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AI Based Pest Detection and Protection of Crop and Leaf

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Abstract: In this world agriculture being the backbone of every developed as well as developing nation. Even though agriculture is our essential source of income and food serving, still farmers faced numerous difficulties due to climate change, degradation of soil quality, moisture, pests, weeds and food security problems. Especially plant infection/disease is one of the ongoing challenges for farmers, which imposes a threat on income and food security. Artificial Intelligence in agriculture has brought an agriculture revolution. This technology has prediction the pest infection and protects the crop from diseases by informing the farmers about the steps to be taken. The classification of the crops is done on the basis of their images by using image processing method and convolutional neural networks are applied to differentiate the healthy crops from the ones that are infected from some disease. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. This paper discussed the methods used for the detection of plant diseases using their leaves images. Further, based on the disease detected the required amount of the pesticide and their quantities are calculated to help farmers in making fast solution. The experiment is evaluated for paddy leaf and its various diseases are identified using MATLAB tool. The analyzed data will be transmitted as an SMS send to the user by PIC microcontroller. The objective of this project is to solve the problem novel way by early detection and elimination of pests with time-effective manner and gives more accurate results.

Keywords: Image Acquisition, Segmentation, Feature extraction, CNN, Microcontroller

I. INTRODUCTION

India is a cultivated country and about 70% of the population depends on agriculture. Farmers have large range of diversity for selecting various suitable crops and finding the suitable pesticides for plant. Disease on plant leads to the significant reduction in both the quality and quantity of agricultural products. The studies of plant disease refer to the studies of visually observable patterns on the plants.
Monitoring of health and disease on plant plays an important role in successful cultivation of crops in the farm[1]. In early days, the monitoring and analysis of plant diseases were done manually by the expertise person in that field. This requires tremendous amount of work and also requires excessive processing time. The image processing techniques can be used in the plant disease detection. In most of the cases disease symptoms are seen on the leaves, stem and fruit. The plant leaf for the detection of disease is considered which shows the disease symptoms.

A Country's economy development depends on the agricultural land mass and productivity. Majority of the population are depended on the agriculture. Farmers cultivate various crops based on the soil fertility and availability of resources. Due to changes in the environmental conditions such as rain fall, temperature soil fertility, the crops can get infected by fungi, bacteria and viruses. They use suitable pesticides and herbicides for the plants for preventing diseases and increasing the productivity and quality of the product.

Visual observation patterns on the plants are used for identifying and studying the plant diseases. Detection of plant disease at the initial stage will be beneficial since the disease can be controlled. In few countries the farmer's don't have any idea or facility for contacting the experts. Existing method for detection is visual observation of the leaf patterns by experts. But it requires large expert team. In such situation, an automated plant infection or disease monitoring system will be very useful. By comparing the plants leafs in the agricultural farm land with the stored plant disease symptoms by automation will be cheaper.

II. RELATED WORK

In this section, various method of image processing for plant disease detection is discussed. The vegetation indices from hyper spectral data have been shown for indirect monitoring of plant diseases. But they cannot distinguish different

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diseases on crop. Wenjiang Huang et al developed the new spectral indices for identifying the winter wheat disease. They consider three different pests (Powdery mildew, yellow rust and aphids) in winter wheat for their study. The most and the least relevant wavelengths for

different diseases were extracted using RELIEF-F algorithm. The classification accuracies of these new indices for healthy and infected leaves with powdery mildew, yellow rust and aphids were 86.5%, 85.2%, 91.6% and 93.5% respectively [1].

Enhanced images have high quality and clarity than the original image. Color images have primary colors red, green and blue. It is difficult to implement the applications using RGB because of their range i.e. 0 to 255. Hence they convert the RGB images into the grey images. Then the histogram equalization which distributes the intensities of the images is applied on the image to enhance the plant disease images. Monica Jhuria et al uses image processing for detection of disease and the fruit grading in [3]. They have used artificial neural network for detection of disease. They have created two separate databases, one for the training of already stored disease images and other for the implementation of the query images. Back propagation is used for the weight adjustment of training databases. They consider three feature vectors, namely, color, textures and morphology [3]. They have found that the morphological feature gives better result than the other two features.

