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A Survey on Pest and Disease Monitoring of Crops

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***Abstract*— Maintenance of Crop health is essential for the successful farming for both yield and product quality. Pest and disease in crops are serious problem to be monitored. pest and disease occur in different stages or phases of crop development. Due to introduction of genetically modified seeds the natural resistance of crops to prevent them from pest and disease is less. Major crop loss is due to pest and disease attack in crops. It damages the leaves, buds, flowers and fruits of the crops. Affected areas and damage levels of pest and diseases attacks are growing rapidly based on global climate change. Weather Conditions plays a major role in pest and disease attacks in crops. Naked eye inspection of pest and disease is complex and difficult for wide range of field. And at the same time taking lab samples to detect disease is also inefficient and time-consuming process. Early identification of diseases is important to take necessary actions for preventing crop loss and to avoid disease spreads. So, Timely and effective monitoring of crop health is important. Several technologies have been developed to detect pest and disease in crops. In this paper we discuss the various technologies implemented by using AI and Deep Learning for pest and disease detection. And also, briefly discusses their Advantages and limitations on using certain technology for monitoring of crops.**

***Keywords*— Deep Leaning, Pest Monitoring, Disease Monitoring, Computer Vision**

I. INTRODUCTION

Agriculture is the backbone of India. Major crop loss is due to pest and disease attack. Recent days there is many types of insects that affects the growth of the crops and damages the fruits, leaf and flowers. Various insects are grasshoppers, weevils, beetles and small insects like fly larva and thrips can cause serious damage to crops. In April 11,2020 the locust attack has affected 90000 hectares across 20 districts in Rajasthan. The U. N. Food and agriculture, has cautioned of further such attacks on both sides of the border between India and Pakistan. But for a country already battling a pandemic, Pest attack is yet another major challenge. Diseases are of two types biotic and Abiotic. Biotic disease is by living organism like fungi, bacteria and viruses. Abiotic diseases are non-living caused by pollution, herbicides, too much or too little nutrients that plant requires for their healthy grow. Correct diagnosis is needed for successful management of crop diseases. The use of approved seeds, the use of disease resistance crop varieties, the maintenance of adequate soil nutrients and minimal use of pesticides will avoid pestilence and diseases in crops.

In early days the naked eye inspection is used to inspect pest and disease in crops which is not effective. They softly pull up the plants to detect insects and shake or knock into the plastic bucket or sweeping net. It is difficult to find certain pests, those that target plant base. So during inspection it is important to search below as well as above. Earlier Extension officers were trained in certain types diseases in crops. Extension officers review the farm and take the samples to laboratory to find what kind of pest and disease attacked in crops. Testing samples is time consuming and travelling is difficult in pandemic situation. Then various technologies where developed to identify pest and disease in crops. But still there is no complete framework for identifying pest and disease attacks in crops accurately, technologies are at the stage of demonstration.

II. LITERATURE SURVEY

There are various technologies developed using Artificial Intelligence and Deep Learning for pest and disease monitoring of different crops. Let us discuss the various methodologies used for pest and disease monitoring and briefly explain their advantages and disadvantages.

A. Pest And Disease Identification Of Crops In Computer Vision And Machine Learning

In 2019, L. S. P. Annabel and et al. [12] integrated Artificial Intelligence with image processing to detect tomato leaf disease. Here Image pre-processing, converts RGB to Greyscale Image and in image segmentation masking is done. Image with green colour is marked as 0 and damaged area is marked as 1. [12] Based on the image space region, image pixels are broken into multiple groups and objects. For further analysis, useful fragments are retrieved and used. Feature extraction collects features from the parts of images that are diseased. Here Grey Level Cooccurrence matrices (GLCM) is used. A randomised decision tree is implemented here in order to train the system to achieve supervised machine learning.

Michael Gomez Selvaraj and et al. [15] It finds various types of banana pests and diseases of which there are signs in different areas of the plant. Develops a Smartphone aided banana disease identification platform for worldwide access to producers. Images are gathered and labelled. Data splitting is then performed and datasets are trained, validated and checked. Result detects the type of disease in banana and

performance is evaluated. Shima Ramesh and et al.,[28] Uses Random forest from the dataset created to distinguish between good and diseased leaves. The Histogram of an Oriented Gradient (HOG) is a feature descriptor that is used to classify objects , object presentation, and its intensity gradient defines the outline of the image. For a reduced number of image datasets, Random Forest provides greater accuracy. [28] Machine learning is used to train the vast publicly accessible databases that provide us with a simple way to diagnose disease on a colossal scale.

