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Smart Agriculture: Leaf Disease Detection And Curative Counsel Using ECNNPLD

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Abstract

India is an agricultural country where 70% people depend on agriculture. Hence economically, India highly depends on crop production. Plants are not always healthy, diseases in plants can be regarded as a critical factor which causes the reduction in crop yield and this is the major rationale for early disease detection in plants. Appropriate measures on disease identification should be introduced to prevent the issues and minimise the losses. Regular monitoring and authentic disease identification in initial stages of plant growth can increase the quantity and quality of crop yield. Application of technical algorithm correlating the machine vision and mobile vision is actively explored for the sake of achieving the intelligence farming by early plant disease detection. A mobile application is obviously desirable to aid the farmers or garden enthusiasts in diagnosing the sorts of plant ailments. Although some similar applications exist, most of them achieve the function by submitting the image to a team of plant pathologists or expert garden advisors to get possible identification results and some advices. In this paper the study of android application based on image processing and remedy classification techniques used for the detection of plants by observing the symptoms on leaves is presented. The application named as ECNNPLD prediction app turns out to be user friendly to capture the leaf images from mobile camera to process the pre-processing stage, segmentation stage, and post processing stage to predict the diseases. Proposed research work also trained remedies for classified diseases. Application directly suggests curatives to the farmer for the purpose of crop protection. Further, it also focuses on enhanced Convolutional neural network (ECNN) which is one among the CNN based powerful classification techniques.

Keywords: *Enhanced Convolutional neural network, Plant leaf diseases prediction, Android app.*

1. INTRODUCTION

The agriculture sector has been the main contributor in Indian economy. With the escalation in population, although the contribution of agriculture is constantly falling, still it remains the chief employment division with a fringe of difference. So, there is a need to accelerate the pace for competitive, productive, diversified and sustainable agriculture. To enhance the food quality and productivity, research in agriculture increasingly gained attention recently. Accurate diagnosis of crop diseases and subsequent classification are the most complicated processes to perform as it can be influenced by different parameters such as climate, nutrition and environment. With the development of the science and technology, progressive scientific tools based on machine vision for achieving intelligent farming become active computing research areas. Besides crops production, garden enthusiasts often confuse about the symptom of their plants [1]. Students, researchers and farmers taking plant pathology as the core domain are often being asked by their friends or laboratory about the plants and measures to eliminate the diseases. Although curing the plant is too late at that time, it is still very useful to prevent the disease being spread to other plants in the future. Advantageous software is really desirable to help the plants enthusiasts in

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identification the disease as quickly as possible in the initial phase. A Smartphone app is an apparently convenient approach for an untrained person to learn about what kinds of disease a plant suffers [2].

Although there have been some similar applications such as `Garden Compass Plant / Disease Identifier' (iTunes Store) for iPhone or`A&L Plant Disease Diagnosis'(GooglePlay) for Android app store, most of the farmers need to take a picture and submit it to a team of plant experts who will diagnose the symptom [4].However, the farmers have to wait long duration for the result and pay money for the application. The major drawback of the aforementioned applications is that the application is only meant for disease identification not for curative suggestion. The development of a machine learning based mobile application to satisfy the needs such as analyzing the picture, diagnosing the ailments, disease classification and recommendation of remedies which is free of charge and short result-waiting period is the longing requisite [3]. Moreover Access is hardware nonpartisan, needed to use a computer system, which can be inconvenient for the user. Thus, it can be seen that an implementation of a completely successful application for leaf disease detection and remedial suggestions is extremely useful for the garden enthusiasts for improved agricultural production. agricultural is a very important produce for the economy of India which have played a very important part in our economy in past ages but not as abundant in the present times due to various diseases effecting the crops. Thankfully, recent awareness concerning apple agriculture is emerging and what other enriched way there is than presenting an amenity that can be used by any farmer through their mobiles.

This paper is organized as follows. Section II briefly summarizes the proposed system related work. Section III provides the detailed description of the proposed enhanced Convolutional Neural Network based leaf disease remedies classification System. Section IV presents the Experimental results and analysis. Conclusions and future work are given in Section V.

