoloration is where many plant viruses get their name, such as the tobacco mosaic virus. Also, decreased plant growth is also commonly seen in viral infections.

Fig 4.3 Leaf affected by virus

So, these are our observation on how to classify the various plant disease and how to be cautious about that.

V. PROPOSED SYSTEM

The main purpose of proposed system is to detect the diseases of plant leaves by using feature extraction methods where features such as shape, color, and texture are taken into consideration. Convolutional neural network (CNN), a machine learning technique is used in classifying the plant leaves into healthy or diseased and if it is a diseased plant leaf, CNN will give the name of that particular disease. Suggesting remedies for particular disease is made which will help in growing healthy plants and improve the productivity.First the images of various leaves are acquired using high resolution camera so as to get the better results & efficiency. Then image processing techniques are applied to these images to extract useful features which will be required for further analysis.
Proposed system have an end-to-end Android application with TFLite. Proposed system opted to develop an Android application that detects plant diseases. It has the algorithms and models to recognize species and diseases in the crop leaves by using Convolutional Neural Network. Proposed system use Colab to edit source code.

A dataset of 54,305 images of diseased and healthy plant leaves collected under controlled conditions Plant Village dataset. The images cover 14 species of crops, including: apple, blueberry, cherry, grape, orange, peach,pepper, potato, raspberry, soy, squash, strawberry and tomato. It contains images of 17 basic diseases, 4 bacterial diseases, 2 diseases caused by mold (oomycete), 2 viral diseases and 1 disease caused by a mite. 12 crop species also have healthy leaf images that are not visibly affected by disease. Our dataset contains solutions for several plant textures such as

1. Apple scab
2. Apple black rot
3. Apple cedar apple rust
4. Cherry including sour powdery mildew
5. Cherry including sour healthy
6. Corn maize cercospora leaf spot gray leaf spot
7. Corn maize common rust
8. Corn maize northern leaf blight
9. Corn maize healthy
10. Grape black rot
11. Grape esca black measles
12. Grape leaf blight isariopsis leaf spot
13. Grape healthy
14. Orange haunglongbing citrus greening
15. Peach bacterial spot
16. Peach healthy
17. Pepper bell bacterial spot
18. Pepper bell healthy
19. Potato early blight
20. Potato late blight
21. Squash powdery mildew
22. Strawberry leaf scorch
23. Tomato bacterial spot
24. Tomato early blight
25. Tomato late blight
26. Tomato leaf mold

27. Tomato septoria leaf spot
28. Tomato spider mites two spotted spider mite
29. Tomato target spot
30. Tomato yellow leaf curl virus
31. Tomato mosaic virus

Data generators that will read pictures in our source folders, convert them to `float32` tensors, and feed them (with their labels) to our network is set up.

As data that goes into neural networks should usually be normalized in some way to make it more amenable to processing by the network. In our case, we will pre-process our images by normalizing the pixel values to be in the `[0, 1]` range (originally all values are in the `[0, 255]` range). We will need to make sure the input data is resized to 224x224 pixels or 299x299 pixels as required by the networks. You have the choice to implement image augmentation or not.

Apart from just detecting the plant disease using the above methods our system directs the user to an e-commerce website. This website displays all the pesticides that are available for the detected disease with its MRP rate. Along with this the directions to use it is also available in the website. Thus by comparing the rate and features of the pesticides the user can purchase it

VI. RESULTS AND DISCUSSION

There two different conditions for training and testing. One is under the lab conditions, which means that the model is tested with the images from the same dataset from which it is used for both training and testing. The other condition is that field condition; this means that our model has tested with the images taken from the real world conditions (land). Since the lighting conditions and background properties of the images are totally different when we take samples from the real field, there is a chance that our model to produce a very low accuracy, when comparing to the accuracy values acquired during the lab conditions. So to overcome this impact, we had an idea of having a mixed variety of images during the training phase (heterogeneity).

Fig.6.1 Loss vs No.of epochs

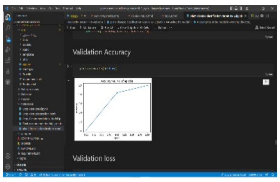


Fig.6.2 Accuracy vs No.of epochs

The accuracy of Real-time detection of apple leaf disease using deep learning approach based on improved convolution neural networks is less when compared to the proposed system because it detects multiple diseases in a single system.

Input (apple)	**Faster R-CNN**	**Proposed system**
Scab	58.82	70.82
Black rot	68.12	82.68
Cedar apple rust	90.34	94.96

VII. CONCLUSION

There are number of ways by which we can detect disease of plants and suggest remedies for them. Each has some pros as well as limitations .On one hand visual analysis is least expensive and simple method, it is not as efficient and reliable. Image processing is a technique which is most spoken for very high accuracy and least time consumption are major advantages offered. The applications of K-means clustering and Neural Networks (NNs) have been formulated for clustering and classification of diseases that effect on plant leaves. Recognizing the disease accurately and efficiently is mainly the purpose of the proposed approach. The experimental results indicate that the proposed approach is a valuable approach, which can significantly support an accurate detection of leaf diseases in a little computational effort. Alongside the supply of cultivation tools, the farmers also need access to accurate information that they can use for efficient crop management and there is no better way than providing them a service that they can use through the software.

The first convolutional layer filters the input image with 32 kernels of size 3x3. After max- pooling is applied, the output is given as an input for the second convolutional layer with 64 kernels of size 4x4. The last convolutional layer has 128 kernels of size 1x1 followed by a fully connected layer of 512 neurons. The output of this layer is given to Softmax function which produces a probability distribution of the four output classes

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