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# Tele-pathology in plants for disease diagnosis in agriculture: Review and analysis

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**A**BSTRACT

Early diagnosis of diseases play a crucial role in increasing the agricultural productivity and ensuring food security. Specially, in many parts of the world, immediate disease identification remains difficult due to the lack of necessary infrastructure. Besides that, many challenges are noticed to identify the plant diseases correctly such as multiple and simultaneous disorders in a single plant, different disorders having similar symptoms etc. In spite of all the challenges, deep learning approaches have shown promise in classifying the complex diseases correctly. As digital India is advancing, smart agricultural systems will provide assistance to farmers, and "Tele-pathology in plants" is the way forward. In this context, a literature review on classification of different kinds of approaches and techniques has been presented with the objective focus on designing an inclusive system architecture for Tele-pathology in plants. Discreet studies focusing on specific verticals are present among the research community but a holistic structural approach formalizing the use cases is missing. The purpose of this research is to propose and explain a system architecture with interplay among different system blocks such as crop disease imagedataset, annotation of digital image dataset by consultation with the domain expert, generation of disease markers and establishing different algorithmic techniques.

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## INTRODUCTION

The creation of digital image dataset for the major crops of India can motivate the research community to carry out the state of the art research effectively. In the mean time, it encourages the comparative research in the field, where in turn the researchers can validate the research study by accessing the digital image dataset. Using the machine learning techniques, detection and recognition of plant disease is likely to give better performance and hopefully it can provide comprehensive ideas to the end users to treat the diseases in its early stages. We can overcome the problems related to the manual visual interpretation of plant diseases which is considered as very tedious task.

In the area of disease control, most of the research work have focused on the treatment and control of weeds, and few studies in India have been focusing on the automatic identification of diseases. The automatic plant disease diagnosis application software can be of great benefit to those users who have little or no information about the crop they are growing, the basic structural blocks outlined in Fig. A, give a top level overview of such a software system. The current research work is a two-part paper. In this article we review the existing state of the art and based on that a system model is proposed which is implemented (Singh and Singh, 2019).

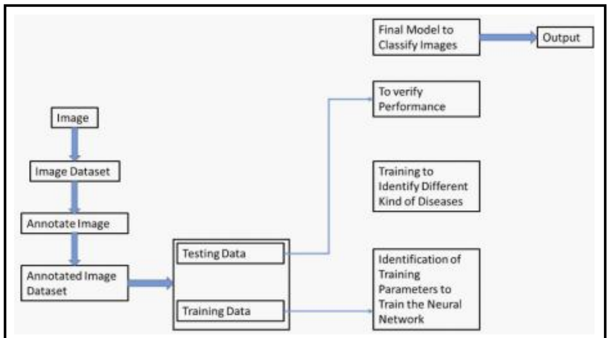


**Fig. A: System overview for the plant disease detection**

## MATERIAL AND METHODS

In (Suman and Dhruvakumar, 2015), the authors have discussed about the paddy disease detection using only color and shape features. Initially, the extraction of shape features using Principal Component Analysis (PCA) method is carried out. Then the colour features are extracted by using colour based grid moments. The extracted features are combined together and given to the Support Vector Machine (SVM) classifier. Finally, 70 per cent accuracy is obtained for four kinds of paddy diseases. But, the collaboration with agricultural institute is missing in this research.

Rothe and Kshirsagar (2015) have proposed the pattern recognition techniques for the detection and classification of cotton leaf diseases. The dataset images are taken from the field of Central Institute of Cotton Research Nagpur. Active contour based segmentation algorithm is used for the isolation of diseased spots. Authors have also suggested some feature directions to the similar concept for the crops of wheat, orange, citrus and maize etc.

Babu and Rao (2007) have developed a software model, to suggest remedial measures for pest or disease management in agricultural crops. The software system is divided into modules namely: Leaves Processing, Network Training, Leaf Recognition, and Expert advice. Using this software, the user can scan an infected leaf to identify the species of leaf, pest or disease incidence on it and can obtain solutions for its control.

**Amrapalika:**

An expert system for the diagnosis of pests, diseases and disorders in Indian mango was an application of expert system in the agriculture domain (Ranjan *et al.*, 2006). It was developed as a rule-based expert system by using ESTA.

