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A Study on Real Time Plant Disease Diagnosis System

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Abstract: We aim to develop a real time application to the farmers for managing crop diseases. However, disease detection requires continuous monitoring of experts which might be prohibitively expensive in large farms area. Automatic detection of plant diseases is an essential research topic as it may prove benefits in monitoring large fields of crops and thus automatically detect the symptoms of diseases as soon as they appear on plant leaves. Regarding plant disease diagnosis methodologies to detect diseases on crops, image processing in disease diagnosis and eAGROBOT was studied. This paper is aiming to all are collectively used and formed semi real time system for a disease diagnosis which uses image processing and data mining concepts to give pesticide recommendation and pesticide cost estimation system. Thus the android application makes a good foundation for following effective characteristic parameters for the disease diagnoses and setting up recommender system. The system is to be designed and developed using Android studio as front-end software and SQLite as back-end software. The pictures and remedial measures of the diseases were stored in the database and can be retrieved whenever necessary. The challenge is to make the farmers listen to the crop disease diagnosis system and to get the advice related to the crop diseases. The constraint here is to develop the expert in local languages so that farmers can operate the ES by themselves and get expert advice from the system.

Keywords: Pesticide, Real Time Plant Disease, Pesticide Cost Estimation System.

1. INTRODUCTION

Diseases are important factors to restrict the growth of crops in agriculture producing, which may reduce yields of crops greatly and quality of products. At present, the diagnosis of crops diseases mostly depends on manual recognition, but some problem occurs, on the one hand, it can be mistakenly diagnosed by farmers because they usually judge the symptoms by their experiences. On the other hand, the disease treatment may be dallied over because the technician or expert can't go to the locale to diagnose in good time. Relative to the person's vision, computer image processing technique take on some characteristics such as speediness, huge information and distinguish small diversity which can't be distinguished by person's eyes, so image processing technique can help farmers to judge the reasons and severity of crop diseases, and it takes on important theoretical and practical significance for improving the automatic management of crop. Common symptoms include abnormal leaf growth, color distortion, stunted growth, shriveled and damaged pods. Although diseases and insect pests can cause considerable yield losses or bring death to plants and it also directly affects human health.

These require careful diagnosis and timely handling to protect the crops from heavy loses. In the plant, diseases can be found in various parts such as fruit, stems, and leaves. Leaf presents several advantages over flowers and fruits at all seasons worldwide. This enables machine vision to provide image based automatic detection and guidance. The idea behind creating an application is to enable many people to benefit from the knowledge of one person - the expert. A proposed application typically has three components viz., knowledge base, inference engine and user interface. The knowledge base is the component that contains the knowledge obtained from the domain expert. Normally, the way of representing Knowledge is using rules. The inference engine is the component that manipulates the knowledge found in the knowledge base as needed to arrive at a result or solution. The user interface is the component that allows the user to give input to the system and receive the results of those inputs.

In this paper, we propose a novel framework that focuses on the disease detection for plants. The farmers can capture the images of plant leaves using any mobile camera having a resolution greater than 5 mega pixels. The farmer needs to just capture the image of the plant leaf through the mobile camera and send the image to a central system. After acquiring images, through the proposed work, normal and abnormal leaves are classified based upon the extracted features from leaf images. The extracted features, class and the percentage area of abnormality will be given as input to the DSS. The proposed algorithm will automatically recognize the plant based on the color, texture, and shape of the leaf. The purpose of the proposed project and research work is to provide inputs for the DSS, developed for providing advice to the farmers as for when they require over mobile internet.

A. Challenges Faced By Farmers

Plant diseases can cause a significant reduction in both quality and quantity of agricultural products [4]. Typically different types of diseases are seen at different stages of development of the crops. The rate of spread differs and so does the type of pesticide. Visual inspection is the main approach adopted in practice for detection and identification of plant diseases [4]. However, this requires continuous monitoring by experts which might be prohibitively expensive. Further, in some cases, farmers may have to travel a long distance to contact experts, this makes consulting experts too expensive and time consuming [5][6][7]. Therefore, quick, automatic, less expensive but accurate method to detect plant disease cases is of great practical significance [5] [6].