2. BACKGROUND

Early detection of various diseases of plant image is necessary for identification of various plant leaf, fruit and vegetable diseases. Effort has been made for development of various algorithms that can segment the diseased area and can extract various features of diseased plant image accurately and efficiently so that various plants related disorders can be identified on time by using different classification algorithms. The use of image examination on different fields has turned out to be fundamentally essential since recent years. The following segments will talk about some past work done in detecting different plant diseases. Here, literature review is partitioned into two subsections depending on detection of plant disease. Section 2 represents the review of different disease detection algorithms on leaves of plants. In the plant diseases detection, many text data exist and it can be organized approximately into two most important classifications: truth and opinion. The truth is the objective statements whereas opinions are the subjective statements. The objective statements are on components for instance. Opinions are individual sentiments, feelings, evaluations, and mindsets associated with the specific object. The major component of the research on image-based data has been focused on mining from truth based data, for instance, mobile based searching, retrieval of information, grouping, topicalization, text classification, etc.

Ali, H et al (2017) developed an automatic scheme for classification of cotton foliage diseases that is alternaria, myrothecium and bacterial blight. A graph cut method was applied for the segmentation of diseased portion to extract colour features to train the Principle Component Analysis (PCA), Nearest Neighbourhood Classifier (KNN) algorithm. Approximation rates of 92.5% and 92.3% were accomplished in testing and training the dataset to classify the leaves infected with powdery mildew. Performance of classifiers was calculated with the pictures taken using an automated imaging system. Finest precise approximation rates of 69% and 80% were

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attained for pre symptomatic arrival recognition of gray old and powdery mildew diseases, individually.

M. Akila, et al (2018) presents a machine learning approach for recognition of the visual symptoms of plant diseases in the color images. Segmentation is processed initially to separate diseased regions of plant leaves, further group of features extracted from segmented image. RGB encoding technique used in this work to separate the red, green and blue component images were separated, the patterns formed and images of various healthy betel leaves collected and stored in the system. The colour layout descriptor was utilized for a range of likeness based reclamation and visualization were extracted beside shape factors as features. The diseases that were chosen for research were myrothecium, bacterial blight and alternaria. The network connectivity is measured to compose the feature vectors which discriminates these damages. The results of automatic classification using LDA and SVM are reviewed after obtaining the characteristics. [6].

Detection in grape leaf is done by Padol et al (2016) via Support Vector Machine (SVM) classifier. Digital clicks of leaves are taken as input and fed into training and testing phases. Further image quality is enhanced. Resizing the image to size 300x300 is performed and components of green color are attained by means of thresholding. Gaussian filtering eliminates the noise. K-means clustering identifies the segmented region of diseased and extraction of features of color and texture are done. Hence, the sort of leaf infection is detected via Linear Support Vector Machine (LSVM) classification technique and achieved high accuracy of 88.89% [7].The presented approaches have been estimated in the recovery of images and documents on the cloud. This model for retrieval purpose is termed as SSRM (Semantic Similarity Retrieval Model) which combines the conceptual similarity into its retrieval process. The output from the experimentation illustrates the promising performance enhancements of process over state of the art information retrieval approaches. The precision of plant diseases analysis by employing LSVM (Linear support vector machines) in this area may be enhanced significantly. This utilized an integration of distinct pre-processing approaches in order to minimize the noise in the text furthermore the method of chi-square is used to eliminate the unwanted characteristics which do not influence its orientation. The precision level attained is shown with the experiments.

The diagnosis and classification of leaf and stem diseases are performed by an approach developed by Bashish et al (2010). Initially in image-processing-based process, K-Means approach performs the segmentation and transmitted to a pre-trained neural network [8]. Al-Ghor area in Jordan is taken as input data in a test bed. It is a combined structure in which one can be able to make use of background lexical information concerning the word-class relationships and extracts the information for particular domains by employing any convenient training examples. The empirical output on heterogeneous domains proves that this method implements better when compared to employing separately the background knowledge or training data and also the different methods to employing lexical knowledge along with image classification. High accuracy is achieved here significantly and detects leaf diseases automatically. Accuracy and automated detection are achieved by the experimental results. Statistical classification-based approach of the developed Neural Network classifier attained 93% precision in detection and classification [9].

