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Leaf Disease Diagnosis and Pesticide Spraying Using Agricultural Robot (AGROBOT)

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***Abstract* – Agriculture is the most essential and foremost economic activity of all the times. Until industrial revolution, the huge number of human population depends only in agriculture. But now, agriculture in India is undergoing a structural change which leads to a crisis situation. The one of the major problem developed in the agricultural field is the attacks of pests in crops. Suitable evaluation and diagnosis of crop disease in the field is very critical for the increased production. In the first module of this project, an automatic pesticide sprayer is involved to spray the pesticide to the localized area of the affected crops. This system is based on two pistons that are alternately filled with pesticide. The piston movement is controlled by stepper motors at low velocity. The inlet and outlet valves are under accurate control of solenoid valves. This will give accurate and continuous flow of fluid, even if the fluid properties and fluid conditions are varies. The design is ideal for pesticide sprayer application. In the second module, an effective pest disease diagnosis can be done by image processing. Also, the various classification and segmentation methods have been studied simultaneously.**

***Index Terms* – Agriculture, crop disease, pest disease diagnosis, stepper motors, solenoid valves.**

I. INTRODUCTION

India is the land of agriculture where three fourth of the population depends on the agriculture. Farmers will cultivate various crops in their field in accordance with the climate and other resources available to them. But to get high yield and good quality, some technical skills along with technological support is needed. The perennial fruit crop management involves very close monitoring especially in the field of disease management, which will cause serious post harvest effect. In plants, disease is identified as the change or impairment of the normal functions of the plants which will produce some symptoms. Symptom is a phenomenon of identifying some unusual evidence in the normal plants.

The disease causing agents in plants will be majorly defined as pathogens of any agent. The symptoms of these pathogenic agents will be witnessed mostly in leaves, stem and in branches of the plants. Therefore, for effective and successful crop cultivation, the disease diagnosis and the percentage of disease affected in plants are mandatory.

II. NEED FOR DISEASE DIAGNOSIS

Most of the images are generated in a single experiment especially in biological science, which has been used for many future references and studies. The acquired defective images will be classified or processed either manually or with some distinct software packages. The major issue faced is, this process has tremendous work along with excessive processing time from different individuals. The perennial fruit crop management involves very close monitoring especially in the field of disease management, which will cause serious post harvest effect.

It is evident that the abnormal symptoms produced by the pathogen will cause impairment in the physiological functions of the plants. To avoid this, the early detection of the plants disease and also remedy for those disease need to be addressed. This early detection and correction will help to reduce the effect of the damage produced in the plants. Also, the quick implementations of these remedies need to be implemented in order to rectify most of the serious damage to the whole plants.

In this paper, we have evident one of the promising approach for the disease identification has been done using image processing technique and remedy for the identified disease has been implemented.

III. PROPOSED SYSTEM ANALYSIS

Plant diseases have produced an enormous post effect scenario as it can cause significant reduction in both quality and quantity of agricultural products. Early pest detection is a major issue dealt with the plantation crops. First step involves in keen and regular observation of plants. Then the diseased plants will be classified and the affected part of the plants images will be acquired using scanners or cameras. These images are then subjected to pre-processing, transformation and clustering. Then, these images are given as input to the processor, and the processor will compare the images. If the image given is affected image, then an automatic pesticide sprayer is involved to spray the pesticide to the localized area in the leaf. If not, the processors will automatic discard it and the robot will move further.

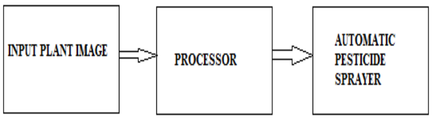

Figure 1: Basic Blocks of Pesticide sprayer

Pesticide sprayer can be applied for the following purposes:

- **TASK 1:** Identifying the defective and non defective leaves in plants.
- **TASK 2:** Classifying the type of disease attacked in the leaves.
- **TASK 3:** Pesticide spraying in defective areas.

An automatic pesticide sprayer is involved to spray the pesticide to the localized area of the affected crops. This system is based on two pistons that are alternately filled with pesticide.

The inlet and outlet valves are under accurate control of solenoid valves. This provides a continuous flow of pesticide and an accuracy that is not affected by varying fluid properties and flow conditions. The design is ideal for pesticide sprayer application.

IV. BLOCK DIAGRAM

There are three main units namely:

1. Input unit.
2. Spray and Control Processing unit.
3. Output unit.

A. Input Unit

- Input unit consists of the power supply Unit which provides power to each and every electronic component in the Robot.
- The pesticide storage unit for storage of pesticide in liquid form.

