Survey of Plant Disease Detection Using Image Classification Techniques

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Abstract- **This paper presents an overview of various kinds of plant disease and different machine learning algorithms applied in farming fields for malady identifying. India positioning second in overall farm yields. As indicated by 2018, agribusiness section utilized more than 50% Indian manpower & contributed 18% to total national output. In India, cultivating is one of the significant sources of earning. Day by day increment of population results increment requirements and utilization of products of the soil. To meet the increase in demands the agriculture sector need a boost to increase the yield. In India agribusiness part is confronting serious issues because of deficiency of water, soil efficiency, common disaster, plant disease, bugs and so forth. Plant disease are a main consideration bringing about loss of yield. Early disease detection and effective adapted precautionary measures helps in keeping disease from spreading. Continuous observing of the plant by human expects can be costly for the farmers. Automated image recognition is done by utilizing distinctive AI algorithms for plant disease detection.**

Keywords: Computer vision, Digital image processing, CNN (Convolutional_Neural_Network, Machine learning Agriculture, Plant disease detection, Leaf.

I. INTRODUCTION

The agricultural lands and yields have been taking care of supplying feeding currently. Thus in field of cultivating, anticipation of infection in plants expect a critical activity. Farmers widely use pesticides to prevent the crops from disease, however sometimes it happens that the infection is not evenly spread across the field but occurs at some specific spots [1]. To distinguish these spots of disease in starting stage, use of computerized disease identification system proves useful. Automation in the field of agriculture is witnessing a great success in many agricultural aspects including detection of various plant diseases [2][3]. Focus of almost every country has shifted towards the automation of agriculture to attain preciseness and accuracy and to serve the continuously increasing demand of food. Among the major challenges in agriculture, plant disease detection is a significant factor affecting the outcome of farming.

Quality of vegetables, fruits, legumes and grains is affected by plant disease, and heavy loss in production and subsequently economic loses are observed, so there is requirement of fast and effective plant disease detection and assessment methods [3][4]. Experts do the manual procedure for plant illness detection. For larger farmlands, multiple experts are required, which would costs a lot. At the same time, in specific countries, farmers do not have appropriate fitting workplaces from which they can contact to experts.

The farmers have to contact experts from far away and cost a lot of fortune. To resolve this problem, the automatic disease detection technique winds up being important. Automated disease detection process is quite simple and less expansive then the manual disease detection. This furthermore supports image processing to give picture based customized process control, examination, and robot direction. [5]. Image classification techniques if utilized for disease detection gives results that are more accurate. This process proves to be the best approach to forestall the agribusiness setback.

Plant disease identification by visual way is increasingly difficult and simultaneously less accurate. However in the event that disease detection technique is used, it will take less time and processing power and proves to be progressively exact. Some broad maladies in plants appears dark coloured, yellow spots, and some are infectious, viral and bacterial diseases. Image processing is being used for estimation of infected area. Image segmentation is the process of collecting images into different parts. Now a day there are various strategies used for preforming image segmentation, stretching out from the fundamental thresh-holding procedure to forefront concealing picture division systems. Computers does not any special technique for intelligent objects recognition, so a great number of techniques have been developed. The segmentation procedure relies upon various features found in the image. This might be shading data, limits or fragment of an image.

I. Rechenberg first introduced evolutionary computing in the 1960s. Other researchers then took his idea forward. Some evolutionary changes might not appear much at first; however, they can have great impact in the survival of any species. Genetic algorithms is associated with evolutionary algorithms, which create solutions for optimization. The best-fit generation is used to create the next generation. This is done to ensure that the new generation will have more fitness then the previous. The best fir generation (parent) is selected to create the next generation (offspring) is chosen based upon the fitness of individual, the one with the most fitness have the most chances to form a new generation.

II. DISEASES ANALYSIS

Image analysis is done for the following purposes:

1. Detecting leaf, stem, and fruit diseases.
2. Quantify affected area.
3. Find the reason of affected area.
4. Determine the colour of the affected area
5. Determine size & shape of fruits.