The early stages of symptoms are difficult to be distinguished and clearly assigned by naked eye; furthermore these symptoms vary significantly with variety/ cultivars of apple. Microscopic studies can be conducted only after acervuli build up to assign the host pathogen relationship. This ultimately causes time lapse and poor management of the diseases. Therefore, an early and reliable diagnosis of the disease is of utmost importance to manage the disease in time and reducing the primary inoculum for next season as well. Thus the proposed study will help in early detection of the two diseases leading to increased throughput & reducing subjectiveness arising from human experts in detecting the plant diseases.

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In this chapter, it reveals the existing researches on image data mining. It also detailed about the diseases analysis and the various tools used for it. It describes many numbers of strategies which comprises of techniques for pattern mining and machine learning with several degrees of automation. The problems with the existed methods are also stated properly. The next chapter covers the proposals for sentiment analysis and it overcomes the difficulties existed in the previous approaches.

3. SYSTEM DESIGN

a) Advances in CNN Architecture: Embedded and mobile systems ConvNets

This research uses two consecutive mapping i.e. deep convolution networks which is a scheme in order to preserve the mapping in concert with an adaptive vector quantization; and spectral clustering which is an assorted learning based on Eigen composition along with the local density oriented similarity, A. Lavin and S. Gray (2016) proposed technique was found to outperform both other deep CNN based and neural based clustering scheme in all the cases during entire research [10].

Figure 1 represents the proposed architecture. However, H. G. Chenet al (2016) proposed a combination of further normalizing the extracted Eigen values and using eigenvectors of part of the samples for training the CNN and ASP sensor [11] which have been used in recognition of Cercospora Leaf Spot, Alternaria Alternata, Bacterial Blight, Anthracnose and wheat leaf rust. This problem is addressed here using color, shape and texture features of the diseased images. Y. W. Q. H. Jiaxiang Wu et al (2015) introduced QCNN Mobile apps is a framework of deep convolutional neural network (CNNs), that achieves 4:02x speed-up against the existing apps [12] [14]. Proposed mobile application carried and continues of K.Subhadra and Dr.N.Kavitha (2020) windows application of plant disease classification application. Pre-processing stage used in median filter, segmentation of image used to ROI based Bat algorithm approach, feature extraction GLCM method applied to predict finally classification EANN approach used to diagnosis the diseases [15]. Plant village Datasets are used for leaf diseases diagnosis, previous windows application predicts only the leaf diseases not the suggestions regarding remedies as windows application is not suitable for providing suggestion. This drawback is being rectified by the proposed mobile based approach and previous window application methods are more suitable for proposed mobile based application and extended to remedies suggestion. Figure 1 describes the proposed EANNPLD prediction architecture modal.

1) *ECNNPLD prediction app*: Google analysist [13] applied and implemented proficient method for CNN MobileNets for embedded based apps. ECNNPLD prediction model is modified version for MobileNet model. The proposed ECNNPLD disease-diagnose system involving the most effective methods are to be implemented for effective and efficient for less convolution identification of diseases in fruit crops. In this approach, semantic-oriented subjective information is derived initially and ranking is computed depends on the frequency of features. The algorithm is examined by using T-Mobile dataset to exhibit the usefulness of the ranking method. The presented approach scope is to arrange the viewpoints of the user in a suitable way so that the Diseases can be carried out effectively depends on the Feature Extraction. Figure 2 illustrates proposed architecture model.