The approach for detecting the visual symptoms of plant diseases was developed by Jayas *et al.* (2009). This research investigated the potential of soft X-ray imaging to detect fungal infection in wheat. Healthy wheat kernels and infected kernels were scanned using a soft X-ray imaging system and algorithms were developed to extract the image features and for classification. Patil (2009) developed a Web based expert system for diagnosis of micro nutrients deficiencies in crops. It described application of expert system in agriculture particularly in the area of nutrient deficiencies in crops. Patil and Kumar (2011) have done literature survey that provides a new insight in detection of the diseases of plant.

The scope in doing research in this field is as follow: There are two main characteristics of plant disease detection using machine-learning methods that must be achieved, they are: speed and accuracy. Hence, there is a scope for working on development of innovative, efficient and fast interpreting algorithms which will help plant scientist in detecting disease.

The researchers (Camargo and Smith, 2009a and b) described an image-processing based method which can identify the visual symptoms of plant diseases from the colored images analysis. The processing starts by converting the RGB image of the diseased plant or leaf into the H, I3a and I3b colour transformations. This algorithm effectively detects and selects the regions that from the point of view of a human expert are considered diseased. The advantage of this paper is the ability to identify the diseased region in images with different range of intensities distribution. However, it needs proper modification to scale the approach to other part of plants like stems etc. Moreover, the ranges of disease visual symptoms of plant leaves are different with other parts of plant.

Fujita *et al*. (2018) discussed the detection of diseases in cucumber using deep learning approach. The cucumber leaf images are captured on-site. Deep learning convolutional neural network is used to train the cucumber diseases. An accuracy of 78 per cent is obtained after training the model. In (Zhou *et al*., 2009), developed an application to detect rice diseases using image processing techniques and Support Vector Machine (SVM). Segmentation is carried out upon the rice disease spots. Then, shape and texture features are extracted. Finally, with the help of SVM method, very few disease types are classified. The merit of this approach is that, the accuracy to classify the images is found to be 97.2%. On the other hand, the authors have considered only three diseases from Rice crop.

In (Sanchis *et al*., 2009), proposed the citrus fruits classification method to detect and identify the type of external defects in citrus fruits using multi spectral computer vision. Firstly, they have segmented the images as unlabeled regions, healthy and defects skin. After that, the classification algorithm is applied. As a result, the approach can classify the 11 defects in the citrus fruits with an accuracy of 86 per cent. However, processing all the images takes lots of time. Hence, the execution time is more in this approach.

Khalid *et al*. (2011) put forward an unsupervised diseases pattern recognition for the herbs. The authors have used the classification algorithm that can provide an adjustable sensitivity-specificity herbs diseases detection from the acquired images. They have also provided a suitable treatment and control for each identified herbs diseases. In (Zhang *et al*., 2009), the authors have enhanced the segmentation rate of the images which contains green vegetation with the help of introducing a mean-shift procedure into the segmentation algorithm. However, this approach has taken very high running execution time. Hence, it is to use in the real time application. In (Albert *et al*., 2007), Alexander *et al*. discussed the neural network approach to segment the agricultural landed fields. They have used the remote sensing data. They could classify the images successfully.

## RESULTS AND DISCUSSION

Based on the review of existing state of the art a computational model is proposed. The basic building blocks of the model and the approach to structure them is explain below. Fig. 2 outlines the system overview. Based on this proposed model an initial work has be conducted in Singh and Singh (2019).

**Creation of Digital Image Dataset:**

The procedure to acquire the digital image dataset is depicted in Fig. 1. Initially, the major cultivating crops from India such as Rice, Potato, Ginger are considered. For each crop, 5 major kinds of diseases are to be considered. For each disease, around 500 to 1,000 number of images will be acquired from the field. At the same time, the digital images with different qualities such as good, better and best are to be captured using the digital camera, mobile devices, Internet sources etc. These captured images will act as digital image dataset which form the input for the training model. The existing image dataset for the different crops are collected from the homogeneous background. In this work, the various crop image dataset will be acquired from the heterogeneous background.

