A Survey of Existing Leaf Disease Techniques using Artificial Neural Network

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Abstract—*Agriculture productivity is something on which Indian economy heavily depends. Major portion of India depends on agriculture. But due to diseases in leaves there is a great loss to farmers. In earlier times disease detection in plants was carried out by naked eyes observation method but it is not very efficient at medium to large scale. Automatic detection techniques can be used for disease detection in plants is efficient and time saving and accuracy. The automation of plant disease identification has gained attention in last few years. So, with the improvement in ANN, its families and Machine learning techniques there is a significant scope of improvement in the pre-existing methodologies for leaf disease detection, segmentation and identification. With the help of modern sensors and imaging techniques the efficiency and accuracy of ANN model have significantly improved, as we know that the process is highly dependent on qualityof data sets and the algorithm we use to process these datasets. This study focuses on various implementations of these ANN's and their benefits such that they deal out optimal or near optimal solutions.*

Keywords: *Artificial neural network, Plant pathology, Principle Component Analysis (PCA), Support Vector Machines*

1. Introduction

Plant Pathology is the study of diseases in plants which is caused by environmental condition and pathogens. It is the process in which we detect the disease caused to plants. Plant pathologists are the scientists who studied the disease caused by bacterial, fungal and virus.

Plant pathology study the diseases caused by both biotic and abiotic agent. In which biotic agents consists of fungi, bacteria, viruses and insects it may be defined as the plant diseases caused by living organism. Therefore abiotic agent consists of Rain, wind, soil and pollution it may be defined as non-living organism. It is the study of the mechanism of disease developed by pathogen as well as the interaction between plant and pathogen. It developed strategies for managing the disorder and losses caused by them. Diseases caused by Bacterial, Fungal and Virus shown in figure 1.

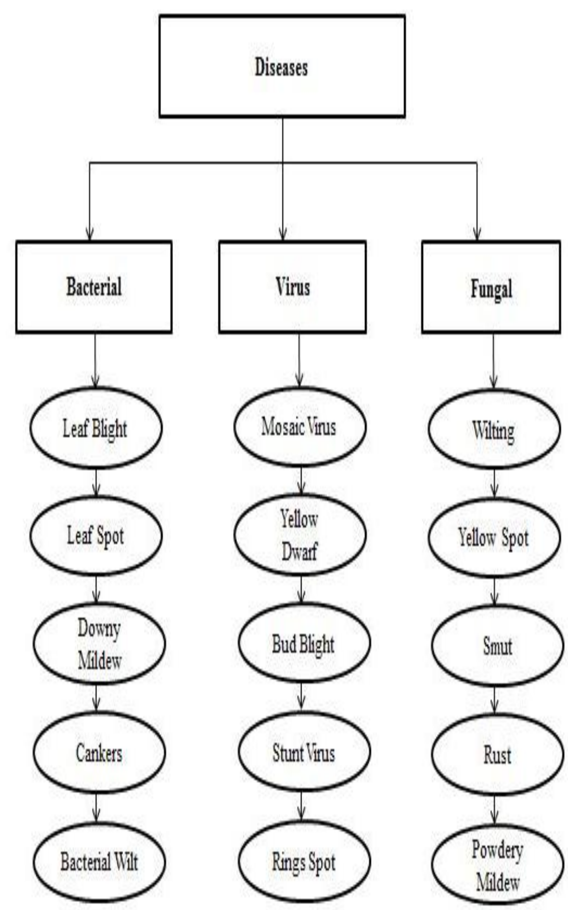

Fig. 1 Classification of plant disease

Some popular imaging techniques and the sensors required for the image acquisition process as follows.

Table 1 Imaging Techniques

Imaging Techniques	Sensors	Resolution	Raw Data	Image processing Environment
Visible light image processing	Sensitive cameras in the visible spectral range	RGB channels or Gray value images	Time series, organ parts or Whole organs	Controlled
Fluorescent image processing	Fluorescence cameras and setups	In the red and far-red region Pixel Based mapping of emitted Fluorescence	Time series leaf tissue or Whole shoot	Controlled
Thermal Image processing techniques	Near-IR cameras	In infrared region Pixel-based mapping of surface temperature	Time series leaf tissue or Whole shoot	Controlled
Near IR imaging	Near-IR cameras, multispectral line, active thermography, scanning cameras	Discrete or Continuous spectra for each pixel in near-IR imaging	Single-time-point analysis of shoots and canopies, single-point assessment of seeds	Controlled
Hyper-spectral Image processing	Thermal cameras, hyper-spectral cameras, SpectrometersNear-IR instruments,	indoor time series experiment,Crop vegetation cycles	Discrete or Continuousspectra	Controlled
3D image processing	Timeof light cameras, Stereo camera system	complete shoot at different resolutions	Depth maps	Controlled
Laser image processing	Different ranges Laser scanning instruments	complete shoot at different resolutions	3D point clouds, Depth maps	Controlled

