A SURVEY ON PLANT MONITORING

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Abstract: Identifying plant growth and their diseases from the images taken from the plant is one of the very interesting research areas in agriculture as well as in computer field. In this paper, it represents the survey of various techniques that are used on various steps of image processing for pre-processing techniques, feature extraction and machine learning for classification of a plant disease. Detailed study of some of the papers related to plant growth and some plant related diseases are mentioned.

Keywords: **Sobel edge, Hue Saturation Value, Hue Saturation Intensity, GrabCut, Multiclass Support Vector Machine.**

1. INTRODUCTION

Plants are very important for the ecosystem and survival of individual since they maintain the balance in an environment, they are important for the development of human being and their living. The Plant is very useful for various industries such as in medical industries, food industries, beverages industries, soap industries and much more so monitoring the plant is very important in order to determine their growth or whether the plant is infected by their diseases. Plant diseases have become a threat because it can significantly reduce the agriculture products. In India, 70-75% of the total population depends on agriculture. Monitoring the growth rate and health of plant plays a very important role in the thriving cultivation of crops especially diseases that can affect production significantly and subsequently, these monitoring can be improved by the help of technology. In this project, it includes three main modules remotely taking pictures of the plant, measuring the growth of a plant [1] [2] [3] [4] [5] [6] and detects diseases [7] [8] [9] [10] that occur in a plant.

1.1 Determining growth of a plant:

a. Image acquisition

b. Image pre-processing

c. Image segmentation

d. Feature extraction

e. Feature comparison

1.2 Detection of diseases in a plant

a. Image acquisition

b. Image pre-processing

c. Image segmentation

d. Feature extraction

e. Detection and classification of plant diseases

The steps of determining the growth of a plant and detection of the diseases in a plant are:

a. Image acquisition

It is defined as the method of acquiring source image using some hardware devices such as digital camera. There are different types of camera used for image acquisition [1] [2] [5].

i. The Image is acquired using an android phone and after taking pictures it is automatically sent to the server for processing.

ii. The Image is acquired using Logitech HD pro webcam C910 of the stereo vision system and for the camera to move above the planting bed motor was used.
iii. which it is mounted on their PE plastic board attached and place at 23cm above the planting bed in order to get the image of the whole plant and it is moving from left to right and the image is fed into the computer connected.

iii. Phytotyping 4D which uses Light field camera is used to obtain the three-dimensional (3D) structure of plant growth which provides focus image and depth image.

b. Image pre-processing

Image pre-processing step involves image restoration, correction of image distortion, removal of noise and pre-processing of color. Pre-processing [2] [7] aims at improving the image in which unwanted distortions are suppressed.

i. Color processing:

   a. RGB color spacing: RGB color space which stands for Red(R), Green (G) and Blue (B) and this is a commonly used color space and it can be perceived by human eye, these are known as primary color and any color can be formed by combining or mixture of two or more primary color.

   b. HSI color space: HSI stands for Hue (H), Saturation (S) and Intensity (I) in which H gives the spectrum of a different color such as red, yellow, green etc. Saturation it gives the measure of which color is diluted by white light. Intensity gives the brightness and it is not possible to measure.

   c. LAB color space: LAB consists of three channel Luminance(L) and two color channels which is 'a' and 'b', and this color space in device independent, in this type of color model the differences in color that we perceived it correspond to distances.

ii. Noise removal: Removal of noise is done to restore the image, the image may be dirty with dots, speckles or stains and these can be removed by using a filter such as low pass filter, averaging filter, weighted averaging filter etc.

c. Image segmentation

Image segmentation [7] [12] [13] is a method of partitioning object from digital image, where object can be segmented from its background, or image is segmented into multiple segments using different criteria, it can be segmented using color, shape etc. and there are various methods such as Edge detection methods, Thresholding based methods, Region-based methods, Cluster-based methods and Graph-based methods.

i. GrabCut [12] color image segmentation: GrabCut is based on Graph Cut and it is a color image segmentation. In the GrabCut algorithm first initialization of the Gaussian Mixture Model is done with the interaction of a user, the boundary of an object is processed with 'Border Matting' algorithm. In this segmentation algorithm, the user has to select an object from an image with a rectangle box and the GrabCut will give the result. There is also a modification of GrabCut algorithm where Multi-scale Gaussian Smooth with GMM is introduced.

