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Greenhouse Automation and Disease Detection using Image Processing Algorithm

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Abstract: The processing of any particular information involves analyzing the data, describing the problem and providing a solution. Now-a-days both automated and controlled processing plays a vital role in everyday life. Automated processing of data makes any process to be compiled in a very less time with less energy consumption. We have developed many automated systems in various fields from automatic text application to smart home systems. In this project the main objective is to develop an automated greenhouse system with disease detection in plants. This project is done under the supervision of CSIR, Taramani. A small size greenhouse is developed with constant monitoring system using IoT and an individual system to capture plant images used to detect disease in plants using image processing algorithms. The ultimate goal of this project is to produce low cost, less energy consumption system which can be used by farmers as well as consumers. The initial stage of this project focuses on image processing techniques and only vegetable and fruit crops are used in the analyses process. This paper helps the end user to create his own nursery and encourages first generation greenhouse worker.

Key words: Image processing steps · IoT · Greenhouse · MATLAB

INTRODUCTION

The crop cultivation process is important, without proper cultivation it leads to decrease in plant production.Agriculture is the foremost important thing by which natural ecosystems are transformed into ones devoted to the production of food. For agiven size of the human population, agriculture is essential for our survival. The land, water and energy resources required to support this level of food production, are available in vast. Thus agriculture represents a major way in which human'ssurvival depends on the whole terrestrial system. Agriculture is basically different from undisturbed ecosystems because harvesting crops removes a particular group of cultivable plants from the whole ecological system. The product that can be harvested from an agricultural system, which is called as yield, represents a loss of materials such as water and nutrients from the soil which in turn changes into a consumable crop. Farmers can increase yields by adding energy and materials and by increasing the efficiency of energy conversion and allocation to the harvested product, or by reducing losses that occur during the growing process.

The greenhouse automation process brings a main change in the overall cultivation process. It can support for any age group of people with no effects on the environment. This process can be used by anyone when it is connected to suitable communication system. Hence the disease obtained in this process is easily detected [1]. As a normal greenhouse is prone to a strict amount of diseases which are occurring due to less sunlight, water and acidity nature of the soil [2].

The nation is striving a lot to find ways and means to keep its burgeoning population adequately fed. On one hand it is facing the problem of reduction in productivity and on the other, challenges posed by liberalization. Nowadays people are looking for different ways to improve farming. But in the end people don't meet the required requirements to achieve the whole process. For eg consider any crop production state, Tamil Nadu performed well ahead of other major states in terms of

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productivity of crops [3]. When a problem is encountered, it is difficult to find the correct solution. This happens in any application that is created by the user. So In this paper a small greenhouse model is constructed and a step of process is followed in achieving a normal accuracy. A greenhouse is a structure with a glass or plastic roof and side walls that is used for the production of ornamentals and food crops which is used for seasonally or year round. The closed environment of a greenhouse has its own unique requirements, compared with outdoor production. Pests and diseases, extremes of heat and humidity, which have to be controlled and irrigation is necessary to provide water. Significant inputs of heat and light may be required, particularly with winter production of warm-weather crops. Here, the system is an application oriented. The phase one of my project depends on developing an image processing algorithm to detect disease in plants.In step 1 the disease detection is done. In phase 2 the embedded system is constructed and a solution for the detected disease is discussed using implementation of Iot and analog devices.

In the end an application is implemented in the future so that the Iot module sends user about the disease and the end user sends information to the relay circuit to provide solution to the crop problems. This is the first application oriented system which has ever been designed [4].

Advantages of Greenhouses:

- The production yield is 10-12 times higher than that of outdoor cultivation depending upon the type of greenhouse, type of crop, environmental conditions.
- Production reliability of crop increases when cultivated under greenhouse cultivation.
- This method is ideally suited for vegetables and flower crops.
- Other than vegetable crops, year round production of floricultural crops can be done in this.
- Off-season production of vegetable and fruit crops, non-seasonal vegetables can be produced in this method.
- Disease-free and genetically superior transplants can be produced continuously in this method.
- When an automated system is used we can control the efficient utilization of chemicals, pesticides to control pest and diseases.
- Here, the water requirement of crops very limited and easy to control by normal people.