B. Current Practices

During a survey conducted among the farmers, they are aware of the more common diseases and seek the help of nearby knowledgeable farmers or approach dealers with a sample of the infected crop if in case of doubt. Even then, once in three years, some farmers face extensive crop damage, the main reason being novel diseases and delay in getting critical information about controlling the spread. Over the years farmers have been using helplines setup by the government, such as the Kisan Call Centre, and are also exploring new solutions that leverage emerging imaging and M2M technologies The satellite based solutions can indicate the presence of disease but detection of disease type is more challenging if the spread is limited to 1 acre. Agriculture departments under Government of India on the other hand plan to take corrective action when a considerable mass of land up to 5 to 8 acres is found infected. In contrast, small-holder farmers use pesticides when less than 1/3rd of an acre is infected.

C. Opportunity for Image Based Solutions

Both visible and infrared regions of the electromagnetic spectra are used extensively to detect and diagnose defects in the crop as well as soil. Studies show that machine learning methods can successfully be applied as an effective early disease detection mechanism [4] [5] [6] [7]. Examples of such machine learning methods that have been applied in agricultural researches include Artificial Neural Networks (ANNs), Decision Trees, K-means, k-nearest neighbors, and Support Vector Machines (SVMs). Proposed method based on the application of K-means as a clustering procedure and ANNs as a classifier tool [6] in terms of speed of computation and accuracy. Two steps are added; one in which green colored pixels are identified for masking and second where pixels with zeros red, green and blue values together with the pixels on the boundaries of the infected cluster are completely removed. Some solutions are also available in the microscopic to the telescopic range, such as the ColorPro software for estimation of infected leaf area, chlorophyll, protein, and bacterial colonies count; CytoPro for chromosome analysis and others by BARC [2]. This has manifested confidence in image based solutions similar to the satellite solutions.

The rest of the paper is organized as follows: Section 1 gives an introductory part and importance of leaf disease detection. Also describes various types of leaf diseases and its symptoms. Section 2 describes the literature survey which presents a detailed discussion on recent work carried out in this area. The proposed approach is illustrated in section 3. The pre-processing steps used in the algorithm are introduced in section 4 which includes a proposed methodology for leaves disease extraction and classification on various image processing techniques. Section 5 describes the details regarding system architecture. Finally, section VI concludes the paper.

2. LITERATURE SURVEY

Although professional agriculture engineers are responsible for the recognition of plant diseases, intelligent systems can be used for their diagnosis in early stages. The expert systems that have been proposed in the literature for this purpose, are often based on facts described by the user or image processing of plant photos in visible, infrared, light etc. The recognition of a disease can often be based on symptoms like lesions or spots in various parts of a plant. The color, area and the number of these spots can determine to a great extent the disease that has mortified a plant. Higher cost molecular analyses and tests can follow if necessary. A Windows Phone application is described here capable of recognizing vineyard diseases through photos of the leaves with an accuracy higher than 90%. This application can easily be extended to different plant diseases and different smart phone platforms. But it is using a small training set for the image detection and also has the limitation of an application platform that is windows based application everyone cannot have a windows phone so it is not the feasible platform as much concerned with farmer's use [1].

A Study on the Method of Image Pre-Processing for Recognition of Crop Diseases Focuses on image pre-processing which can make a good foundation for the effective characteristic parameters for the disease diagnoses and more for setting up pattern recognition system. It only focuses on the image pre- processing for better segmentation effect. We are aiming to join all functionalities in which image processing is a mechanism only. Leaves with spots must be pre-processed firstly in order to carry out the intelligent diagnosis to crop diseases based on image processing and appropriate features should be extracted on the basic of this. And only in this way, crop diseases can be recognized accurately. So, the image pre-processing is very important. The image pre-processing can make following extracting of characteristic parameters not to be affected by background, shape, size of leaf, light and camera and it also make a good foundation for following effective characteristic parameters for the disease diagnoses, as well as setting up pattern recognition system [2].

eAGROBOT- A Robot for Early Crop Disease Detection using Image Processing is a Real time testing system results are obtained from cotton and groundnut plantations. The accuracy levels for disease identification for groundnut and cotton plantations are found to be satisfactory. To achieve better detection accuracy with different plant species we have to use efficient methodology [3].