Zulkifli Bin Husin et al, in their paper [4], they captured the chilly plant leaf image and processed to determine the health status of the chilly plant. Their technique is ensuring that the chemicals should apply to the diseased chilly plant only. They used the MATLAB for the feature extraction and image recognition. In this paper pre-processing is done using the Fourier filtering, edge detection and morphological operations.

Computer vision extends the image processing paradigm for object classification. Here digital camera is used for the image capturing and LABVIEW software tool to build the GUI. The segmentation of leaf image is important while extracting the feature from that image. Mrunalini R. Badnakhe, Prashant R. Deshmukh compare the Otsu threshold and the k-means clustering algorithm used for infected leaf analysis in [5]. They have concluded that the extracted values of the features are less for k-means clustering. The clarity of k-means clustering is more accurate than other method. The RGB image is used for the identification of disease. After applying k-means clustering techniques, the green pixels are identified and then using otsu's method, varying threshold value is obtained. For the feature extraction, color co occurrence method is used. RGB image is converted into the HSI translation. For the texture statistics computation the SGDM matrix is generated and using GLCM function the feature is calculated [6].

The FPGA and DSP based system is developed by Chunxia Zhang, Xiuqing Wang and Xudong Li, for monitoring and control of plant diseases [7]. The FPGA is used to get the field plant image or video data for monitoring and diagnosis. The DSP TMS320DM642 is used to process and encode the video or image data. The nRF24L01 single chip 2.4 GHz radio transmitter is used for data transfer. It has two data compress and transmission method to meet user's different need and uses multi-channel wireless communication to lower the whole system cost. Shantanu Phadikar and Jaya Sil use pattern recognition

techniques for the identification of rice disease in [9]. This paper describes a software prototype for rice disease detection based on infected image of rice plant. They used HIS model for segmentation of the image after getting the interested region, then the boundary and spot detection is done to identify infected part of the leaf.

III. PLANT DISEASE DETECTION

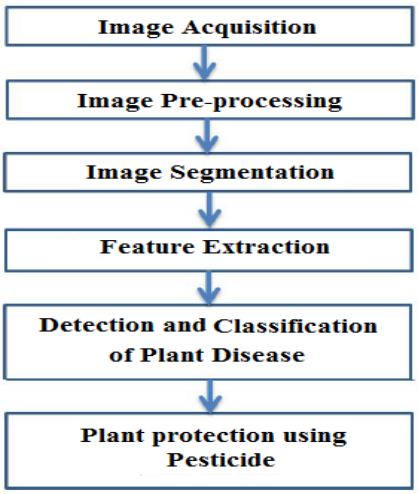

Fig.1 Basic steps for plant disease detection and classification

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Fig.1 shows the flow diagram of the proposed plant disease detection and classification method for paddy leaf.

A. Image Acquisition

The images of the plant leaf are captured through the camera. This image is in RGB (Red, Green and Blue) form. Color transformation structure for the RGB leaf image is created, and then, a device-independent color space transformation for the color transformation structure is applied [6].

B. Image Pre-processing

To remove noise in image or other object removal, different pre-processing techniques is considered. Median filter is used for removing salt and pepper noise. Image smoothing is done using the smoothing filter. Image enhancement is carried out for increasing the contrast. Then the histogram equalization which distributes the intensities of the images is applied on the image to enhance the plant disease images. The cumulative distribution function is used to distribute intensity values [2].

C. Image Segmentation

Segmentation means partitioning of image into various part of same features or having some similarity. The segmentation can be done using various methods like k-means clustering, converting RGB image into HIS model etc. The K-means clustering is used for classification of object based on a set of features into K number of classes. The classification of object is done by minimizing the sum of the squares of the distance between the object and the corresponding cluster.