ii. K-means clustering [7] [13] is a clustering method which is simple and computationally faster and it works for a large quantity of variables. In K-means clustering based on color-segmentation some color space is used such as LAB color space, and for color separation de-correlation stretching is apply, convert an image from RGB color space to LAB color space where L is luminosity, 'a' falls along red-green axis and 'b' is the chromaticity layer which falls under blue-yellow axis. Classification of colors in A and B is done using K-means clustering since information of color exists in 'a' and 'b' space so objects are pixels with 'a' and 'b' values. Euclidean distance is used to get three clusters using K-means classification method; every pixel is labeled using the results from K-means.

d. Feature extraction

Feature is extracted using different types of feature extraction algorithm [11] and it is also related to the reduction of dimensionality.

i. Color feature: color is one of the very important features of an image. Color features can be defined based on particular color space, there are many different types of color space some of them are RGB, HSV, HSI, HMMD, LAB etc. Once color model is specified then color features can be extracted from images and some of the commonly used color features are Color coherence vector (CCV), color histogram, color moments etc.

ii. Texture feature: Determining texture is an important characteristic for many images, since texture is a repeated pattern it can be measured from a group of a pixel and based on the domain of texture feature there are two main categories of texture feature they are spatial texture feature and spectral texture feature. The most commonly used texture feature extraction are Gabor filter.

iii. Shape feature: The shape is very important to be able to recognize and identify real-object, shape feature technique can be classified into contour-based extracts feature only from shape boundary and region-based methods calculate feature from the entire region of an image.

e. Detection and classification of plant diseases

After features are extracted, classification [7] is done by using a neural network. Some of them are discussed below:

i. MSVM classifier: Multiclass Support Vector Machine (MSVM) is a classifier that separates data into more than two classes. SVM is the classifier that uses hyper-plane which is also known as decision boundary to classify between the classes. The mapping of non-linear input to linear data it provides good classification in high dimensional space. The distance is maximized between different classes by SVM. The samples that are near to the margin are selected to determine the hyperplane is called support vectors. The boundary is maximized between the hyperplane and the classes.

ii. PNN (Probabilistic Neural Network): It is a non-linear classifier and it is a feed-forward neural network which uses minimum Bayesian risk criterion. It has 3 layers of nodes the input layer, the hidden layer and the output layer, at the output node for class X, all the Gaussian values for class X are summed up and the sum is scaled to, the probability volume under the sum function is unity and so that the sum forms a Probabilistic Density Function(PDF). In the hidden layer, there are nodes in the group of class 1 and some node for the group of class 2. PNN takes less time in training than traditional Back-propagation.

iii. Back-propagation Neural Network [15]: In Neural Network the training set is divided to use for testing and training, the back propagation algorithm trains the neural network, Gradient Descent method (GDM) is used to reduce the mean squared error between actual error and the output node.

2. Literature Survey

[1] Ta-Te Lin et al. In this paper an automated vision-based measurement system of plant growth is developed in which stereo vision technique is used, an image of a plant is acquired during growth process by using two off-the-shelf cameras, first the crude images were processed to find the match equivalent points between two images in position. In this paper, SURF algorithm is used and the error that we get after using SURF is corrected by using another algorithm RANSAC, the minimum cut algorithm is used to remove the error caused by light angle differences in two images. SGBM is used for plant feature extraction, but in this paper there are unexpected small changes in growth curves. These changes are due to curly and overlapped leaves.

[2]Hannes Vanhaeren et al.[2015] In this paper an aerial view image is taken using phytotyping 4D(four dimensional) on a daily basis and the plant is separated from the background by image segmentation and this is done by segmenting the image in red, blue and green(RGB), convex hull is used to get the border of the image and to determine the area covered by the plant, in this paper it mention that while plant is growing there can be overlapping of one leaf over the other so to determine this Euclidean distance transform of the edge-filtered image is used, in this paper the accuracy is quite low for determining plant size and there is problem in identifying the overlapping of the leaves.