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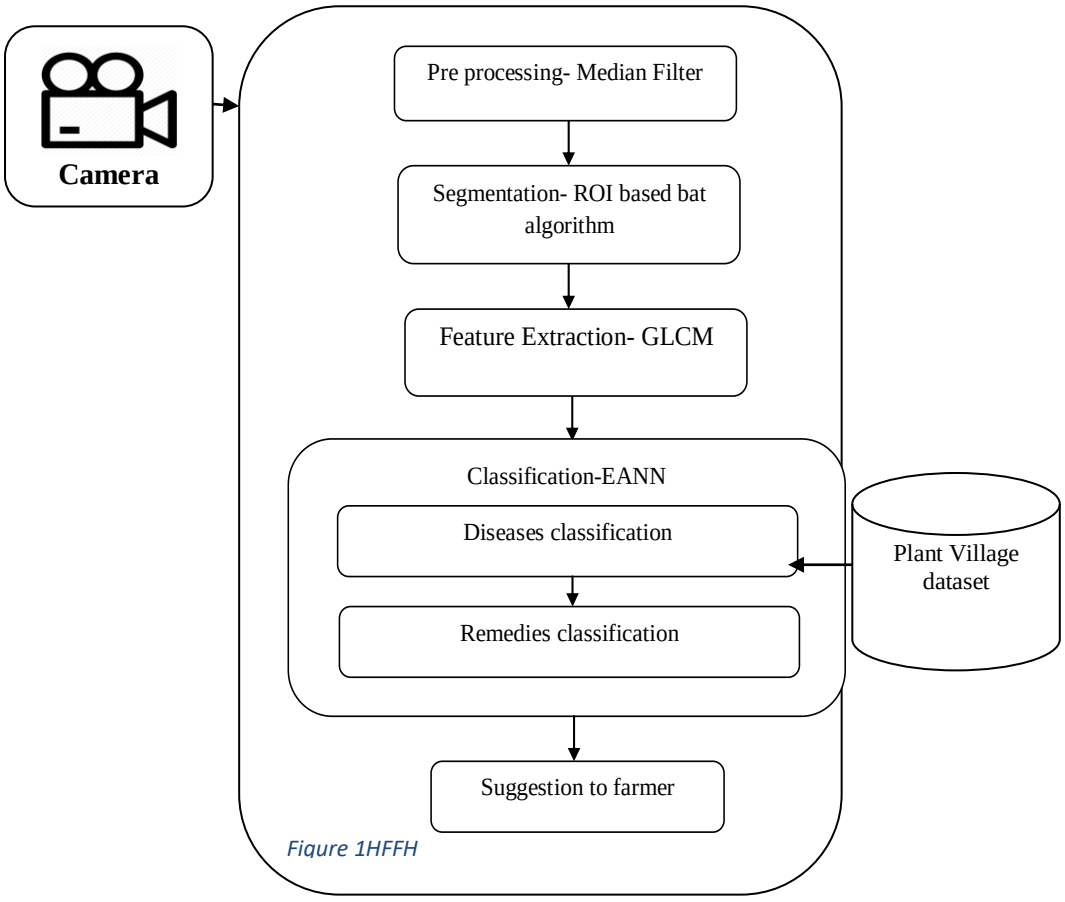

Fig 1. Architecture diagram for proposed ECNNPLD prediction app

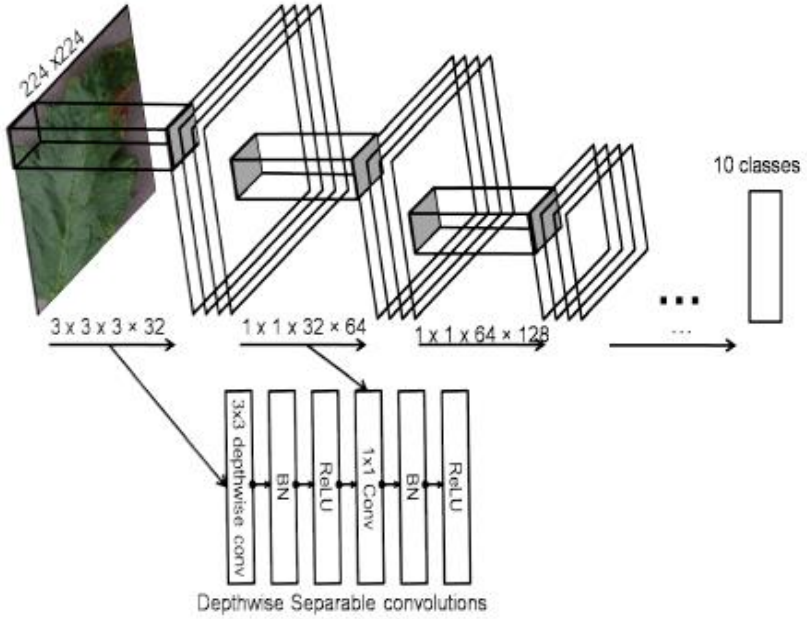

Fig 2. The structure of enhanced Convolutional neural network plant leaf prediction model