Artificial Intelligence and Machine learning plays a very important role in Plant Pathology. With the help of artificial intelligence techniques farmers can easily identify and detect the diseases in plants. Farmers can easily understand the cause of disease in early stage. India is an agriculture country. Most of the India population depends upon agriculture growth but diseases caused to plants may cause great loss to farmers and Indian economy growth. With the help of artificial techniques farmers can easily identify the disease in early stage. Some of artificial techniques in plant pathology are-Agriculture robotics, Soil and Crop monitoring and Predictive Analysis .In early stages farmers suffers from diseases caused by chemicals during the spraying in fields but with the help of AI it can be done by Automatic machines which helps farmers to stay away from diseases.

Neural network recently have been applied successfully in many disease detection in plants.

Network parameters are used to train networks in order to improve mapping in training process. Artificial intelligence (AI) is that branch of computer that emphasizes on creation of intelligent machines that act and behave like humans. AI can be defined as the study of intelligent agent’s i.e. any machine that makes its own decision and produce result.AI is also defined as the intelligence of machines. The research on AI is based on intelligent agents “agents that perceives its environment using sensors and act upon the environment using actuators”. AI has nowadays become important part of technology. The research that is associated with AI is highly technical and specialized. Whereas traditional techniques have their advantages and disadvantages when compared with that of some intelligence techniques named as artificial neural networks. Some of the traditional segmentation techniques that use the basic image processing methodology are given in Table 2.

Table 2 Classification of traditional techniques

Segmentation Techniques	Explanation	Pros	Cons
Thresholding	Histograms peaks are used to find particular threshold value	Highly dependent on peaks and simplest methods are used and there is no need of previous information	No Spatial details are required
Edge Detection	Not based on continuity detection	Good for contrast images and objects	Not applicable for too many edge or wrong detection
Region Partitions	It is Based on the process of portioning images into homogeneous regions	It is easy to define similarity criteria and there is less noise, more immune	It is expansive
Clustering Techniques	Divided into homogenous clusters and partial memberships are used	It is used for real problems	It is not easy to determine membership function
Watershed Technique	topological interpretation is used	More Stable results	Complex calculation and continuous boundaries are detected

2. ARTIFICIAL NEURAL NETWORK (ANN)

Artificial Neural Networks (ANN) is based on BNN which is used for computation. ANN are basically the electronic models based on the structure of brain(mind). Mind learns from the experiences and that is how ANN works. ANN comprises of various nodes which are connected to each other and one of them performs a certain mathematical operation. ANN is basically inspired implementation that are used to perform certain tasks such as clustering, classification, pattern-recognition etc. on computer. ANN has many advantages but the most important advantage is that it can learn from observing data sets. ANN has three layers that are interconnected to transfer information. A simple ANN structure as shown in Fig 2.

Benefits of ANN

There are basically four benefits of ANN. They are

1) Neural networks can learn organically which means an artificial neural network's outputs aren't limited entirely by inputs .This ability is valuable for robotics and pattern recognition systems.

2) These Non-linear systems have the capability to reach the computationally expensive solutions using shortcuts. This nonlinear short-cut mechanism is fed into

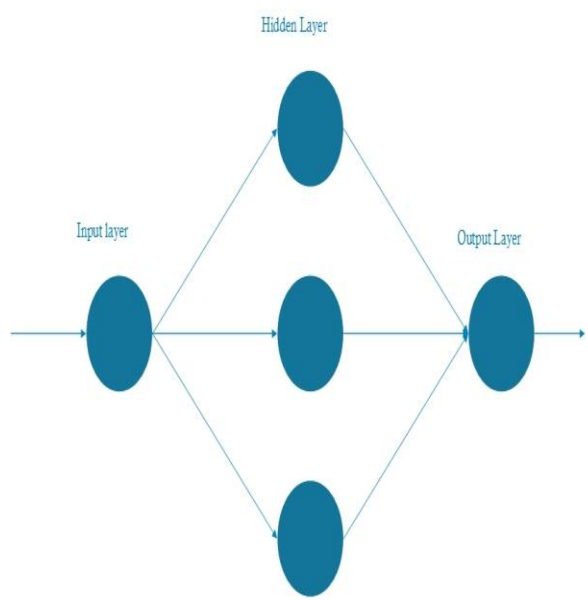

Fig 2 Semantic view of Artificial Neural Network

artificial neural networking, which makes it valuable in commercial big-data analysis.