[3] Chuanyu Wang et al.[2015] In this paper binocular stereo camera is used, for a selected maize plant marks are set with relevant static locations as reference for growth, displacement of this marked point are considered as growth value, median filter algorithm is used for noise reducing and extraction of the from soil background is done by using division algorithm and growth is measured by using plane calibrating algorithm, in this paper they aim on focussing on more automatic and robust monitor technology and systems for maize as well as other plants.

[4] Biao Jiaet al. [2014] In this paper cotton canopies color images were captured using a digital camera, the image sensor used wascharge-coupled device (CCD). All images were stored in Joint Photographic Experts Group (JPEG) format. The Image is

segmented into RGB color information. Canopy cover was calculated knowing the G: canopy reflectance green band of an image, R: canopy reflectance of the red band of an image and L is the soil baseline with values of 0 for full canopy cover and 1 for bare soil, in this paper the image segmentation is not proper so there is a need of improvement in segmentation process.

[5] Ta-Te Lin et al. In this paper stereo vision technique is used, SURF algorithm is used for finding the corresponding and matching position between two adjacent images, and in order to filter the false point matched by SURF another algorithm, RANSAC was used. The eliminate the errors caused by light angle changed, minimum cut is used to match up borders with minimal error found and these processes are continued until all adjacent images are formed into one extended image or the complete image, background of an image is were removed using GrabCut algorithm. This system can be further applied to find the most suitable environmental conditions.

[6] Federico Apelt et al. [2015] In this paper it uses light field camera and after the image is acquired watershed-based segmentation was used to extract the plant from the background, Sobel edge detection filter is used, components that do not belong to the plant are removed. To detect overlapping of leaves canny edge detection filter is used followed by distance transformation. Systems can be enhanced in future by improvements in hardware and computational methods.

[7] Sachin D. Khirade et al. [2015] In this paper RGB image is acquired through the camera and pre-processing is done by enhancing the image and increasing the contrast. Image segmentation is done using boundary and spot detection algorithm, K-means clustering and Otsu threshold algorithm and the features are extracted based on the color using color co-occurrence Method and leaf color extraction using H and B components and for classification part, ANN is used.

[8] Ghulam et al.[2013] This paper aim to implement image processing software for automatic detection and classification of plant diseases and for this first image is acquired that has been taken and stored in some hardware store devices and followed by pre-processing which include image restoration, correction of distortion, and removal of noise and then the features are extracted based on color using color co-occurrence methodology(CCM)and the classifier used is Radial Basis Function Neural Network(RBFNN).

[9] Kshitij et al. [2014] In this paper image is acquired through the android phone which is set up 30cm above from the leaves and sends to the central server for processing and the image is taken for pre-processing in which image is converted into standard library format (binary image) and then the features are extracted for the comparison with the features that was already stored in database. In this paper, it is difficult to segment when the background is complex.

[10] Arivazhagan et al.[2013] In this paper classification is done based on feature of the texture of plant leaves, first image is acquired in which to extract useful features that are necessary for further analysis, the acquired RGB is converted into HSI(hue, saturation, intensity) color space and then masking into green pixels in which we identify the mostly green color pixels and threshold is given if some green pixel is less than the threshold is given the value zero, this concept was used in the sense that green color leaf mostly represent healthy leaves. Segmentation of leaves is done into number of equal patches of 32*32 pixels and the useful segments is taken for further processing, since in this paper classification of healthy and unhealthy leaves is based on texture color co-occurrence method is used developed through the SGDM and some of the texture like energy, contrast, Local homogeneity, cluster shade and cluster prominence are computed and for classifying method the co-occurrence feature of the leaves are extracted and compared with the complementary features stored in the library features, in this paper the feature identification vectors need to further optimized.

Conclusion

Plant growth is a quantitative trait, the use of computer vision for plant sciences and especially for monitoring of plant has become an interesting stage. In this paper, it represented a survey on the different method for determining the growth of a plant and identifying the diseases that can affect a plant from growing by using various image processing technique. There are many methods for growth and disease detection and classification but still, there is lack of research on these topics. All diseases cannot be detected and some of the growth rates of a plant cannot be determined.

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