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b) Brief description of adapted model

ECNNPLD prediction model depends on both methods profundity wise distinguishable filters and factoring to minimize the total computation in the initial layers. Here, research methodology is divided into three stages: pre processing, processing and post processing. In processing stage, a novel algorithm is developed for the segmentation of diseased part of the enhanced leaf. A novel algorithm for the segmentation of region of interest from the diseased leaves with live background is also proposed here which gives better results as compared to existing segmentation algorithms. For this, performance parameters like jaccard index, dice coefficient and accuracy are evaluated. Simulated results demonstrate that the proposed segmentation algorithm is an efficient approach that can segment diseased leaves from live background more accurately. Segmented region of interest (ROI) further is used for the extraction of features of diseased part so that the classification of the diseases can be performed accurately in post processing stage. After the segmentation, textural features of segmented ROI, such as 1st order and 2nd order gray level co-occurrence matrix features are calculated. This includes mean, variance, skewness and kurtosis as 1st order textural features and contrast, correlation, energy, entropy, smoothness and homogeneity as 2nd order textural features. Finally, textural features of segmented region of interest is applied to four different classifiers out of which ECNN proved to give the most precise results. To improve the accuracy of the disease detection system, a novel algorithm for enhancement technique and automated segmentation of leaves diseases has been proposed in research work. Basic research methodology used for proposed work is represented by Figure 2.

Input: Video Sequence
Output: Visual output, remedies classification
1. Initialize the camera sequence
2. Capture leaf frames i.e Frame ‘i’ and frame ‘i+1’. (The time interval between these two frames is limited by the delay for moving object detection)
3. Convert each of these leaf image to grey scale.
4. Subtract images ‘I’ from ‘I+1’ to generate different types of depth images CNN parameter.
5. Filtering images to remove noise and to detect the edges of the images
6. If the diseased leaf is the task and if the distance between the marked areas is larger, then repeat the process (vice-versa).
7. Calculate the difference between the images measured in terms of pixel. Extract the feature compare to the train model.
8. Perform evaluation of the output extracted with respect to trained modal predict the diseases and suggest remedies.

Fig 3. Pseudo codes for ECNNPLD model

Figure 3 illustrates the details of ECNNPLD based pseudocode for leaf diseases detection. ECNN classifier has been used by a number of researchers for the purpose of classification. ECNN is one of the classification methods which are based on classifying the objects on the basis of closest training examples. ECNN is the central and most straightforward classification method when there is very less prior information regarding the circulation of data. EANN is a standout amongst the most well-known classification algorithms for recognition of patterns. Numerous analysts have discovered that the ECNN calculation achieves great results in their tests on various information sets. However ECNN classification has three confinements: (i) complexity is more because all the training samples are utilized in classification (ii) the system‟s performance exclusively depends on training set and (iii) no weight variation between sample points. The Enhanced artificial neural network govern is the easiest type of ECNN when N = 1. In this strategy each sample ought to be classified identically to the Neurons samples. In this manner, if the classification of a specific sample is not known, the prediction can be made by the classification of its closest samples. Given a training set and a query sample, the distance between the training set samples and the query set samples can be calculated. Therefore, the unknown sample can be classified on the with respect to classification of the neural network.

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The execution of a ECNN classifier is principally controlled by the selection of N and the applied distance or separation metric. Choosing the right value of parameter „N‟ usually depends on the data. Usually to remove noise in the classification, 'N' must be chosen to the higher side but it makes the boundaries between the classes less distinctive. An effective value of parameter „N‟ can be chosen using various techniques but commonly used technique is cross-validation. To discover the k closest features, the similarities between the training samples have to be found. When the samples for training are less, the NN classifier is no longer ideal but if there are large number of samples, then EANN classifier needs additional time to find out the similarities. This issue can be resolved in 3 different ways: by decreasing the feature space dimensions; utilizing smaller data set; utilizing enhanced algorithms. The classifier is produced just with the samples of training and it doesn't utilize any extra information. There is no distinction between the samples with modest number of information and gigantic number of information. So it doesn't coordinate the real wonder where the samples have uneven dissemination. In this research work, N nearest neighbour classifier is implemented on the extracted first order and second order features from the segmented ROI images.