D. K-means clustering

The algorithm for K –means Clustering:

1. Pick center of K cluster, either randomly or based on some heuristic.
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center.
3. Again compute the cluster centers by averaging all of the pixels in the cluster. Repeat steps 2 and 3 until convergence is attained.

E. Feature Extraction

Feature extraction plays an important role for identification of an object. In many application of image processing feature extraction is used. Color, texture, morphology, edges etc. are t he features which can be used in plant disease detection. In paper [3], Monica jhuria et al considers color, texture and morphology as a feature for disease detection. They have found that morphological result gives better result than the other features. Texture means how the colour is distributed in the image, the roughness, hardness of the image. It can also be used for the detection of infected plant areas.

F. Classification

In this system for detecting the rice blast, bacterial leaf blight and other disease of paddy, it involves major two phases one is training the model and the other part is detecting the given image of the disease. The first phase deals with training the model using the image dataset. Both healthy and disease leaf image dataset are collected. Here we have collected 200 images of rice blast, 200 images of bacterial Blight and 200 healthy paddy leaf images. The images are downloaded from the kaggle website. These images are trained with the help of Convolutional Neural Network (CNN) Algorithm. CNN architecture consists of an input layer, multiple hidden layers and an output layer. In hidden layer consist of Convolution layer, Rectified Linear Unit, pooling layer and fully connected layer. The CNN architecture for the proposed model is shown in Fig 2. The input layer takes the resized, gray scaled image and output layer produces the detection of the disease and provides remedies. The final layer is the fully connected layers which takes the high-level filtered data and translate them into categories with labels.

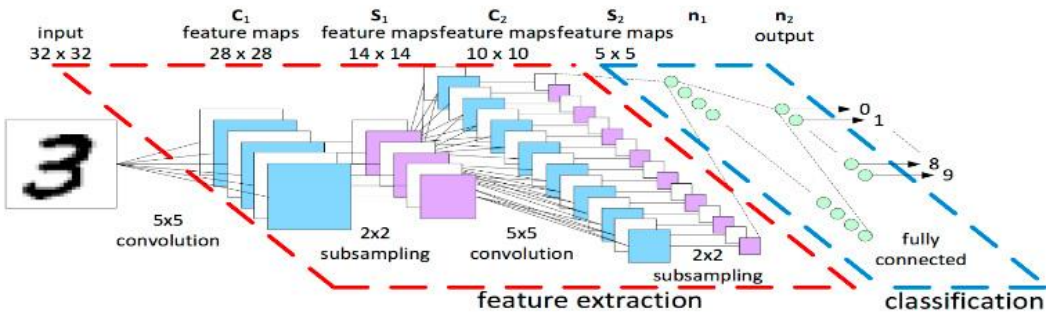

Fig. 2 CNN layers

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In the testing phase same data preprocessing is done and the image data is uploaded to CNN algorithm then the given image is compared with the training model vector then the model is able to detect the disease and provides the remedies. If more data set is used during the training the model provides better accuracy while detecting the paddy leaf disease. Some of the results obtained from our model are shown in the Fig.3.