In 2018, Guiling sun and et al.,[30] Proposed a multiple linear regression model. An improved histogram segmentation is used and it calculates threshold automatically and accurately. Meanwhile, true colour image and regional growth method are combined to enhance precision and intelligence.[30] The proposed system has therefore been shown to have powerful image recognition capacity, high accuracy and reliability. M.A. Ebrahimi and et al.,2017 [31] The primary objective is to classify the strawberry pest(thrips) using the method of classification of the support vector machine with various kernel functions. Mean Square Error (MSE), Mean Percent Error (MPE), root of Mean Square Error (RMSE) and Mean Absolute Error (MPE) are used for classification.[31] Results show that the optimal classification with the Mean Percent Error (MPE) is less than 2.25% using the SVM approach with intensity and region index as the color index.

Vignesh Dhandapani et al.[32] In 2018, they proposed a digital image processing system for the identification, recognition and processing of plant diseases. Mobile application is developed to identify disease in leaves which is connected to central server. Based on the visual symptoms K-Means and support vector machine is used to identify disease.[32] K-Means is used to split the data set which contains the information of particular dataset in to a fixed number of clusters and SVM is used for classification and regression analysis. Amirtha A. Joshi and et al., 2016 [33] A technique was proposed to diagnose four types of diseases in paddy (blight, rice blast, brown spot and rice sheath rot). It uses Minimum Distance Classifier (MDC) and K-Nearest Neighbor (KNN) to retrieve characteristics such as structure, color of a diseased portion of the leaf.[33] Output is tested with 11 paddy leaf images and 70 percent used for training and 30 percent used for testing to diagnose disease effectively.

Sridhathan and et al.,2018 [34] Proposed a vision based automatic detection of plan disease using K-means and Grey Level Co-occurrence Matrix (GLCM). Grey Level Co-occurrence Matrix (GLCM) is used for disease classification and produces feature based grey level matrix for the color image and measures spatial distance between the pixels.[34] K-means is used for color segmentation and uses Euclidean distance matrix method. K-means clusters the image based on specified number of groups.

Sujatha R and et al.,2017 [35] Disease is detected by loading original image taken from farm. In contrast enhancement the original image is given as input and enhanced image is taken as output. [35] Then RGB image is converted to HIS by calculating Hue, Saturation and Intensity. Support Vector Machine deals with the acquisition of information and decision-making from a data set. Vijai Singh and et al.,2016 [36] Present an image segmentation algorithm that is used to automatically classify plant leaf diseases. The genetic algorithm is used in image segmentation and co-occurrence features for the leaves are extracted in classification. Support Vector Machine and Minimum Distance Criterion are used for classification. SVN improves the accuracy of disease detection compared to other methods.

Table 1 summarizes the various methodologies used for disease detection on plants and their advantages, disadvantages and accuracy is discussed.

TABLE 1
COMPARISON OF MACHINE LEARNING AND COMPUTER VISION IN DISEASE DETECTION OF PLANTS

Authors & Year	Technology /Methodology used	Advantages/Disadvantages	Performance
L. S. P. Annabel and et al.,2019	RGB to Greyscale, Threshold, GLCM, Random Forest Classifier	**Pros:**Low prediction error,Increase productivity, Early detection of leaf disease **Cons:**More precision is achieved with a minimum dataset only	The accuracy of the planned work has been increased to 94.1%
Michael Gomez Selvaraj and et al.,2019	Deep convolutional neural network (DCNN)	**Pros:**Robust and easily deployable strategy **Cons:** It takes more time to detect disease effectively as it takes long process	Experimental results produce accuracy between 70 and 99%
Shima Ramesh and et al.,2018	Machine Learning: Random Forest	**Pros:**Histogram of an Oriented Gradient (HOG) Feature extraction operates on the cells created and it does not affect by any transformation **Cons:** When practiced with large quantities of images, accuracy can be improved.	Random forest gives 70% accuracy
Guiling Sun and et al.,2018	Multiple linear Regression , Least Square Method	**Pros:**Easily altered by modifying the independent and dependent variables **Cons:** When disease is more serious, the characteristic parameter becomes complex, which makes result unstable	Accuracy Inside: Normal Situation (15)- 93.33% Outside: Random Situation (10)- 90%