ECNN=ClassificationNN.fit(Xtrain,Ytrain,'NumHiddenlayers',6,'NSMethod','exhaustive','Distance',,'DistanceWeight','inverse','Standardize',1); where „Xtrain‟ is a matrix having different features values of all the images in training data set whereas „Ytrain‟ is matrix having output labels of all the images in the training dataset. This command returns a binary classification N neuraons named and 6 hidden layer as 'EANN' based on the input variables „Xtrain‟ and „Ytrain‟. After that N Neurons „EANN‟ is used to predict the labels of test data based upon the extracted features of test images which are saved in the „comfeat‟. For the prediction of labels of test data, following command is used which will give the labels in the variable „Y_ANN‟.

4 RESULTS AND DISCUSSION

Proposed ECNNPLD applicationeffectively deals with plant leaves real time and village dataset, in the tool of android studio 2.0 and classified results are discussed in this section. Accuracy values are estimated based on the 120 types of plant leaves used as trained pattern. Table 1 shows, different diseases and number of images used to mobile application trained pattern from 120 images.

Alternaria Alternata

Cercospora Leaf Spot

Bacterial Blight

Anthracnose

wheat leaf rust

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Fig 4. Tomato leaves with diseases

Proposed dataset comprises of a total 120 images out of which 30 sample images are of AlternariaAlternata, 25 images are of bacterial blight and Cercospora Leaf Spot each, 10 images depict Anthracnose disease. 10 images contain leaf rust disease as the deformity. Remaining 12 images are from healthy leaf category. Figure 5 displays user home screen considered as cloud-based user registration. Each data is being stored and validation of the user is performed.

Table 1. Images Number of Each Class

Class(Disease type)	**Number of images**
AlternariaAlternata	30
Cercospora Leaf Spot	25
Bacterial Blight	25
Anthracnose	10
wheat leaf rust	12
Healthy Leaves	18

The digitally captured image having live background is initially filtered using median filtering method. In the snapshots of GUI, input query image, enhanced image, segmented ROI, features values, the type of disease detected are shown in Figure 6 (a) and Figure 6 (b). The images are of Multiplanar Reconstruction (MPR) type. The affected and unaffected diseases regionsare categorized as a part of segmentation technique.Demarcation between affected region and unaffected portions is available in the result of Figure 6 b).

Features are extracted from segmented diseased regions and corresponding values are listed to figure 6(c) different types of are analysed to identify the impact of high grade upon the leaves. This proposed research will allow farmers to get effective help out of it. Combination of feature extraction like texture with classifiers has added accuracy to the research. This investigation is carried out to study efficiency of image processing for disease detection in crops.11 different types of features are taken into account for classification and curative suggestion purpose. These enhancements to feature extraction techniques are applied based on the paper by K. Subhadra and Dr.N. Kavitha (2020) Multi Label Leaf Disease Classification Using Enhanced Deep Convolution Neural Network (15). Figure 6 shows the effectiveness of the proposed methodology in resolving agricultural image datasets and extracts the features. Finally EANN technique is used to carry out the computer aided diagnosis of leaves which is extensively preferred and remedies are being suggested.