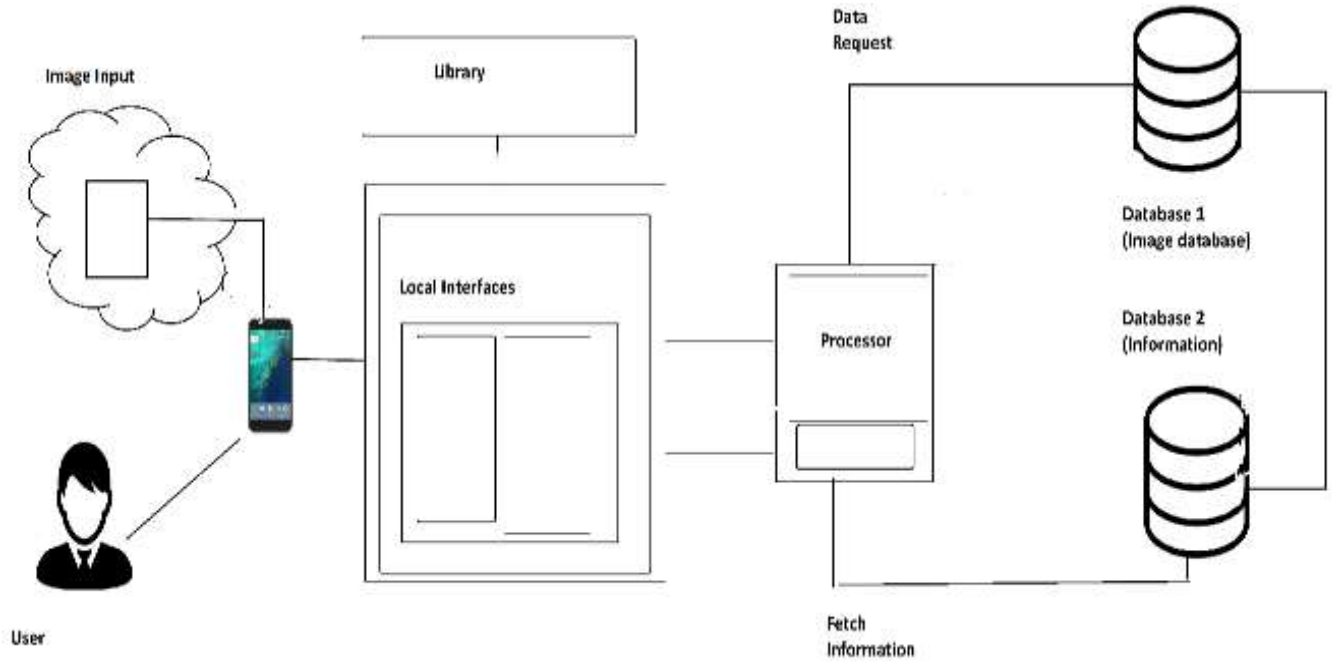
Detection and Classification of Diseases of Grape Plant Using Opposite Color Local Binary Pattern Feature and Machine Learning for Automated Decision Support System Identification of plant disease through the leaf texture analysis and pattern recognition system can be further improved by improving the training ratio [4].

Image segmentation is the key component of identifying plant leaf diseases. Most of the available techniques for leaf disease segmentation use grayscale values, an automatic seeded region growing (SRG) algorithm for color. The color difference between adjacent regions is computed using Euclidean distance metric in the algorithm. The look up table is created by traversing the image vertically and horizontally and any change in the labels of the pixel is noted in the table. The incorporation of the table helps in the better organization in region merging step and helps in the further segmentation of the image. It must be noted that the performance of colored image segmentation largely depends on the color space chosen. The algorithm is first implemented in the YCbCr color space and then implemented in other color spaces like YCgCr, CIELAB, and RGB to check for the best performance of the segmentation algorithm. Experimental results show that the SRG algorithm along with the proposed modification for region merging gives good results in the YCbCr comp Check for the best performance of the segmentation algorithm. In some cases of plant disease, some disease spots are missed and also boundary is not segmented [5].