M. A. Ebrahimi and et al.,2017	Support Vector Machine	**Pros:**In this classification, the likelihood of the error will be low if the critical condition exists. **Cons:** For grouping, the percentage error of hue and saturation parameters is not ideal based on MPE values so more than 10 percent of the forecast would be incorrect.	Detects the target with an error rate less than 2.5%
Vignesh Dhandapani and et al.,2018	K-means, Support Vector Machine	**Pros:**Increase Productivity, provides low cost and easy detection of leaf disease **Cons:** There is a chance of multiple diseases on single image	SVM provides better performance than other models.
Amirtha A. Joshi and et al,.2016	Minimum Distance Classifier (MDC), K-Nearest Neighbor (KNN)	**Pros:**It provides improved results in terms of time complexity and precision. Because of its less time and simplicity for classification, the distance classifier is used. **Cons:** Four type disease alone detected there are other type of diseases in paddy.	Accuracy achieved by KNN is 87.02% and SVM is 89.23%
Sridhathan and etal.,2018	K-Means, Grey Level Co-occurrence Matrix (GLCM)	**Pros:**It reduces time of detection and reduces labour cost **Cons:** It should be tested with more dataset for more crop identification.	Accuracy is 98.27%
Sujatha R and et al.,2017	Support Vector Machine (SVM), K-means	**Pros:**Can identify disease easily and with low cost **Cons:** Accuracy can be improved by using more images	Affected area of the image will be displayed in percentage
Vijai Singh and et al.,2016	Minimum Distance Criterion and Support Vector Machine	**Pros:**Disease is identified in initial stage and uses less computational effort. **Cons:** To improve recognition rate in classification other models can be used	Overall Accuracy is 97.6%

Table 1: comparison of various methods in disease detection of plants

B. Deep Learning Techniques For Disease Detection Of Crops

P. Bhatt and et al., 2019 Explores the unsupervised segmentation approach for managing and tracking crop health and growth conditions. In order to assess the potential change in the crop such as the appearance of a seed, flower, disease, deficiency or pest, individual segments can then be analysed for their color, texture and scale.[22] 94 percent accuracy in segmenting cabbage with black moth pest, 92 percent on a citrus tree in spotting fruits and 81 percent on tea leaves in having segments impacted by helopeltis pest. Yan Guo et al., proposes a mathematical model focused on deep learning to identify and recognize plant diseases, which increases generality, precision and quality of preparation. First, in diverse ecosystems, the To understand and localise the leaves, the region-proposed network (RPN) is used. [29] Then the segmented image based on the effects of the RPN algorithm contains the function of symptoms by the Chan-Vese algorithm.[29] The segmented leaves are finally entered into the transfer learning model and conditioned by the dataset of diseased leaves under the sample background..

Yanfen Li and et al.,2019[37] Presents a system for identification of crop pests that detects 10 crop species by the implementation of the Convolution Neural Network (CNN). GoogLeNet method is used to remove the complex background and it performs better than other traditional methods. [37] Performance of using GoogLeNet is improved to 6.22% compared to other traditional methods. Proposed method can be used for implementing in real environment. Alvaro Fuentes and et al.,2017 [38] A deep learning method was suggested for the identification of pests and diseases in tomato plants. Combined as a meta-architecture, Faster Region-based Convolutional Neural Network (Faster R-CNN), Single Shot multibox Detector (SSD) and Region-based Fully Convolutional Network (R-FCN) are used. [38] The proposed device detects nine distinct types of complex-based pests and diseases. VGGnet and Residual Network (ResNet) are combined with meta-architecture for effective detection of pest and disease in tomato plant.