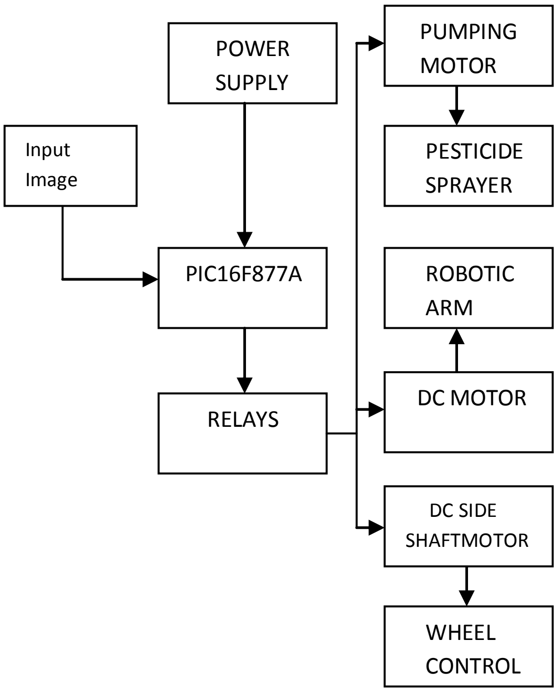

Figure 2: Block Diagram of pesticide sprayer.

B. Spray and Control Processing

- The PIC 16F877A Controller is the Heart of the Robot.
- The Driver Circuit is connected to the PIC Controller which in turn is connected to DC Motors for the purpose of Driving the Robot.
- The Pesticide Pump is used to transfer the pesticide from storage tank to the Sprayer head.

C. Output Unit

- The Direction Control unit controls the direction of the robot wirelessly.
- The Spraying Unit Will sprays the pesticide in specified direction.

Figure 2 describes the detailed diagrammatic representation of automatic pesticide sprayer. Input to the system will be the processed image; i.e. normal or defective leaf images, will be given to the PIC microcontroller. The controller will process the image and classify it as infected or normal leaf. If the input image is a pest affected image, then the processor will provide access to the relay.

The relay will act as a switch and switch on the pumping motor, which in turn spray the pesticide to the localized affected area in the infected leaves, automatically. If not, no action will be taken, the processor display it as normal image.

An automatic pesticide sprayer is involved to spray the pesticide to the localized area of the affected crops. This system is based on two pistons that are alternately filled with pesticide.

The inlet and outlet valves are under accurate control of solenoid valves. This will give accurate and continuous flow of fluid, even if the fluid properties and fluid conditions are varies. The design is ideal for pesticide sprayer application.

V. CONCEPTUAL SCHEMATIC DIAGRAM AND RESULTS

The PIC16F877A controller will be fed with the input. The controller will be connected with a stepper motor and an LCD display. If the input is normal leaf image, the motor will stay idle and a message will be displayed in the LCD, stating that the given image is normal. If not, the motor will start running; also a message will be simultaneously displayed in LCD stating that the given image is abnormal. Proteus ISIS and Micro C software are used for simulating the pesticide sprayer.

Automatic pesticide sprayer consists of following modules.

- Input image.
- Controller.
- Power supply unit.
- Relays.
- Pumping motor and pesticide sprayer device.

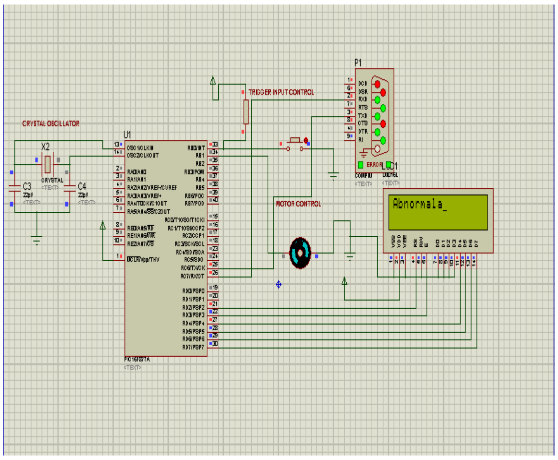

Figure 3: Simulated output for abnormal input.

The Figure 3 depicts the simulated output acquired when the input image is given as abnormal image. The LCD will display the abnormal image content and the motor will stop running once the processor detects the diseased image.

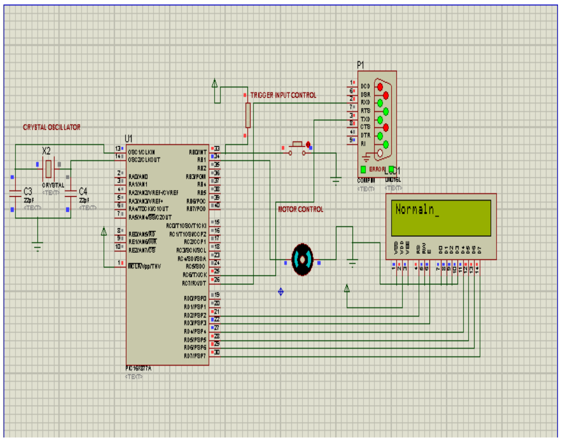

Figure 4: Simulated output for normal input.