3) Artificial neural networks have the potential for high fault tolerance.

4) Artificial neural networks can results in a self-debugging and diagnosing network, asked for finding out specific data that is no longer communicating, these artificial neural networks can regenerate large amounts of data by inference and help in determining the node that is not working.

These benefits can be seen in some popular applications of ANN such as:-

- Speech Recognition
- Character Recognition
- Signature Verification Application
- Human Face Detection

3. MACHINE LEARNING

Machine learning is used to classify and detecting leave diseases. Machine Learning is much more diversified tool which uses implementations of already existing neural network techniques to provide angeneric algorithm which can separate or identify certain traits in the given input, these can be done in linear or non –linear regression depending on the scenario. Machine Learning is closely related to Data mining. Python is the first language in Machine Learning was implemented .Machine learning also plays a very important role in plant pathology. The accuracy of Machine learning algorithm is also good. Some Machine Learning Algorithms are- ANN, Deep Learning, Genetic Algorithm, Bayesian Network, support vector machine (SVM). Some steps in Machine learning are-Gathering Data, Data Preparation, Choosing a model, Training, Evaluation, Hyper parameter Tuning, Prediction. We can use 80% of data for training and 20% of data for Evaluation.

4. LITERATURE REVIEW

In this article our focus is on Artificial Neural Network its family and Machine Learning that have been used for the classification of plant leaf disease .We have gone through several research papers and the outcome belong with these results as being presented in this section

Anne-KatrinMahlein et al. in [1] proposed an artificial neural network (ANN) technique for winter wheat and spot detection. The accuracy of the proposed model is 96%.Anicet K. Kouakou et al. in [2] all proposed an ANN technique for identification and detection of cucumber mosaic virus in cucumber leaf. The output of the proposed method is accurate and presented by the number of correct responses. They have worked on 380 cucumber leaves in which 200 are healthy leaves and 100 leaves affected by disease.TrimiNehaTete and SushmaKamlu in [3] have worked on Artificial Neural Network for identification and detection of diseases in plant leaves such as early scorch in Chrysanthemum leaf, citrus canker in lemon leaf, black spot in rose leaf and late scorch in bitter gourd leaf .They have worked on sample images of leaves .The average Threshold value of all diseases are 96.25%

Kuo-Yi Huang in [4] proposed an Artificial Neural Network model for classifying and detecting of Phalaenopsis seedling diseases which includes bacterial soft rot, bacterial brown spot, and Phytophthora black rot. They have worked on 289 infected samples images have been taken. This method provides an accuracy of 89.6% with classifying the disease and provides accuracy of 97.2% without classifying the disease.

Xin Yang and TingweiGuo in [5] have worked on the Artificial Neural Network for plant resistance genes discovery and plant diseases classification. They have been working on Differentiating Hydrophilic-lipophilic balance (HLB) from Zinc deficiency. The accuracy of the proposed model is 92.2%.Pranjali B. Padol and S. D. Sawant in [6] proposed the Artificial Neural Network model for identification and detection of Downy mildew, Powdery Mildew and Anthracnose in Grape Leaf. The accuracy for Downy Mildew=86.67%, Powdery Mildew=91.67%. The average accuracy of the proposed model is 89.17%. They have worked on 137 grape leaf images out of which 75 Downy mildew disease images and 62 are powdery mildew leaf images.

