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Vision Based Detection and Classification of Disease on Rice Crops Using Convolutional Neural Network

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***Abstract*— This paper presents a combination of K-mean s clustering, SVM and CNN based classification techniques for the crop disease / infection with target as Rice crop. Agricultural crops show variation in features of healthy crops in color, texture and growth. Manual inspection and monitoring of crops is incompatible for large farm sizes so aerial monitoring or camera imaging can prove to be helpful for agriculturists in pre-determination of crop diseases. The use of image processing algorithms involving K-means clustering, Support vector machine and Convolutional Neural Networks enables classification process. The supervised classification techniques involve prior training process which determines the accuracy. The training dataset involved initially with 10 image set which was increased to over 50 to obtain accuracy over 95 percent.**

Keywords- *Image Processing, K-means clustering, SVM, CNN*

I. Introduction

Today agriculture is witnessing a change towards organic foods which has led to the development of techniques for green house vegetation and growth of wide varieties of crops. Detection and identification of pests, infections in farming fields is a prerequisite necessity for proper management and reduction in production loss and crop damages. With progression of science and technology and development of machine vision systems there has been a improvement in work speed, accuracy and decrement in involvement of human labor. The identification of crop parts predominantly leaves with symptoms due to pest or disease attack plays an important role in successful cultivation of crops [1, 2].

The visual detection of agricultural pests/diseases/infection involves image or video processing by the smart systems. Image processing in any domains works on two basic principles that involve color and shape. The proposed system involved image acquisition through smartphone camera on the field over infected crop areas. With the integration of various image processing techniques the proposed system is to classify and quantify two target diseases namely Scirpophaga Incertules (Rice Yellow Stem Borer) and Dicladispa Armigera (Rice Hispa) [2].

II. Related Works to Research Background

M.A. Ebrahimi et al. describe the use of SVM difference method with difference kernel function for classification of parasites. Extensive mathematical calculations for error analysis were performed using MSE, RMSE, MAE and MPE. The target pests are classified with high accuracy and graphs depict that detection of target region by integration of image processing technique with SVM classification with accuracy [1].

Huajie Liu et al. discuss the influence of imaging processing pipeline on the quality of imaging. The authors propose and implement the imaging processing pipeline with the balance between performance and resource, considering the features of microscopic camera and programmable logic device [2].

Paul Boissard et al. presents a strategy based on advanced in automatic interpretation of images applied to leaves of roses scanned. A cognitive vision system is proposed that combines image processing learning and knowledge based techniques [3].

Mohammad mehdi Maharlooei et al. presents the way to use image processing technique to detect and count different sized soyabean aphids on soyabean leaf grown in greenhouse.

The results also show captured image with an inexpensive regular digital camera give satisfactory results order illumination [4].

III. Materials and methods

A. Image acquisition and sampling

Most images were obtained through fields manually using a smartphone camera for the infected crop regions as visible from the manual inspection. For the training purpose of the system, some images were edited to improve dataset without affecting the detection algorithm. The input original images were taken in an ample brightness environment and natural environment. Algorithm was developed in MATLAB R2018b, processed the input acquired image and implemented various pre-processing techniques and detecting infection using classification techniques [5].

B. Image Pre-Processing

The acquired image needs to be filtered and pass through noise removal techniques as a standard practice. Pre processing techniques involve filtering, noise removal, contrast enhancement, histogram equalization to name a few.

C. Feature Extraction

The process of image processing urges with the desired extraction of information either in the form of disease like tumor in medical imaging or text for document imaging or infection in the agricultural imaging. Referred to as "Region of Interest" is to be separated out from the residual background in order to classify and extract desired features.

D. K-means Clustering

K-means algorithm classifies pixels based on a set of features into K number of classes. Clustering refers to the grouping of various segments of an image based on their features. For an image consisting of green leaves and white flower so based on the color features it can be clustered into two broader subparts. Further in the training phase, area of region is segmented among the three for each trainee image which is collected as a feature. During classification these features database is used to compare the test segmented region of interest [6, 7].

E. Using Support Vector Machine

SVM classification is a better, faster and accurate method of classification in the domain of image processing. Instead of features as segmented parts, layers of features are generated during the training phase. Better results can be obtained during the classification if the features layers are trained and sorted accurately. Multisvm () function and fitcsvm () function defined in Matlab give accurate results for binary classification [8, 9, 10].

F. Using Convolution Neural Network

CNN is among the developed image classification algorithm which consist of series of convolution layers with filters (Kernals), pooling, fully connected layers (FC) and then employ softmax function to classify an object [11,12].

IV. METHODOLOGY

The study area was focused to rice crops targeting two distinct diseases namely Rice Hispa and Stem Borer. Visual inspection reveals the characteristics including color transformation of leaf part and other part of the crop with pest visible in some of the acquired images.