Unhealthy Region of Citrus Leaf Detection Using Image Processing Techniques to determine the defect and severity areas of plant leaves. Need further research on test equipment, image processing and analysis method [6].

Development of Expert System to Diagnose Rice Diseases in Meghalaya State is to develop an expert system to the farmers in Meghalaya state for managing rice disease. Need expertise in generating the result. The decision making process may be delayed in some cases hence it unfollow the time constraints [7]

3. PROPOSED APPROACH



1. Platform

An image processing technique that can be implemented as a smart phone application is presented in this paper for the recognition of plant diseases. The described image processing technique can be used either as a standalone application for more accurate diagnoses [2] [4] [5]. The system isolates the lesions (or spots) that can appear at various parts of a plant like the leaves, or the fruit. The diagnosis is based on the number of spots, their area, and their color features. These features are compared with predetermined limits in order to select the matching disease.All this functionality is performed with the help of android application which has latest android platform compatibility.It uses android SQLite database for database operations. The library information is provided explicitly and some android libraries are used by the application.

2. Image Processing

It is the key process done after platform concern management, it performs all image processing operations with the help of segmentation techniques like segmentation and image feature extraction methods.

3. Database Management and Connectivity

Databases are primarily divided into two categories based on the type of information storage one is for image type data storage which has two type of images stored that is healthy images of crop and defected images of the crop. The second database is for information storage of crops their diseases, pesticides and their cost database records. Both data interlinked with processors for generating the end result.

4. Experimentation and Results

The experimentation process includes comparing the extracted image with the image in the database to check the disease after computing the image is sent to compare with First database images. The generated row then compared with information records to generate the result report with the pesticide recommendation and their cost estimation system.

ALGORITHM STEPS AND METHODOLOGIES

1. Distance Matrix

Distance Matrix is used to calculate the distance between each pair of species, and then find a tree that predicts the observed set of distances as closely as possible. The distance matrix is a two dimensional array containing the distances, taken pairwise, between the elements of a set. The distance matrix, introduced by CavalliSforza and Edwards and by Fitch and Margoliash. They were influenced by the clustering algorithms of Sokal and Sneath. Distance matrix is used in hierarchical clustering and phylogenetic analysis to carry out their distance and to calculate exact measures between the points. In general, the merges and splits are determined in a greedy manner. The results of hierarchical clustering are usually presented in a dendrogram. Manhattan Distance considered by Hermann Minkowski in 19th Century Germany is a form of geometry in which the usual distance function or metric of Euclidean geometry is replaced by a new metric. Manhattan Distance is also known as Taxicab metric/rectilinear distance/Snake distance.

Block row distance is defined as

The formula for this distance between a point $\boldsymbol{X}$=($\boldsymbol{X}_1$, $\boldsymbol{X}_2$,….$\mathbf{X}_n$) and a point $\boldsymbol{Y}$= ($\boldsymbol{Y}_1$, $\boldsymbol{Y}_2$,…..$\mathbf{Y}_n$) is $d = \sum_{i=1}^{n} |x_i - y_i|$

Where n is the number of variables, and $\boldsymbol{Xi}$ and $\boldsymbol{Yi}$ are the values of the i[th] variable, at points $\boldsymbol{X}$ and $\boldsymbol{Y}$ respectively.

2. Image Segmentation

Segmentation partitions an image into distinct regions containing each pixel with similar attributes. Segmentation is the first step from low-level image processing transforming a greyscale or color image into one or more other images to high-level image description in terms of features, objects, and scenes. Segmentation techniques are either *contextual* or *non-contextual*.

3. Non-Contextual Thresholding

Thresholding is the simplest non-contextual segmentation technique. With a single threshold, it transforms a greyscale or color image into a binary image considered as a binary region map. Non-contextual thresholding groups pixels with no account of their relative locations in the image plane. Contextual segmentation can be more successful in separating individual objects because it accounts for the closeness of pixels that belong to an individual object.