Alessandro dos Santos Ferreira et al. in [7] have worked on CNN for detection of growing broadleaf weed and grass in soybean crops. They have worked on dataset consists of 15,336 segments . The accuracy using convolutional neural network model is 98%. Jiang Lu et al.[8] presents Deep learning framework on wheat leaf disease detection .Types of diseases are- powdery mildew, leaf blotch, black chaff, stripe rust, smut, leaf rust. Result of the deep learning technique shows accuracy around 96%.Konstantinos P. Ferentinos in [9] presents convolutional neural network model for identification of plant disease and detection of disease. It will take 25 different plants with different types of diseases and accuracy of this model is 99.53%.Yang Lu et al.in [10] presents a Deep convolutional neural network model for identification and detection of Rice diseases. They worked on diseases like-rice blast, rice false smut, rice brown spot, rice bakanae disease, rice sheath blight, rice sheath rot, rice bacterial leaf blight, rice bacterial sheath rot, rice seeding blight and rice bacterial wilt. The accuracy of the purposed model is 95.48%.They have worked on dataset which consists of 500 common rice disease images.

Xinjie Yu et al.in [11] proposed performance metrices are Rsquare10 P=0.903, RMSEP=0.307% and RPDP=3.238.SrdjanSladojevic et.al in [12] proposed a convolutional neural network model for different types of plant diseases in Peach, Apple, Pair , Grapevine, pair. The diseases are- powdery mildew, Taphrinadeformans, Erwiniaamylovora, Venturia, Rust, Gymnosporangiumsabinae, gray leaf spot, Wilt, Mites, Downy mildew. The accuracy of proposed model is 96.3%. They have worked on dataset consists of 30880 images. Amanda Ramcharan et.al in[13] have worked on Deep Learning model for Cassava disease detection.The overall accuracy using this model is 93%.Sue Han Lee, Paul Wilkin et al. in[14] proposed aCNN model to learn unsupervised feature consists of 44 different plant spices .The accuracy of proposed model is 99.6%. Jiang Lu et.al in[15] have worked on Deep framework for identification and detection of Black Chaff, Leaf Blotch, Leaf Rust, Powdery learning Mildew, Smut and Leaf Rust in wheat leaf. The accuracy of the method using Deep learning is 93.27%.

PornntiwaPawara et.al in [16] are worked on convolutional neural network method for identification and detection of diseases in AgrilPlant, LeafSnap and Folio. The accuracy of the method is 95.9%.Kamil Dimililer and EhsanKiani in [17] have worked on back propagation neural networks (BPNN) for identification and detection of harmful herbs in Maize plant. The accuracy of purposed model is 88%. They have worked on dataset consists of 80 images.

Xiaoli Wang et.al [18] proposed a BP neural network technique for identification and detection of rice leaves diseases. They have worked on 60 sample images of diseased leaves. They worked on two type of diseases-Rice shealth blight disease (RSB), Rice brown spot disease (RBS).The accuracy of the proposed technique is 92%.

Dheeb Al Bashish et.al in [19] have worked on Back propagation neural network for identification and detection of diseases in plant leaves. They worked on some common diseases. The accuracy of the proposed method is 93%.Ramakrishnan.M and SahayaAnselinNisha in [20] have proposed a Back Propagation Algorithm technique. They worked on Groundnut leaf disease detection. Types of diseases occurred in groundnut leaf are-cercospora, Cercospodiumpersonatum, phaeoisariopsis, altemaris leaf blight .The accuracy of the proposed algorithm is 97.41%.They have worked on 400 sample images infected by diseases.

DanijelaVukadinovic et.al in[21] have worked on machine learning approach for the identification of Mycosphaerellamelonis disease .They have worked on cucumber fruit .The accuracy of the method is 95%. They have worked on 200 cucumber samples JingweiHou et.al in [22] have worked on ant colony clustering algorithm (ACCA) for identification and detection of Grapevine leaf roll disease (GLD) on grape leaves. The accuracy of proposed model is 85.7%.Na Wu, Miao Li, Lei Chen et.al in [23] have worked working on Machine Learning algorithm linear discriminant analysis (LDA) for detection of cucumber leaf diseases. They worked on diseases are-Target spot, Angular leaf spot, Downy mildew, Powdery mildew. The accuracy of the algorithm is above 90%.Uwe Knauer et.al in [24] have worked on Machine learning algorithm linear Discriminant Analysis (LDA) for identification and detection of Powdery Mildew infection in Grape Vine (grape bunches).They have worked on dataset of 30 grape bunches. The accuracy of this model is 75%.Patrick Wspanialyand MedhatMoussa in [25] proposed the Machine learning model for identification and detection of Powdery Mildew disease in Tomato Plant. The accuracy of the proposed model is 85%.They worked on 60 set of images.