System Model:

Disease Detection

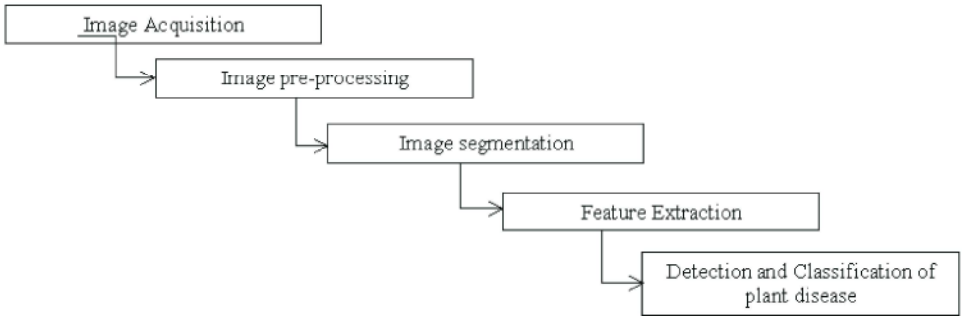

Image Acquisition: The image acquisition is the process in which the image to be analysed is captured using camera. The captured image is in the RGB form which is referred as Red, Green and Blue form. For this RGB image a separate color transformation structure is applied. In the camera a sensor array of CCD is used due to its broad range of sensing properties which is packed in a rugged array form. CCD sensors finds its usage in digital cameras and other light sensing instruments. The response of each sensor is proportional to the integral of the light energy projected onto the surface of the sensor, which the same property that is used in astronomical and other applications requiring low noise images. Noise reduction is achieved by letting the sensor integrate with the input light signal over minutes or even hours. Since the sensor array is two dimensional, its key advantage is that a complete image can be obtained by focusing the energy pattern onto the surface of the array [5].

Image Pre-Processing: To remove noise in image, different pre-processing techniques is considered. Image clipping is a process by which cropping the leaf image is done to get the image region. After clipping a smoothing process is done which is called as image smoothing using the smoothing filter. Finally, image enhancement is carried out to increase the contrast.

Image Segmentation: Image Segmentation involves in the segmenting a particular defect region from the whole image. It may also be used to segment based on same features or certain similarity. In this paper, I follow K-means segmentation followed by otsu's threshold method and finally converting RGB image into HIS model etc. Image segmentation is the process of partitioning an image into meaningful parts and is perhaps the most studied and most important topic in image analysis. This can be attributed to the importance of segmentation in image analysis and the fact that a universal method does not exist that can segment all images [6].

K-means Clustering: The K-means clustering process 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 respective cluster.

The algorithm for K –means Clustering:

- A center is chosen from a k cluster randomly or based on some heuristic.
- In image each pixel is assigned to nearby cluster which minimizes the distance between the pixel and the cluster center.
- Again compute the cluster centers by averaging all of the pixels in the cluster. Steps 2 and 3 are repeated until convergence is attained.

Otsu Threshold Algorithm: Thresholding creates binary images from grey-level images by setting all pixels below to some threshold to zero and all pixels above the threshold to one. The Otsu algorithm defined in is as follows:

- According to the threshold, separate pixels into two clusters
- Then find the mean of each cluster.
- Squaring the difference between the means.
- Multiply the number of pixels in one cluster than times the number in the other cluster.

The infected leaf region shows the symptoms of the disease by changing the color of the leaf. Hence the greenness of the leaves can be used for the detection of the infected portion of the leaf. The R, G and B component are extracted from the image. The respective threshold is calculated using the Otsu's method. Then the green pixels is masked and removed if the green pixel intensities are less than the computed threshold [7].

Feature Extraction: Feature extraction plays an important role in the identification of an object in an image. In many application of image processing feature extraction is used so that it simplifies the further processing. Color, texture, morphology, edges etc. are the features which can be used in plant disease detection. In disease detection they consider color, texture and morphology as a feature for disease detection. They have found that morphological result of the process gives better result than the other features. Texture means how the colour is distributed in the image, the roughness, hardness of the image [8]. It can also be used for the detection of infected plant areas. High-level feature extraction concerns finding shapes in computer images.

Color Co-occurrence Method: In this method both color and texture are taken into account to get a unique feature for that image. For that the RGB image is converted into the HSI translation.

$$V = \max(Rs,Gs,Bs),$$

$$S = \frac{V - \min(Rs,Gs,Bs)}{V}$$

$$H = \frac{Gs-Bs}{6S} \quad \text{if } V=Rs,$$

$$H = \frac{1}{3} + \frac{Bs-Rs}{6S} \quad \text{if } V=Gs,$$

$$H = \frac{2}{3} + \frac{Rs-Gs}{6S} \quad \text{if } V=Bs$$

Leaf Color Extraction Using H and B Components: The input image is enhanced by using diffusion technique to preserve the information of the affected pixels before separating the color from the background. To distinguish between grape leaf and the non-grape leaf part, H and B components from HIS and LAB color space is considered [9].