The typical architecture of a Convolution Neural Network with the processes involved for classification [12].

- Input Image
- Feature Learning
  Convolution + Relu
  Pooling
- Classification
  Flatten
  Fully Connected
  Soft max

Deep Learning CNN models allows each test image to pass through a series of convolution layers with filters (kernals), pooling, fully connected layers (FC).Convolution layer extracts features such as edges from input image and preserves relationship between pixels. Padding is done to extract only valid portions of image and discard the ones not fitting with filters. Rectified Linear Unit (ReLU) takes care of the non linearity of the convolution network and takes care of negative and non linear values in the net. Pooling layers section accounts for reduction the parameters for large dataset keeping the necessary information intact. Fully Connected layer flattens matrix into vector and feeds to neural network. Use of Softmax as an activation function the features are combined together for model creation and classification [11, 12].

V. RESULTS AND DISCUSSION

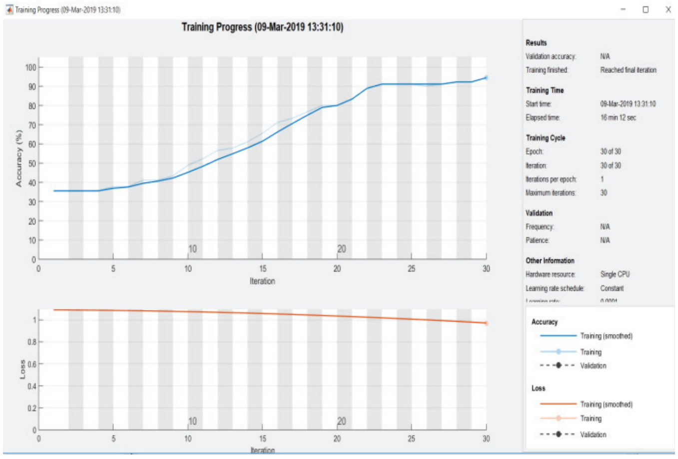

Fig. 1. Training curve for 30 images

Above figure shows the training curve for 30 images total consisting of 10 each in distinct categories which depicts that accuracy is poor for small training dataset.

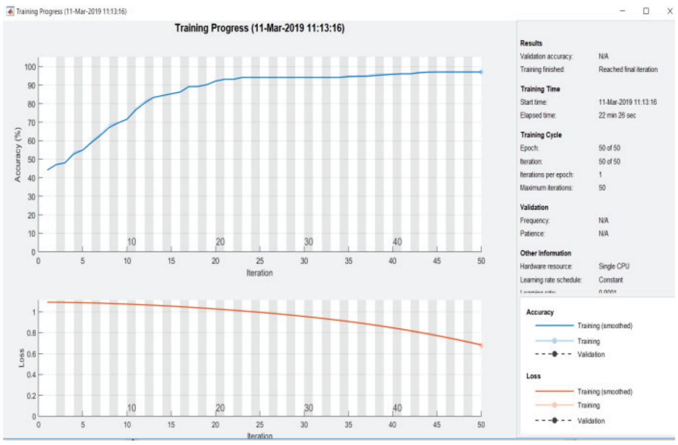

Fig. 2. Training curve for 50 images

Above figure shows the training curve for 50 images total which depicts that accuracy is improved as training dataset is incremented and iterations are about 150.

The proposed system is implemented with a GUI designed in Matlab. The designed GUI with three push buttons to acquire image, classify image and train the dataset respectively. The axes are added for demonstration of images at various processing stages.

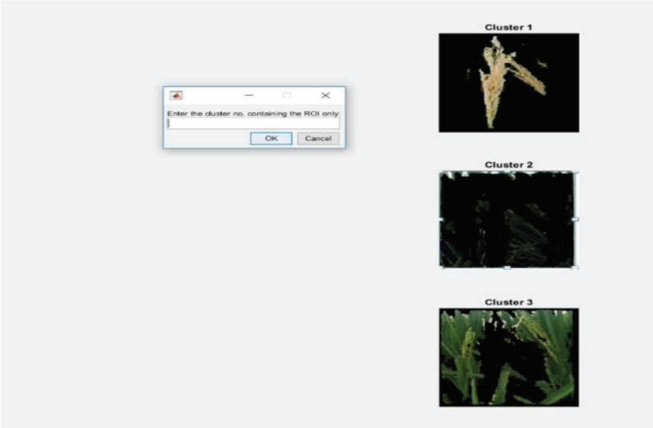

Fig. 3. Segmented portions of the image

This figure shows the segmented portions of the image which are based on K-means clustering and segmentation. Acquired image is segmented into 3 segments out of which the region of interest is to be chose by the user interfaced dialog box.