4. Region Growing

The bottom-up region growing algorithm starts from a set of seed pixels defined by the user and sequentially adds a pixel to a region provided that the pixel has not been assigned to any other region, is a neighbor of that region, and its addition preserves uniformity of the growing region.

Generally, a "good" complete segmentation must satisfy the following criteria:

1. All pixels have to be assigned to regions.
2. Each pixel has to belong to a single region only.
3. Each region is a connected set of pixels.
4. Each region has to be uniform with respect to a given predicate.
5. Any merged pair of adjacent regions has to be non-uniform.

5. K-Means Clustering

The k-means clustering algorithm attempts to split a given individual data set which is the set containing no information as to class identity into a fixed number (k) of clusters. Initially, k number of so called centroids are chosen. A centroid is a data point of imaginary or real number at the center of a cluster.

Clustering is the process of partitioning a group of data points into a small number of clusters. For instance, the items in a supermarket are clustered in categories (butter, cheese, and milk are grouped in dairy products). Of course, this is a qualitative kind of partitioning. A quantitative approach would be to measure certain features of the products, say the percentage of milk and others, and products with high percentage of milk would be grouped together. In general, we have n data points X_i,i=1...n that have to be partitioned in k clusters. The goal is to assign a cluster to each data point. K-means is a clustering method that aims to find the positions u_i,i=1...k of the clusters that minimize the *distance* from the data points to the cluster. K-means clustering solves:

$$arg\ min \sum_{i=0}^{k} \sum_{x \in c_i} d(x, \mu_i) = \arg min \sum_{i=1}^{k} \sum_{x \in c_i} ||x - \mu_i||_2^2$$

Where ci is the set of points that belong to cluster i. The K-means clustering uses the square of the Euclidean distance $d(x, \mu_i)$=‖x−μi‖$_2^2$. This problem is not trivial (in fact it is NP-hard), so the K-means algorithm only hopes to find the global minimum, possibly getting stuck in a different solution.

6. Color Transformation

Color can be described by its red (R), green (G) and blue (B) coordinates (the well-known RGB system), or by some its linear transformation as XYZ, CMY, YUV, IQ, among others. The CIE adopted systems CIELAB and CIELUV, in which, to a good approximation, equal changes in the coordinates result in equal changes in perception of the color. Nevertheless, sometimes it is useful to describe the colors in an image by some type of cylindrical-like coordinate system, it means by its hue, saturation and some value representing brightness. If the RGB coordinates are in the interval from 0 to 1, each color can be represented by the point in the cube in the RGB space.

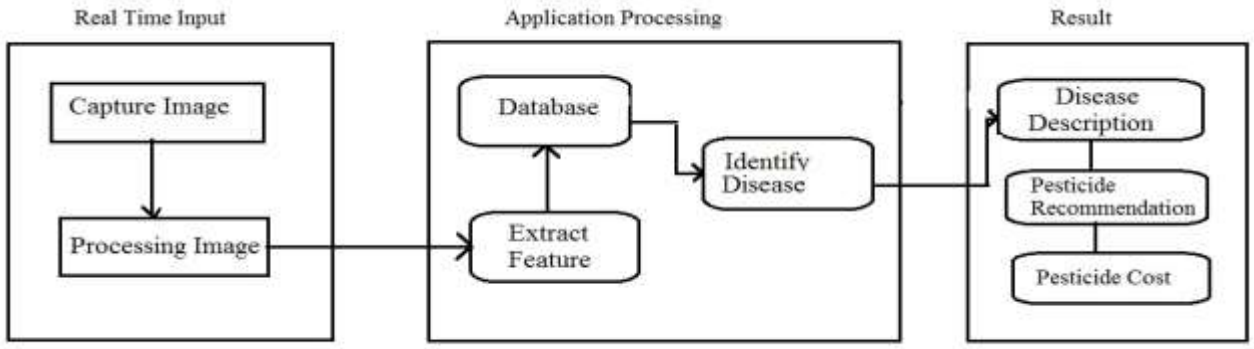
Let us imagine the attitude of the cube, where the body diagonal linking "black" vertex and "white" vertex is vertical. Then the height of each point in the cube corresponds to the brightness of the color, the angle or azimuth corresponds to the hue and the relative distance from the vertical diagonal corresponds to the saturation of the color.