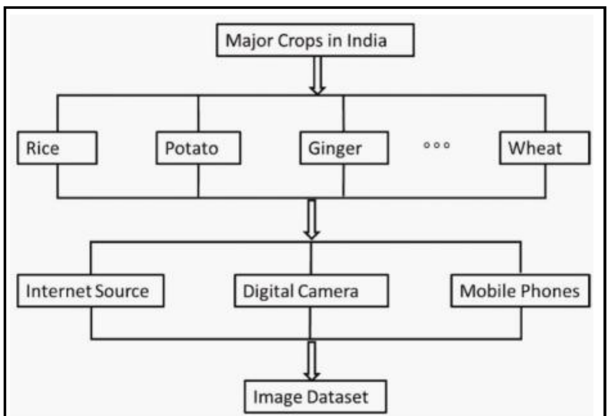


**Fig. 1: Image acquisition**

**Image annotation:**

Image annotation means labeling the images manually according to the type of disease. This is the human intelligence task. For each image present in the digital image dataset, label the disease type which is present in that particular image with the help of the domain expert. There exists two different kinds of methods to identify the diseases *i.e.* diseases identified visually and diseases identified using laboratory test. In this work, both the methods will be taken into an account. Building a model to classify the images using Convolutional neural network

**Building a model to classify the images using Convolutional neural network:**

Tensor flow is an open source machine library and will be used for training the model. It helps to develop the machine learning applications such as image classification convolutional neural networks. Convolutional Neural Networks (CNN) are deep artificial neural networks to classify images, cluster them by similarity, and perform object recognition. It helps to run on mobile platforms such as Android. Convolutional neural networks consist of input layer, convolutional layer, pooling layer, fully connected layer followed by the output layer. Here, convolutional layer applies the number of convolutional filters to the input images in order to acquire the learning parameters for the network. The pooling layer is used to reduce the number of parameters used for learning. Therefore, it reduces the computational complexity. Fully connected layersprovide connections to the previously connected layers. The output layer gives the output at the end of the computation.

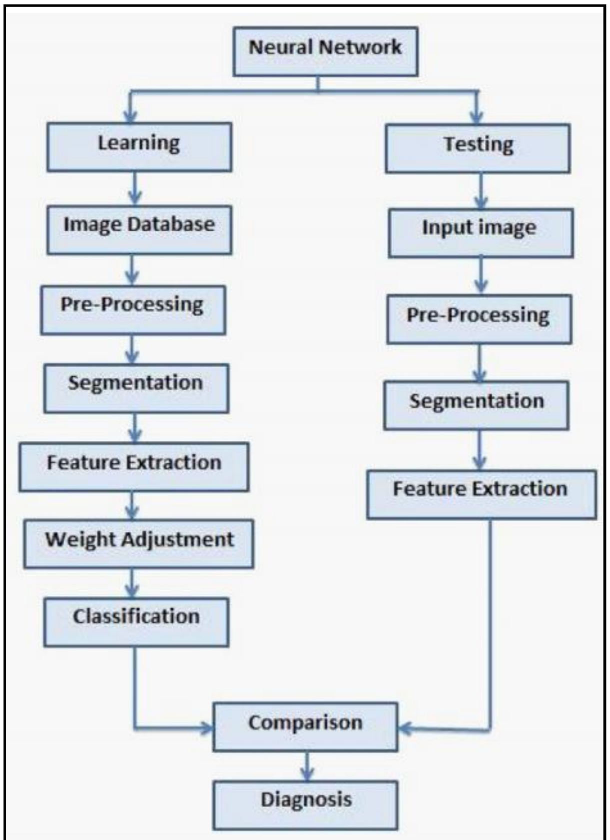


**Fig. 2: System overview**

The implementation in (Singh and Singh, 2019) focuses on SVM (Support Vector Machine) classifiers. It was observed in (Singh and Singh, 2019) that due to dependence on plant type a need to converge different classifier and under one neural network becomes important as defined by Fig. 2. The future step now would be to develop system which are able to identify disease irrespective of plant type. In General this is possible if an affliction is examined based on leaf data, but the same is not true when different plant segments are fed to the system in (Singh and Singh, 2019).

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