The Figure 4 shows the simulation output of detecting defective image. We can see that LCD is displaying the image as well as the motor is also running simultaneously.

VI. IMAGE PROCESSING

The objective is to segment the leaf images using clustering Spatial FCM & classify the diseases using PNN classifier in order to detect the pest in crops. The proposed technique, Spatial FCM is compared with other clustering techniques like K-means clustering. Then the features such as colour, texture are extracted from diseased leaf image & then compared with normal leaf image. After extraction of features, the diseases are identified with PNN classifier. Thus the affected plant disease will be identified and displayed using the Matrix Laboratory software.

VI.CLUSTERING

The basic unit of an image is pixels. The group of pixels will form an image. The grouping of the pixels that belong together that has been replaced by a dataset is called as clustering. It is possible to think of image segmentation as clustering, since we are meant to group the pixels that are belong together. We can group the pixels which have same colour or same texture or they may be situated nearby in the image. In this paper, we have been using K – means clustering in order to cluster the group of images and then it will be used in PNN for disease identification.

VII. K-MEANS CLUSTERING

K-Means clustering or C-Means clustering is used to observe and analyze data as objects based on the distance and locations of various points in the input image. The main advantage of using K – means clustering algorithm is, it has higher efficiency and scalability with minimum computational time in clustering analysis

The algorithm of K-means clustering is explained below:

Input: The input will be N objects which needs to be cluster (x_1, x_2… x_n),with the number of clusters is denoted as k;

Output: The output will be k clusters and the dissimilarities of each object and its nearby cluster will be added. The centre of the nearby cluster will be very small.

Step 1: Arbitrarily select k objects as initial cluster centres (m_1, m_2 ... m_k);

Step 2: Calculate the distance between each object X_i and each cluster centre, and then the nearest cluster will be assigned to each object and the formula for calculating distance as:

$$d(x_i, m_j) = \sqrt{\sum_{i=1}^{N} (x_{i1} - m_{j1})^2}$$

i=1….N; j=1…k, where i represents data and j represents cluster and d (x_i, m_j) is the distance between i and j.

Step 3: The mean of objects in each cluster wii be calculated and the new cluster centres be,

$$m_i = \frac{1}{N_i} \sum_{j=1}^{N_i} x_{ij},$$

i=1,2…k, N_i is the number of samples of current cluster i;

Step 4: Repeat ii & iii until the criterion function E converged, return (m_1,m_2 . . . m_k).

VIII. PROBABILISTIC NEURAL NETWORKS

The main use of the PNN algorithm is the calculation of the class node activation. The class node activation is a simple process. In this process, each class node has the vector activation that need to be summed which is the product of the vectored input. The following equation shows the hidden node activation is the product of two vectors E (example vector) and F (input feature vector

$$h_i = E_i F$$

The class output activations are then defined as:

$$c_j = \frac{\sum_{i=1}^{N} e^{\frac{(h_i - 1)}{\gamma^2}}}{N}$$

In the above equation, N is defined as the total number of example vectors for this class and h_i is expressed as the hidden-node activation, and γ is represented as smoothing factor. The important factor in this is the smoothing factor, which can be selected by experimentation. The details will be lost if the smoothing factor is too large and the classifier cannot generalize if the smoothing factor is too small. The interesting thing about the PNN is that there's no real training that occurs since the example vectors serve as the weights to the hidden layer of the network. Given an unknown input vector, the hidden node activations are computed and then summed at the output layer. The class node with the largest activation determines the class to which the output feature vector belongs.

The following outputs show the step by step process to identify the type of disease in cotton leaf plant.

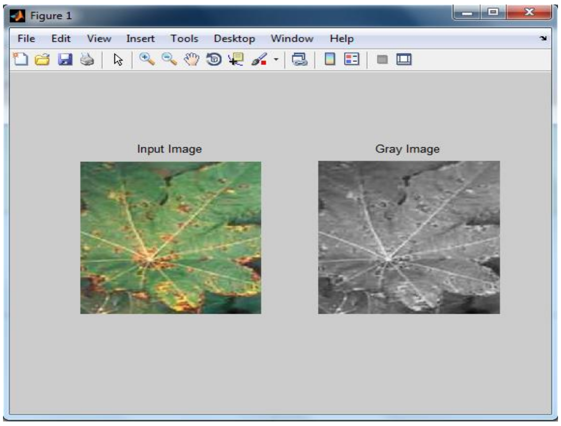

Figure 4: Gray Scale Image

The above Figure 4 shows the conversion of the input defected image into gray scale image.