Jun Liu and etal.,2020[39] In real time, pests and pathogens can be accurately detected on the basis of deep learning object detection. The Deep Learning approach will directly input the initial image instead of image pre-processing, feature extraction and feature classification. In order to optimize the identification process and efficiently diagnose disease, an end-to-end layout is accomplished. [39] It uses images captured in actual environments and uses the Yolo v3 model to detect multi-scale elements to boost precision by using the image pyramid. [40] V Suresh et al., 2020 Proposed an Android framework to detect plant diseases with TFLite. In addition to identification, users are routed to an e-commerce page where the rate and usage of various pesticides is shown. The website is used to compare pesticide MRPs and to buy them. Alagiah suthakaran and et al.,2020[41] suggested model to detect whether or not the leaf is affected by the disease and to use convolutional neural network to measure the damage

region of the diseases. The intensity of the infection detected is determined by the proportion of the region infected.[42] The android framework was suggested for the diagnosis of crop disease and the provision of information on the recommendation and the quantity of pesticide to be used on an unhealthy crop.

Table 2 summarizes the deep learning method used for identification of pest and diseases of crops and their advantages, disadvantages and its accuracy.

TABLE 2
COMPARISON OF DIFFERENT DEEP LEARNING METHODS FOR IDENTIFICATION OF PESTS AND DISEASES IN CROPS

Authors & Year	Technology /Methodology used	Advantages	Performance
P. Bhatt and et al.,2019	Convolutional Neural Network (CNN)	**Pros:**The deployment of the model on the edge is also feasible for flagging crop based changes as it operates on photos taken in unpredictable field conditions in real time. **Cons:** In the method of clustering (i) the need to define the number of clusters that have been built as input along with the picture (ii) to identify the correct features that help to get the right clusters.	Accuracy level in Cabbage- 94% Tea-81% Citrus-92%
Yanfen Li and et al.,2019	Fine-Tuned GoogLeNet	**Pros:**It is Robust and gives better result than traditional methods in terms of accuracy. **Cons:** High processing power and more preparation time are needed for the identification of pests.	Accuracy is 98.91%
Yan Guo and et al.,2019	Region Proposed Network (RPN), Chan Vese (CV), Transfer Learning (TL)	**Pros:**Transfer Learning accuracy is better than traditional model. It is faster, uses low hardware resources and has high training efficiency. **Cons:** The Chan Vese algorithm involves repeated iterative computation and runs for a long time, which does not contribute to the outcomes of this method's real - time detection.	Accuracy is 83.75%
Alvaro Fuentes and et al.,2017	Deep Convolutional Neural Network	**Pros:**It provides a real time application for identifying pest and disease with less expensive and simple technology **Cons:** Due to minimal dataset the accuracy results in false positive or lower average precision	Overall accuracy is more than 80% for the best cases
Jun Liu and et al.,2020	Improved Yolo V3 Convolutional Neural Network	**Pros:**This saves time and money and minimizes the immense harm caused by diseases and pests. **Cons:** For photographs taken in actual environments, the context is messy, there are other variables such as light, angle, difference, etc.	Accuracy is 92.39%
V Suresh and et al.,2020	Convolutional Neural Network	**Pros:**To improve accuracy, mixed variety of images are loaded in training phase. **Cons:** Produces a very low accuracy for the images taken in real environment.	Accuracy for apple leaf diseases Scab-70. 82% Black rot-82.68 % Cedar apple rust-94.96%
Alagiah Suthakaran and et al.,2020	Convolutional Neural Network	**Pros:**Identifies pest at an early stage and reduce the usage of pesticide. **Cons:** Difficult to analyse due to change in light, color and intensity etc. may vary.	Accuracy can be improved by using different image processing techniques.
Nikhil Patil and et al.,2019	Convolutional Neural Network	**Pros:**Reduces the spread, preventing enormous crop losses from upsurges. **Cons:** Detection accuracy can be increased by considering other parts of the crops like root, stem, branches etc.	Accuracy is 89%

Table 2: comparison of different deep learning methods for identification of pests and diseases in crops

III. CONCLUSIONS

In this paper we discussed about the various technologies /methodologies used for efficient detection of diseases and pest in crops and also Machine learning and computer vision technologies, deep learning and other methods used for implementation of pests and diseases in crops are analyzed discusses its advantage and disadvantage in using it. Deep learning techniques are used for accurate prediction of diseases

and pests in crops. Deep learning gives better accuracy than any other traditional methods. Due to minimal dataset for training the accuracy is decreased. In existing the images were taken in real environment to train the model with more dataset it also provides less accuracy due to complex background removal. Detection accuracy can be increased by training the model with more dataset. still technologies are used to identify pest and disease in crops but all are at the stage of demonstration there is no complete monitoring and controlling platform.

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