Table 3 Literature Survey

Ref. No.	Approaches/Techniques	Dataset of Images	Result	Gaps Identify
[1]	Artificial Neural network Principle Component Analysis (PCA) Support Vector Machines(SVM)	Sample images of Cercospora leaf disease.	The accuracy of the proposed model is 96%	Potential not yet explored.
[2]	Artificial Neural network Optical finger printing	300 cucumber leaf. In which 200 are healthy and 100 leaf affected by disease	The accuracy of the proposed model is correct and presented by the no of correct responses	The idea of this study is not to provide highly accurate spectra data for the CMV because we haven't sufficient spectral band in each mode to perform it
[3]	Artificial Neural network Threshold algorithm K-Means clustering	Sample images of infected leaves 1-Early Scorch 2-Citrus Cankers 3-Black Spot 4-Late Scorch	1-Chrysanthemun Threshold Value=95 Disease Name=Early scorch 2-Lemon leaf Threshold value=100 Disease name=Citrus Cankers 3-Rose Leaf Threshold value=140 Disease name=Black Spot 4-Bitter ground leaf Threshold value=50 Disease name=Late Scorch Threshold value of all the =96.25	Algorithm of k mean clustering requires a priori specification about number of cluster centers
[4]	Artificial Neural network GLCM Adjustable exponential transform (AET)	289 infected samples images have been taken	The accuracy of the proposed model is 97.2%	Capable of lesion detection and classification for visible range and not for infected area which is covered.
[5]	Artificial Neural network Naïve Bayes Classifier K Means clustering Support vector machine (SVM),	They create their own data set	The accuracy of the proposed model is 92.2%.	Careful selection of pre-processing data methods and machine learning tools is critical to obtain highest ac-curacy of classification.

[6]	Artificial Neural network K-meansClustering Support Vector Machine (SVM) Fusion Classification Technique	137 grape leaf images out of which 75 Downy mildew disease images and 62 are powdery mildew leaf images.	The average accuracy of the proposed model is 100%	
[7]	Convolutional Neural network SLIC Superpixel algorithm	15,336 segments containing soil, soybean, grass, broadleaf and weed	The precision ofthe model is 98%	Due to the problems in the acquisition of images of the month of January, most of the soy was in vegetative state so there was a false positive rate of up to 3% for the grass to broadleaf weeds
[8]	Deep learning framework	Sample images of leaves affected by powdery mildew, leaf blotch, black chaff, stripe rust, smut, leaf rust.	The accuracy of the proposed model is 96%	The mixed cases of multiple types of diseases or multiple crops, are very difficult challenges
[9]	Convolutional Neural network Artificial intelligence Pattern recognition	take 25 different plants with different types of diseases	The accuracy of the proposed model is 99.53%	Performance degradation due to insufficient or insignificant amount of data.
[10]	Deep Convolutional Neural network	500 sample rice images.	The accuracy of the proposed model is 95.48%	To enhance rice illnesses distinguishing proof exactness, despite everything we have to give a huge number of rice sicknesses pictures tests. Besides, there are an expansive number of parameters in CNNs, and how to locate the ideal parameters is likewise an exploration challenge.
[11]	Deep learning based SAE and FNN		Reasonable performance with Rsquare10 P=0.903, RMSEP=0.307%	SAE and FNN would require more endeavors for proving efficient results.

[12]]	Convolutional Neural network	Sample images of plant diseases in Apple, Peach, Grapevine, Pair are powdery mildew, Taphrinadeformans, Erwiniaamylovora, Venturia, Rust, Gymnosporangiumsabinae, gray leaf spot, Wilt, Mites, Downy mildew	The accuracy of the proposed model is 96.3%	Extension of this study will be on gathering images for enriching the database and improving accuracy of the model using different techniques.
[13]	Deep CNN, Transfer learning, Mobile epidemiology, Inception v3 model	Sample images of cassava leaf diseases	The accuracy of the proposed model is 93%	Symptomatic exactness enhanced just marginally when the flyer was utilized instead of the entire leaf for a few illnesses, while entire leaf pictures gave higher exactness for other infections.
[14]	Convolutional Neural network	Sample images of 44 different spices	The accuracy of the proposed model is 99.6%	Few misclassification seems to be due to the condition of the leaves, where the samples are noticeable affected by environmental factors such as wrinkled surface and insect damages.
[15]	Deep learning Fully convolutional network	Sample images of Wheat leaf disease are- Black Chaff, Leaf Blotch, Leaf Rust, Powdery learning Mildew, Smut and Leaf Rust	The accuracy of the proposed model is 93.27	we need to do is to add corresponding channels in deep architecture and fine tune it based on the new data of added disease classes.
[16]	Convolutional Neural network	Sample images of diseases in AgrilPlant, LeafSnap and Folio	The accuracy of the proposed model is 95.9	Both HOG - BOW yields different results with an accuracy of 92%. Among all studied techniques, the HOG with KNN always results in worst accuracy on all datasets