Classification

Using ANN: After feature extraction process is carried out, the machine learning database images are classified by using neural network. These feature vectors are considered as neurons in Artificial Neural Network. The output of the neuron is the function of weighted sum of the inputs. The back propagation algorithm modified SOM; Multiclass Support vector machines can be used.

Back Propagation: BPNN algorithm is used in a recurrent network. Once trained, the neural network weights are fixed and can be used to compute output values for new query images which are not present in the learning database.

RESULTS

Fig. 1: Original leaf image

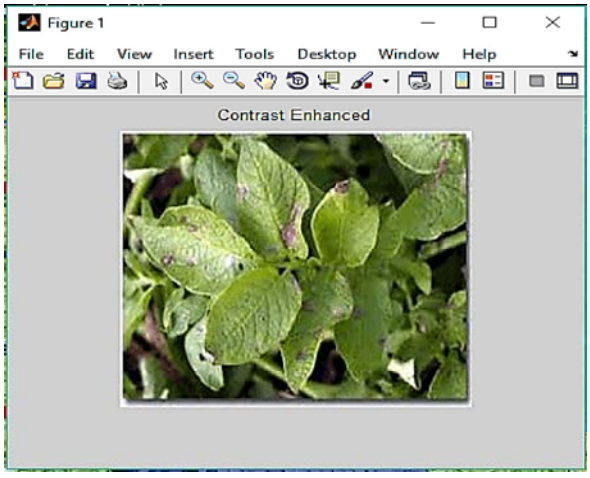

Fig. 2: Contrast Enhanced leaf image

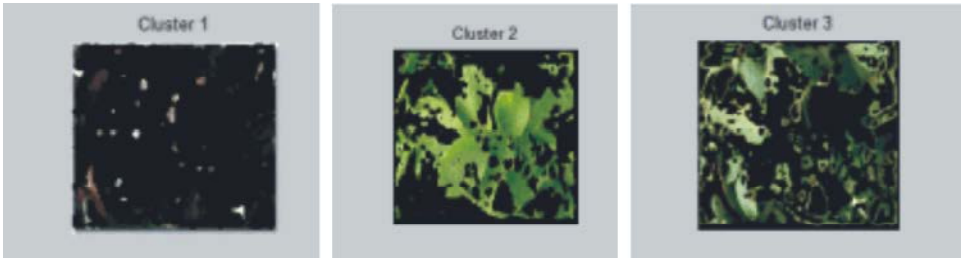

Fig. 3: Segmented Diseased Part

Fig. 4: Detected Disease

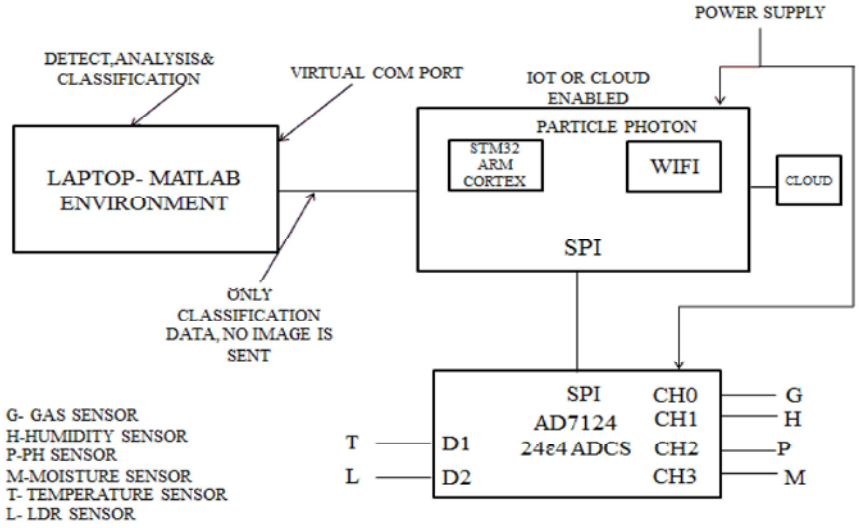

Fig. 5: Future Work

From the above results, the diseased part in the plant is detected and it is segmented seperately. This seperated part is fed into the embedded system cicuitry for further processing of the disease. The process doesn't stop till the disease detection part.It is extended and a separate system to notify the user is formed and the user is notified about further processing of the diseased region.

Furture Work: The further work is extended in developing a harware module using Particle Photon IoT device.It help wirelessly transfer data from the greenhouse to the consumer using a mobile device. It notifies the user for constant monitoring and further controlling of the whole plant. The system is given as.

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