Viral, bacterial and fungal disease mainly affect leaves. These symptoms are easily visible. These may include changes in colour, shape of the plant. Listed below are some symptoms for detection of pathogens in plants while growing:

A. Viral Disease Symptoms:

From all the plant diseases, those brought by infections are proves to be hard to diagnosis. There are no prior indication that can be continuously monitored and are confused as nutrient deficiencies or injury. Aphids, leafhoppers, whiteflies and cucumber creepy crawlies bugs are regular bearers of this sickness.

Fig. 1. Viral disease

B. Bacterial Disease Symptoms:

Pathogenic microbes cause serious illnesses in vegetables. They do not infiltrate straightforwardly into plant tissue yet need to enter through injuries or from plant openings. Wounds on plants can be result from bugs, different pathogens, and farming tools during various tasks, for example, pruning and picking.
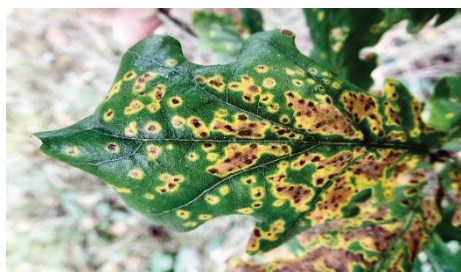

Fig. 2. Bacterial disease

C. Fungal Disease Symptoms :

Plant leaf diseases are caused by fungus, for example Late blight. It initially shows up on lower, old leaves, which are water-drenched or have grey-green spots. At the point when parasitic disease matures, these spots becomes dark and result in growth of fungus on them.
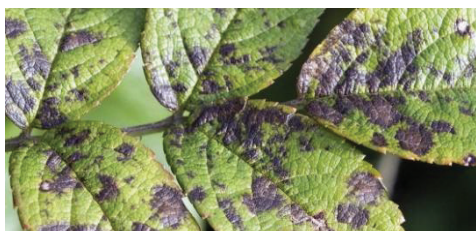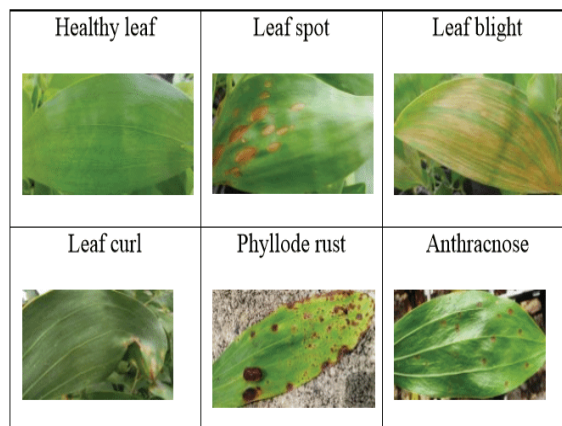

Fig. 3. Fungal disease

Fig. 4. Various plant disease

III. GENERAL METHODOLOGY

The general steps involved in various image-processing techniques are:

1. Acquisition of image
2. Pre-processing of image
3. Segmentation of image
4. Feature extraction from image
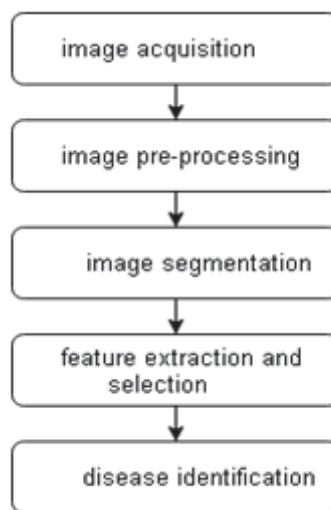5. Disease identification in image

Fig. 5. Image-processing methodology

A. Image acquisition

Is termed as a process of a carefully encoded representation of the visual attributes of an item, for example, a physical scene or the inside structure of an object.