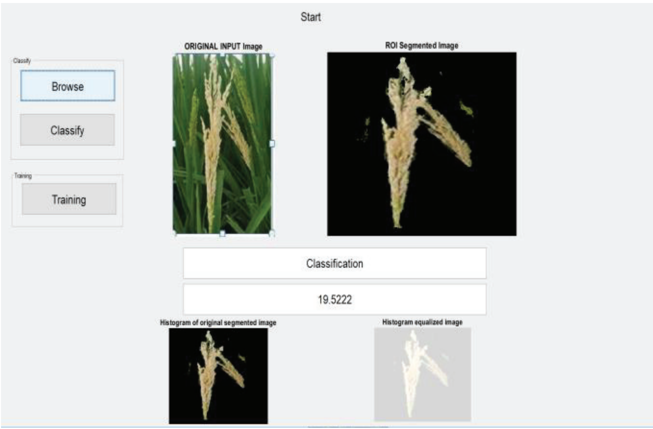

Fig. 4. Segmented portion of the test input image

This figure shows the segmented portion selected from the test input image and uses it further for classification. The bottom axes depict the histogram and equalized histogram images of the segmented region of interest.

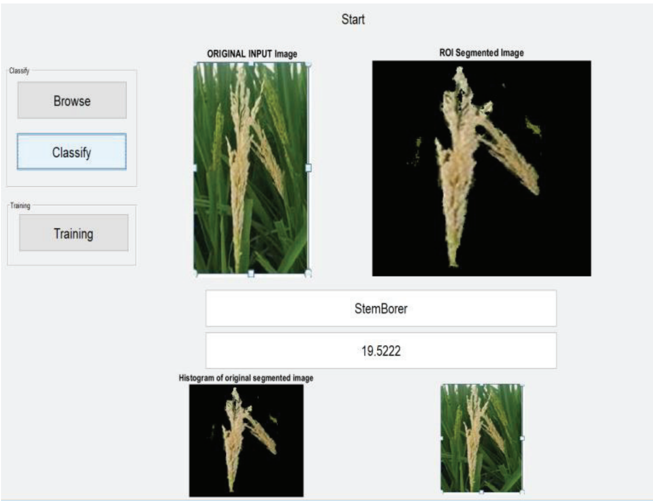

Fig. 5. Complete results with the Stem Borer disease

The above figure 5 shows the complete results with the Stem Borer disease classification as well as quantification. The Quantification is approximated with the Otsu segmentation and binarization of the original image and result is given as percentage of infection.

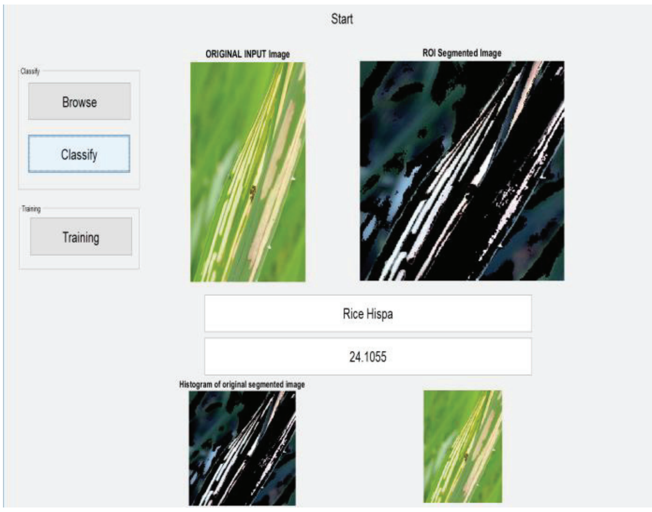

Fig. 6. Complete result for disease of Rice Hispa

The figure 6 shows the complete result for disease of Rice Hispa with classification and quantification.

VI. CONCLUSION

The present work accurately classifies and quantifies the desired two types of diseases from the rice crop and satisfactory results were obtained using combination of K-means clustering algorithm, SVM classifier and CNN based algorithms. The proposed model can be further integrated with more database as per requirement. The classification techniques need to pre-training for the feature extraction. For SVM technique each of the trainee images is individually segmented and user selects the segment with infection. All the infected segments are further processed for feature extraction and database is created for infection. For CNN based classification the trainee image are processed with a plot of accuracy. The images for database are arranged in sub-folders which are processed with the lowest limit of images among all. For small trainee data of about 30 images the accuracy obtained is around 90 percent which increases to more than 95 percent for larger trainee dataset of about 150 images as compared to previous paper [13, 14]. The accuracy of CNN algorithm is further improved with more database image selection.

The designed algorithm for classification can be further implemented to more crops and diseases with the addition of dataset images. The future work is aimed at hardware implementation of the image processing and classification techniques using FPGA board. The MATLAB codes and algorithms can be further processed for HDL code generation using Simulink modeling and HDL workflow advisor. The hardware implementation of image processing algorithms can be further improved in terms of processing speed and hardware resource utilization.

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