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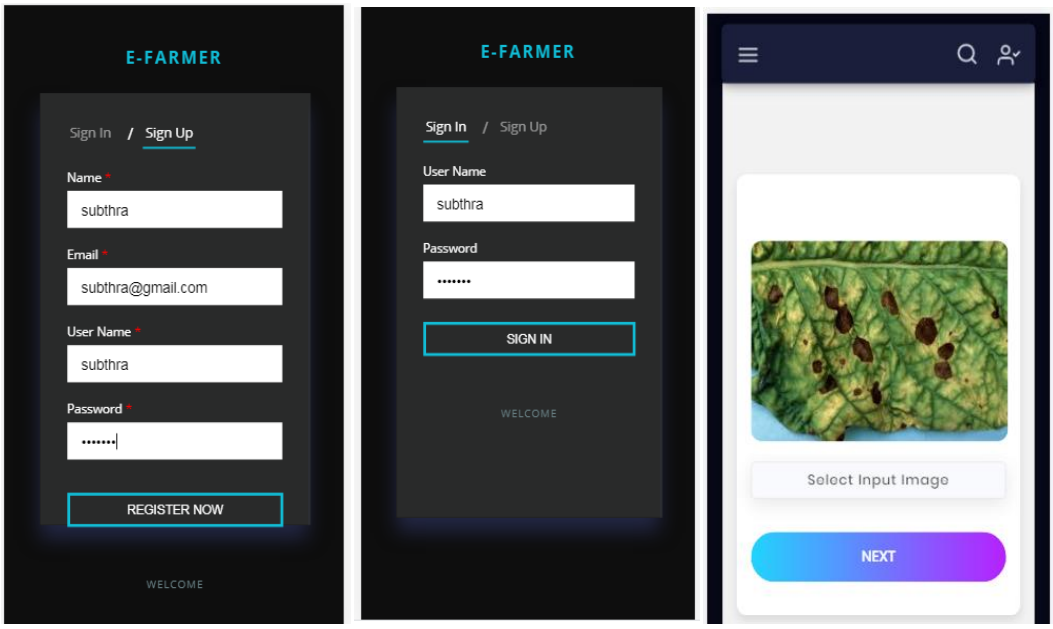

Fig 5. Proposed system home screen

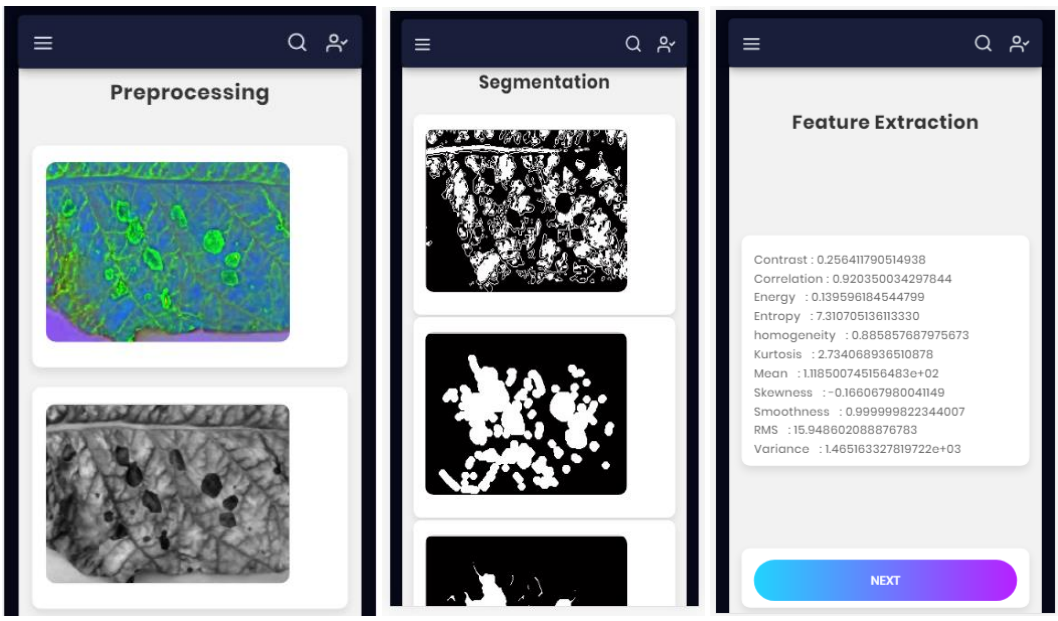

Fig 6. a) pre-processing image b) segmentation images c) feature extraction

Tested ECNNPLD application on some test images example listed figure 6, and obtained the results as tabulated in the table 2. For example, proposed ECNNPLD result of Alternaria Alternata with 0.93640% compared to others diseases as shown in the table 2. Three-channel convolution neural networks by linking three colour modules for leaf diseases detection. In the model, every channel was aided by single colour modules of RGB diseased leaf image. The features were fused over a fully linked fusion sheet to get a deep levelled disease detection feature vector. At last, a layer of the feature vector was used to catalogue the train image into the already defined classes. The investigational results authenticated that the suggested technique beats the modern approaches of the leaf disease detection.