B. Image pre-processing

In software engineering, digital image processing utilizes an advanced computer to process digital pictures through an algorithm. Being a subcategory of advanced signal processing, digital image processing have various advantages over simple image processing.

C. Image segmentation

In digital picture processing and computer vision, picture segmentation is the way toward dividing an advanced picture into various fragments. The objective of division is to simplify as well as change the structure of a picture into

1340

something that is progressively meaningful and simpler to process.

D. Feature extraction and selection

In AI, pattern recognition and in picture processing, feature extraction begins from an underlying arrangement of estimated information and manufactures inferred features planned to be informational and non-repetitive, encouraging the subsequent learning and generalization steps.

E. Disease identification

This step involves using the different machine-learning algorithm for successful prediction and classification of plant disease.

IV. LITERATURE REVIEW

D. Moshou *et al* in [1] developed a real time sensing system for plant disease detection in arable (land suitable for growing crops) crops in an early stage. They achieved this through sensor fusion and fluorescence imaging. Used for testing disease detection model of winter wheat the yellow rust (Puccinia striiformis). In this model, images were taken with ambient light and imaging spectrograph. Using the model, they were able to detect infected plants.

In [2] S. Sankaran present a review on different techniques for disease detection. After the study they come to a recognition of developing a rapid, cost-efficient model for plant disease detection would facilitate advancements in agriculture. These techniques includes different methods such as spectroscopic, imaging-based, and volatile profiling-based plant disease detection.

A. Mahlein in [3] outlines recent insights of disease detection by the use of non-invasive optical sensor. This also helps in identification and qualification of the disease. Near range and remote sensing techniques can be used for detection of disease in plants as they demonstrate a high potential classification, identification and monitoring crops. Most efficient sensors for the process are thermography, chlorophyll fluorescence and hyper spectral sensors. For getting a higher accuracy in disease detection, it is recommended to use an imaging system over a non-imaging system.

In [5] M. Jhuria developed a technique for fruit grading and disease detection. They used image processing for monitoring the development of disease on fruits from the plantation to the harvesting of the fruits. This image processing technique make use of artficial neural netork. The proposed technique make use of back propogation for the purpose of weight adjustment of training dataset. Using the proposed methodology they were able to get a 90% correct predictions from vectors morpphology feature. Implementation of the algorithm was done using matlab.

In [7] S. Bankar propose a plant disease detection technique. This technique make use of color detcton, edge detection and histogram matching for effective plant disease detection. Content Based Image Retrievl is mailny concerned with acuurate plant disease detection and is most significant in plant disease identification. They describe a effective, sample technique. The process is done in following two steps. First step include training of dataser and second step include prediction and generating results. They were able to correctly detect plant disease.

E. Omrani *et al* [8] discuss about potential of radial basis function-based support vector regression. They are trying to detect different disease, which appear on apple leaf. These are alternaria, apple black spot, and apple leaf miner pest. In this paper, they used image processing. Through this paper, they present different soft-computing approach related to ANN and support vector machines, which are helpful in detecting the disease. They used k-means clustering for detection of infection on the plant leaves. They concluded that support vector approach generates better results than artificial neural network.

F. Martinelli *et al* in [9] proposed an advanced technique for plant disease identification dependent on nucleic and protein examination. Their study was centred on discovery of pathogen contamination for effective management of polycyclic illness. They concluded that horizontal stream micro arrays might identify diseases in essential destinations. Photogenic and phage show sensors could prompt early assurance determination. Other creative techniques like RS and spectroscopy-based progressions can speed up determination over conventional nucleic destructive and serological tests and enable better examination of the spatial and temporal inconstancy of illness, especially in adjusting and joined with strong reference information.

In [11] V. Singh present an genetic algorithm for plant disease detection. First performing a survey on different disease detection techniques, they proposed an image segmentation technique for automation disease detection. The various phases involved in the proposed methodology are, first image acquisition, pre-processing, segmentation and obtaining useful segments for classification. They were able to obtain optimum results with very less computational efforts. They also concluded that fuzzy logic, ANN, hybrid algorithms and Bayes classifier could improve recognition rate.