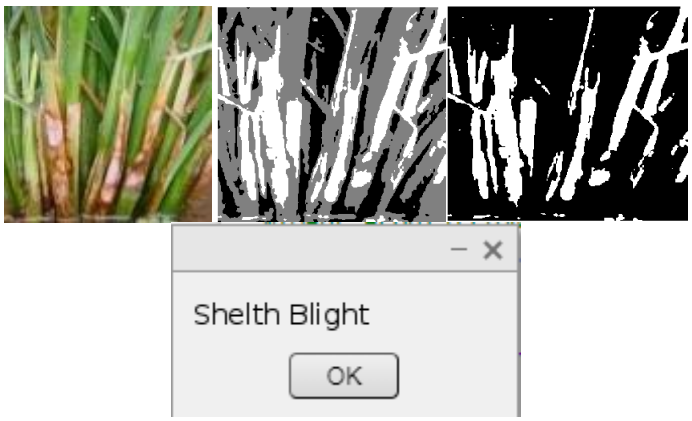

Fig.3 Input, segmented, affected part and the disease identified

IV. HARDWARE REQUIREMENTS

Fig.4 shows the hardware model of the proposed system along with the SMS received. PIC microcontroller is connected to GSM modem and MATLAB software through serial communication. M-script in MATLAB identifies the plant disease using CNN and sends it to the control through serial mode. The controller receives the information and sends the pesticide needed as SMS to the farmers. The prototype also shows the LCD display indicating disease and the pesticide.

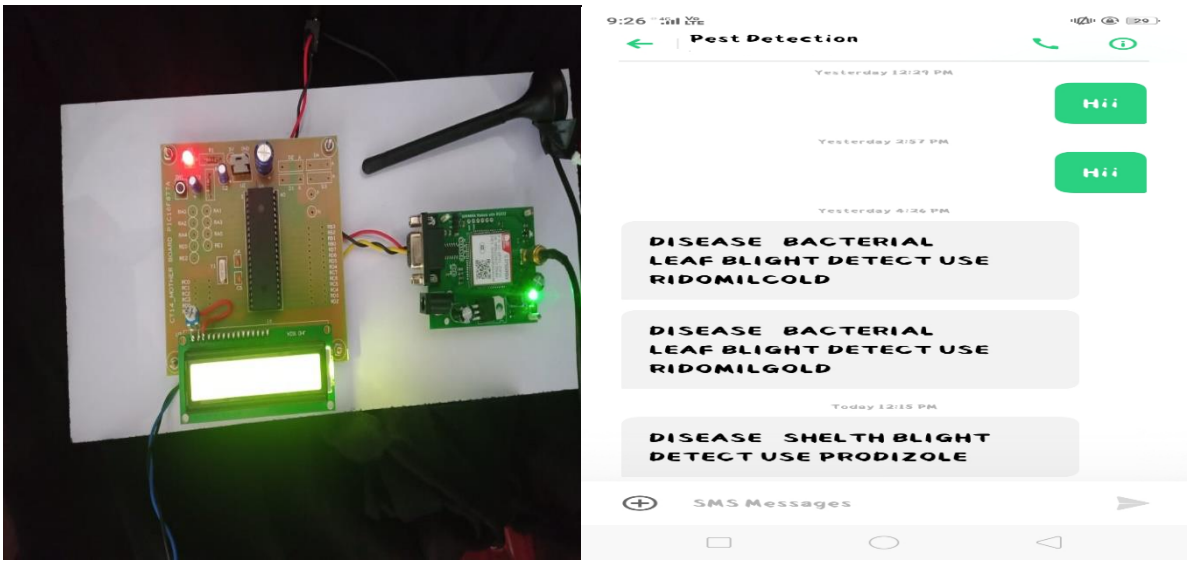

Fig. 4 Hardware model of the proposed system

The main hardware components used in the proposed design are Microcontroller, LCD display and GSM modem.

A. PIC

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

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B. GSM Modem

- Designed for global market, SIM900 is a Dual-band GSM/GPRS engine
- Works on frequencies EGSM 900 MHz, DCS 1800 MHz
- SIM300 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes

C. LCD

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by polarizes, which would result in activating / highlighting the desired characters. The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations.

V. CONCLUSION

Farmers are facing the issues with paddy crop disease identification and unable to find effective pesticide or insecticide to control the infected disease. We solve the above issue by developing a machine learning model using the Convolutional Neural Network (CNN) algorithm that detects the rice Blast, bacterial blight, other diseases and healthy paddy leaf images and provides the solution as about the pesticides in order to control the pests. The information on pesticide for a particular disease is provided to the farmers through SMS with microcontroller interface. We see that the system is robust, user friendly, fast and cost efficient result than existing method.

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