[17]	Back propagation neural network	dataset consists of 80 images	The accuracy of the proposed model is 88%	As back propagation network was implemented with the root mean square function hence the number of iterations increased with decrease in the RMS value.
[18]	Back propagation neural network Infra spectral imaging	60 sample images of diseased leaves	The accuracy of the proposed model is 92%	The spectral response properties of crop canopy have been found to depend on atmospheric, edaphic and bioticconditions, as well as field management strategies.
[19]	Back propagation neural network K-Means clustering	Sample images of common leaf diseases.	The precision of the proposed model is 93%	Few misclassifications in late scorch and tiny whiteness Observed Affected clasees for misclassification were cottony mold, late scorch, tiny whiteness and normal.
[20]	Back propagation neural network Color Co-occurrence matrix	400 samples of infected groundnut leaf diseases	The accuracy of the proposed model is 97.14	As back propagation network was implemented with the root mean square function hence the number of iterations increased with decrease in the RMS value.
[21]	Machine learning	200 cucumber diseases samples	The accuracy of the proposed model is 95%	The width distribution was based on the centre line of the fitting ellipse. This is not a suitable method for the small number of curved cucumbers in the dataset, in alternatives the final classification accuracy was decreased.

[22]	Ant Colony clustering algorithm(ACCA) Pixel classification	Sample images og grape leaves affected by Grapevine leaf roll disease	The accuracy of the proposed model is 85.7%	The identification approach for GLD infection with 11-index FV and ACCA needs to be Continually validated.
[23]	Machine Learning LDA algorithm Pixel classification	Sample images of cucumber leaf disease like- Target spot, Angular leaf spot, Downy mildew, Powdery mildew	The accuracy of the proposed model is 90%	Consider the pixels in complex backgrounds parts as samples and adding them into the training set, without proper classification resulted in a lower accuracy.
[24]	Machine learning	Worked on 30 grape bunches	The accuracy of the proposed model is 75%	The utilization of a different classifier framework, specifically Random Forest, empowers simple changes in characterization exactness by expanding the outfit measure, quick component extraction by computing just the required highlights
[25]	Machine learning	60 set of images affected by Powdery Mildew disease	The accuracy of the proposed model is 85%	For better precision Extending the Hough forest with additional classes can allow the system to search simultaneously for multiple conditions

5. CONCLUSIONAND OUTCOMES

Artificial Intelligence plays a very important role in finding out the diseases from a plant leaf. The ANN achieves better accuracy when compared to other techniques. AI can think, react and behave like humans so it is easy for human to understand as we can replace human with AI. The parameters in AI is simple as compared to others therefore it is easy for computation of leaf disease detection. AI gives good result in training and testing fields. ANN is robust in nature. When these networks are scaled across multiple machines and multiple servers, they are able to route around missing data. We can take larger data set of images in AI. In our literature review there are no data set provided. The others interested authors can create their own data set for identification, classification and detection of leaf diseases. Table shows approaches used, Data set of images, Result and gaps identifying. The use of Digital Image Processing along with Neural Network models in plant diagnosis is yet to be fully explored with the potential to increase timeefficiency, segmentation accuracy and potential to minimize false or miss segmentation. Careful selection of data is very necessary. These networks are highly dependent on dataset we provided to them. These datasets can be affected by Numerous factors. Ranging from availability to defects or mutations dueto Seasonal, Weather change or simple due to Human, Animal interaction. Besides this there is an optimal need for selection of algorithm and the necessary criteria for them as the table shows some algorithms perform well on few diseases while others shows degraded results. The problem for the segmentation can be well handed by using multiple classifier as they provide accurate result. Hence, solution of these classifiers for particular set of disease is also necessary.

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