S. P. Mohanty in [12] proposed an image-based plant disease detection technique using deep learning. Focusing on two basic architecture AlexNet and GoogLeNet for training the algorithm, they took a database of 54306 images of 14 crop and 26 diseases. They concluded that with the use of deep learning algorithm on an available dataset could be utilised for smartphone assisted crop disease detection.

V. Singh [13] presented the use of image segmentation and soft computing algorithm for the purpose of disease detection. Image segmentation is done with the help of genetic algorithm. Step by step process of followed from image acquisition, pre-processing and segmentation. After pre-processing, they use a threshold value for the purpose creating a mask of the leaf for getting a better leaf image. Making use of genetic algorithm and unlabelled points in multiple dimension into k-cluster. They were able to achieve satisfactory result.

P. Moghadam in [15] gives a study of image processing using hyper spectral imaging for plant disease detection. They proposed a hyper spectral imaging and machine learning techniques for the detection of tomato virus in capsicum plant. Use of full spectrum for extraction of discriminatory features was done. They used hyper spectral imaging system for image acquisition. Next step hypercube pre-processing involves two process, leaf segmentation and grid removal for acquiring better sample. Feature extraction involves three steps, vegetation indices, full spectrum,

Probabilistic topic modelling. They were able to extract satisfying results by making the use of full spectrum. The result accuracy increase with increase in feature dimensionality.

In [16] S. Thomas *et al* describes the benefits of using hyper spectral imaging for plant disaease detection. Various studeis shaow the benefit of using hyper spectral sensor for plant disease detection. With the help of this paper they described a review of baisc principles of hyper spectral measurements and available hyper spectral sensors. Evaluation of different possible application of hyper spectral sensors is also done in their study. They review a conclusion with a overview on differnet data analysis methods for extraction of key information for plant disease detection.

T. N. Tete [17] discuss various image classification techniques for plant disease detection techniques, Automatic disease detection is essential for early disease detection in agriculture science. This paper present a methodology based upon two strategy such as thresh-holding and k-means clustering algorithm and classification techniques such as Ann. There are five basic steps followed in image processing listed from image acquisition to classification. Tested various algorithms on influence on the plants concluding that neural network provides more satisfactory results while taking less computational time.

Methodology based upon remote sesed hyper spectral leaf reflectance data for plant disease detection proposed in [19] by D. Krezhova and K. Velichkova. Their aim for the study was to examine the change in plant physiological status caused by various infections. The data for the classification were ollected as a form of hyper soectral reflactance data with the helpof portable fibre optics spectromter. They applied four REP detection techniques the best result was obtained by lagrangian interpolation method.

Among the major challenge in agriculture, plant infection is the biggest factor affecting the agriculture production. In [20] H. Kaur explores that how a machine learning model can be helpful in early disease detection.

TABLE I.   RELATED WORK DONE IN THIS FIELD.