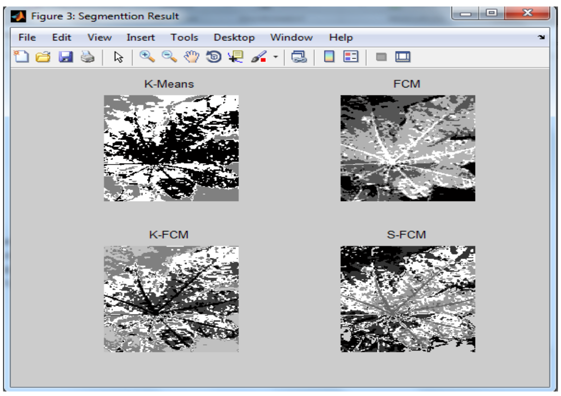

Figure 5: Segmented images.

The Figure 5 depicts the various segmentation techniques. The pre processed image will be used for segmentation.

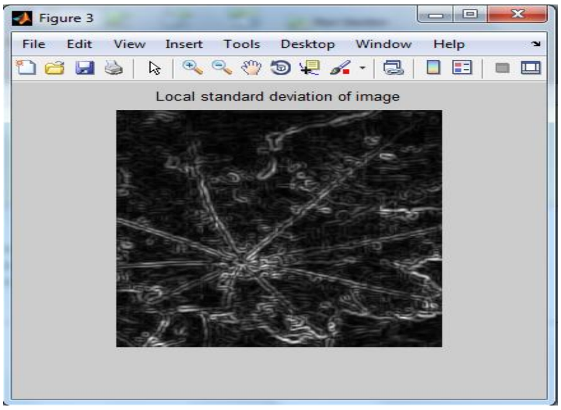

Figure 6 (a): Local Standard Deviation.

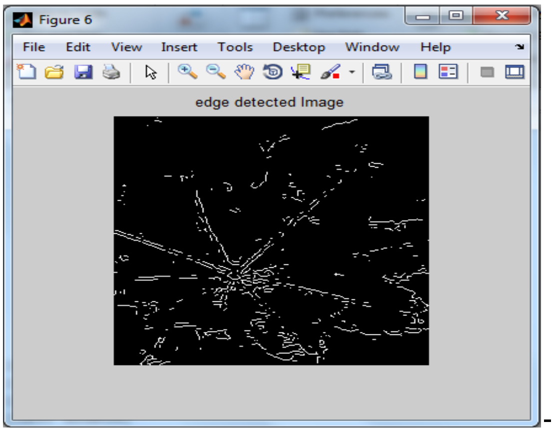

Figure 6 (b): Edge detection.

The above Figures 6(a) and 6(b) show the feature extraction of the segmented image.

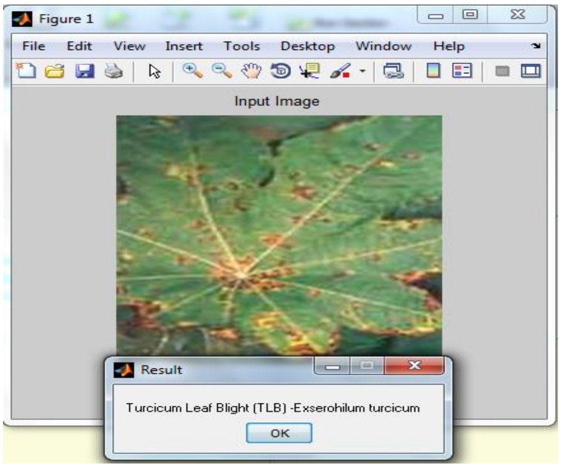

Figure 7: Diagnosed Result of the Leaf.

Figure 7 depicts the output as the disease has been identified using PNN classifier.

IX. MERITS

1. Wireless operation will eliminate the health issues and would even save them from tedious work.
2. It will have less use of manpower.
3. Efficient and health conscious operation due to remote sensing.
4. With the help of live feed of spraying the farmer is expected to control the robot wirelessly from a distant place.
5. This Robot is expected to be an all terrain robot.

X. DEMERITS

1. During the rainy season the sloppiness would reduce the speed of the robot.
2. All the electronics components need to be covered properly else environmental changes could alter the output.
3. The system is bulky.

XI. FUTURE SCOPE

1. Integrated GSM module which could control the start/stop and run operation of the robot.
2. Pre programmed GUI based navigation system.
3. Android interface to navigate the robot.

XII. ACKNOWLEDGMENT

We got a good chance to improve our ability and practical knowledge from this project. On perusing the project, I wish to express our deep sense, gratitude and sincere thanks to Dr. S. Valarmathy, Dr. M.G. Sumithra and Ms.V. Premalatha who had provided us the atmosphere for the development of the thesis and have helped us a lot in work the project.

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