The present color models have some disadvantages in practical use. E.g. we convert an image in some image processing application into some brightness-hue-saturation model and we would like to work with individual components (coordinates) as with separate images. There is desirable regarding the back conversion to have all combinations of the values. It means we need such model, where the range of values of saturation is identical for all hues. From this point of view, the GLHS color model is probably the best from the current ones, particularly for $w_{min} = w_{mid} = w_{max} = 1/3$. The good model should satisfy some demands as:

1. The brightness should be a linear combination of all three RGB components. At least, it must be a continuous growing function of all of them.
2. The hue differences between the basic colors (red, green and blue) should be 120° and similarly between the complement colors (yellow, purple and cyan). The Hue difference between a basic color and an adjacent complement one (e.g. red and yellow) should be 60°.
3. The saturation should be 1 for the colors on the surface of the RGB color cube, it means in case of one of the RGB components is 0 or 1 except black and white vertices and it is 0 in case of R=G=B.

4. SYSTEM ARCHITECTURE

The architecture is categorized into three sections i.e. real time input section, application processing, and result.Real time input goes through these three sections and provides us a result. Our aim behind providing this system architecture is that with the help of leaf image we need to identify disease and recommend pesticides for remove that disease. For that here we need the image processing because here we are finding disease with the help of crop leaf. For clicking the reliable image user need a good quality camera. After clicking the image there might be the possibility of noisy data as well as unwanted data, to remove this we are using image processing technique. After that for identifying the disease we need to extract the features in the activity comes in picture conversion of a colored image into gray scale image due to gray scale image there are only two colors i.e. white and black. Using that we can identify the disease on the basis of points present on the leaf and patterns present on the leaf.



Data mining come into the picture for identifying the disease we need to create training data set. In training data set there are multiple images which have the disease. Which leaf have already occurred disease this all images are stored in training data set. Then we can compare the extracted image with training data set. Then we need to compare this image with training data set, if the extracted image is matched with particular training data set image then we can identify the disease. After that, we got pesticides recommendation from the image. Based on recommending pesticides the cost of pesticides is estimated for particular disease and report is generated as the Disease diagnosis report.

1. Real Time Input

To identify the disease our system provides the user interface. In that user interface, there is one section which manages input image of a leaf. This is mobile application the user can capture the image using android mobiles, which have a good camera and sufficient ram memory. After clicking this image then image goes to in image processing section. Here we assume that users are not familiar with capturing an accurate image that's why we are using image processing here, in that we can remove the noisy data which is present in the leaf image.

2. Application Processing

Now actual working application starts from here. In that section extract the feature of the image that means firstly convert this image into gray scale image then identify the pattern of points which is present on the leaf. We are working here on the distance of points on a leaf. We are finding here this distance using city block algorithm. Then we need to find out edges on the leaf this can find out using segmentation algorithm. After extracting the image it goes into data mining section. In that, we need to maintain the training data set and data set are stored in the form of a cluster.

3. Result

In training data set we have maintained the different pesticides as per the disease. After knowing the disease our task is how to remove this disease and crop makes disease free. There are multiple pesticides for one disease, these different pesticides have different cost then we will recommend pesticides with the cost estimation. The user should select any one pesticides from here and apply for his crop.

5. CONCLUSION

The classification and recognition of crop diseases are of the major technical and economic importance in the agricultural Industry. To automate these activities like texture, color and shape disease recognition system is feasible. A smart phone application for plant disease recognition is presented. It is based on image processing that analyzes the color features of the spots in plant parts. Images were acquired under laboratory condition using a digital camera. The management of plants requires close monitoring especially for the management of a disease that can affect production significantly and subsequently the postharvest life. The naked eye observation of experts is the main approach adopted in practice for detection of plant diseases. The system allows the expert to evaluate the analysis results and provide feedbacks to the famers as a result of their mobile phones. The goal of this application is to develop an image recognition system that can recognize crop diseases. It can be evaluated on various common crop diseases with an accuracy that exceeds 90% using a small training set.

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