S.no.	Year	Author	Methodologies	Plant Disease and Findings
1	2005	D. Moshou *et al*	Sensor fusion of hyper-spectral reflection data somewhere in the range of 450 and 900nm and fluorescence imaging.	arable crops disease detection
2	2010	S. Sankaran	A review on different advanced techniques like spectroscopic, imaging-based, and volatile profiling-based plant disease detection.	developing a rapid, cost-efficient model for plant disease detection would facilitate advancements in agriculture
3	2012	A. Mahlein	Use of non-invasive optical sensor like thermography, chlorophyll fluorescence and hyper spectral sensors.	recommend use of imaging system over a non-imaging system
4	2012	S. Bashir	k-means clustering, color and texture analysis.	malus domestica disease detection
5	2013	M. Jhuria	Use of back propogation for the purpose of weight adjustment of training dataset.	fruit grading and disease detection
6	2012	Z. Bin Husin	Image processing using feature extraction and images classification techniques.	chili disease detection technique
7	2014	S. Bankar	Using canny edge detection and color histogram image processing technique.	able to correctly detect plant disease
8	2014	E. Omrani *et al*	Radial basis function-based support vector regression.	apple disease detection
9	2014	F. Martinelli *et al*	Technique based on nucleic and protein examination, centred on discovery of pathogen contamination.	for effective management of poly cyclic illness
10	2015	S. D. Khirade	Various image-processing techniques like image acquisition, image pre-processing, image segmentation and feature extraction from images and k-means.	use of ANN methods such as self-organizing feature map, back propagation algorithm, SVMs has proven effective
11	2015	V. Singh	Genetic algorithm based image-processing algorithm for plant disease detection.	concluded that fuzzy logic, ANN, hybrid algorithms and Bayes classifier could improve recognition rate
12	2016	S. P. Mohanty	Image-based plant disease detection technique focusing on two basic architecture Alex Net and Google Net for training the algorithm.	concluded that with the use of deep learning algorithm on an available dataset could be utilised for smartphone assisted crop disease detection
13	2016	V. Singh	Use of genetic algorithm and a set of unlabelled points in n-dimension into k-cluster, image segmentation and soft computing techniques for the purpose plant disease detection.	concluded that optimum results were obtained using very less computational efforts
14	2017	A. Ramcharan	Making use of transfer learning to train a deep learning convolutional neural network.	effective and affordable that can easily be deployable strategy for cassava plant disease detection

15	2017	P. Moghadam	Study of image processing using hyper spectral imaging. Used a hyper spectral imaging (VNIR and SWIR) and machine learning techniques for the detection of tomato spotted wilt virus (TSWV).	results shows increased classification performance for capsicum plant disease detection
16	2017	S. Thomas *et al*	they described a review of baisc principles of hyper spectral measurements and available hyper spectral sensors.	concluded review of differnet data analysis methods for extraction of key information for plant disease detection
17	2017	T. N. Tete	presented a methodology based upon two different techniques such as thresh-holding and k-means clustering algorithm and classification techniques such as Ann.	concluding that neural network provides more satisfactory results while taking less computational time
18	2018	K. P. Ferentinos	Convolutional neural network for the purpose of plant disease detection and used different deep learning methodologies for diagnosis of simple leaves images for healthy and disease plants.	They were able to get a very high success and a very useful early warning tool
19	2019	D. Krezhova	Methodology based upon remote sesed hyper spectral leaf reflectance data for plant disease detection, applied four REP detection techniques.	best result was obtained by lagrangian interpolation method
20	2019	H. Kaur	Explored that how a machine-learning model can be helpful in early disease detection.	Machine learning based products are becoming popular now a days for plant diseases detection and for identifying recovery solutions
21	2019	H. Sheikh	Use of CNN (convolution neural network) algorithm, the infected region of the corn and peach plant leaf is segmented and analysed considered a user-friendly system that gives results with best accuracy.	for maize and peach leaf disease detection
22	2019	J. C. Valdoria	Developed an mobile application for terrestrial plant disease detection using image processing deep learning algorithm, results were trained using classification models, accuracy of the algorithm was tested using F1 score testing method.	able to achieve satisfactory results thus supporting the functionality, usability, accuracy, functionality, and portability performance of the application

V. CONCLUSION

This paper discuss about various factors affecting the overall production of the agriculture crops. In this paper, we present a review of various research done over a period in the field of plant disease detection and discussed about their findings. This paper also provides a brief study about different types of disease affecting the growth of the plants and their symptoms. There are five basic steps followed in image processing listed from image acquisition to classification. We concluded that deep learning algorithm provides the best possible results while using less computational efforts and requires less amount time for the prediction. We also concluded that visual system for plant disease detection gives results that are more satisfactory then that of non-visual systems. Digital image processing provides more effective, faster and cheaper results then manual analysis of the plants for the purpose of disease detection.

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