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Table 2. Sample Test Image with Predicted and Expected Results

Image example	Obtained result	Expected results
	AlternariaAlternata - 0.96630	AlternariaAlternata
	Anthracnose - 5.420e-20	
	wheat leaf rust – 9.4526e-15	
	Healthy Leaves -7.693e-22	

Figure 6 represents the designed EANNPLD application which achieves higher true positive rate for existing prediction. From the figure 7 proposed system result shows classification result of AlternariaAlternata diseases and additionally the result areenhanced to suggest the fungicide solution to control AlternariaAlternata diseases along with the mulch and crop rotation method to prevent Alternaria diseases.Finally, textural features of segmented region of interest is applied to four different classifiers out of which proposed approach proved to give the most precise results giving an accuracy of 96.63%.

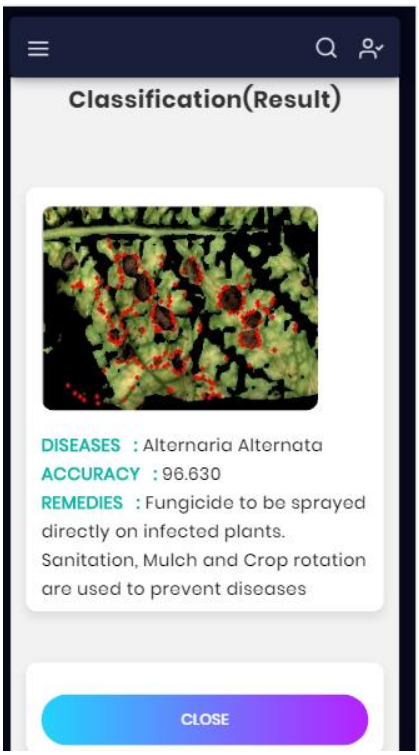

Fig 7. Remedies classification

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Table 3: Proposed System Remedies Classification

Diseases	Remedies	Prevention
AlternariaAlternata	Fungicide to be sprayed directly on infected plants.	Sanitation, Mulch and Crop rotation are used to prevent diseases
Cercospora Leaf Spot	Sulphur sprays, copper-based fungicides,	Seed treatments, Baking soda and neem oil.
Bacterial Blight	Spray Streptomycin sulphate + 300gram Tetracycline and 1250-gram Copper oxychloride.	seed treatments,
Anthracnose	multipurpose insecticide destroys larvae and eggs of insects.	Neem oil spray and seed treatments
wheat leaf rust	triazole fungicides	seed treatments, Foliar fungicides are used to control

Future study can be based on the disease severity to suggest the remedies to farmer which in turn reduces the cost and time to prevent the diseases. As various factors like illumination, background is the governing aspects in case of plant disease, consideration of these factors will lead to accurate results. diseases like AlternariaAlternata, Cercospora Leaf Spot, Bacterial Blight, Anthracnose, and wheat leaf rust may be considered for future disease detection. In this research, specifically the various plant leaf diseases i.e. apple scab and marsoninacoronaria are chosen, as these two are found to be the main diseases affecting the crops.

5 CONCLUSIONS

The cultivation of plants faces threat of various diseases caused by pest, microorganisms, weather conditions, soil profile and deficiency of nutrition etc., which leads to significant reduction in crop yield and hence, disease diagnosis is very essential to enhance crop production and to improve the economic growth. Our contribution and results while using a mobile device by farmers to identify the agricultural diseases based on ECNN algorithm, compared to the previously published, more preliminary, and derived from direct adaptation of the ECNNPLD prediction model. he proposed ECNNPLD model can effectively classify 5 common diseases through image recognition and provide related consultation.To improve the accuracy of plant disease detection, we still need to provide thousands of high quality plant disease image samples by means of eliminating these qualities that are now redundant, their performance in classification is enhanced with a huge reduction in the cost of classification. Simple application of the ECNNPLD prognosis model in computer vision and its applications, especially smart mobile plant disease recognition is useful. Earlydetection ofthe diseases and suggestions of remedies are provided to the farmer to increase production.

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