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Detection of Black Sigatoka on Banana Tree using Image Processing Techniques

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ABSTRACT : *Banana is the premier fruit of Asia and the Pacific. Banana also occupy an important position in the agricultural economies of India, Australia, Malaysia, Taiwan, Sri Lanka, and southern China. Banana agriculture is subject to many natural calamities, but diseases constitute a major problem. Biotic factors caused by pests and diseases present constant threats to banana farmers. Our main aim is not only to detection of bio-aggressors on plant leaves but as early as possible. Now days the techniques of machine vision and digital image Processing are extensively applied to agricultural science and it has great perspective especially in the plant protection field, which ultimately leads to crops management. The paper proposes a software prototype system for pest detection on the infected images of Banana leaf. Images of the infected leaf are captured by digital camera and processed using image growing, image segmentation techniques to detect infected parts of the particular plants. Then the detected part is been processed for further feature extraction which gives general idea about pests. This paper proposes automatic detection and calculating area of infection on leaves of a Black Sigatoka (Mycosphaerella fijiensis) at a mature stage on a Banana Tree.*

Keywords - *Black Sigatoka, early pest detection, feature extraction, image processing, machine vision*

I. INTRODUCTION

Banana is the most important fruit of the Asia and Pacific region. Cavendish clones are grown for the export market, but many indigenous cultivars are produced and consumed locally. Many problems affect banana agriculture. Natural calamities such as typhoons, floods, droughts and occasional volcanic eruptions cause devastating losses in banana production. Biotic factors caused by pests and diseases present constant threats to banana farmers. Some of the major disease problems are caused by viruses. BBTV (banana bunchy top virus), CMV (cucumber mosaic virus), BSV (banana streak virus) and BBMV (banana bract mosaic virus) are the four most important virus diseases affecting bananas. Unfortunately, they are all present in the Asia and Pacific region.

However, the cultivation of these crops for optimum yield and quality produce is highly technical. A lot of research has been done on greenhouse agro systems and more generally on protected crops to control pests and diseases by biological means instead of pesticides. Research in agriculture is aimed towards increase of productivity and food quality at reduced expenditure and with increased profit, which has received importance in recent time. A strong demand now exists in many countries for non-chemical control methods for pests or diseases. However no automatic methods are available which precisely and periodically detect the pests on plants. In fact, in production conditions, greenhouse staff periodically observes plants and search for pests. This manual method is to time consuming. With the recent advancement in image processing and pattern recognition techniques, it is possible to develop an autonomous system for disease classification of crops.

In this paper, we focus on early pest detection. First, this implies to regularly observe the plants. Disease images are acquired using cameras or scanners. Then the acquired image has to be processed to interpret the image contents by image processing methods. The focus of this paper is on the interpretation of image for pest detection.

II. IMPORTANCE OF EARLY PEST DETECTION

One important goal of future crop production is to reduce the usage of herbicides. Important agricultural crops are threatened by a wide variety of plant diseases and pests. About 42% of the world's total agricultural crop is destroyed yearly by diseases and pests. Farmers often must contend with more than one pest or disease and new pesticide-resistant pathogenic strains attacking the same crop.

2.1 Black Sigatoka

Black sigatoka is a leaf spot disease of banana plants caused by ascomycete fungus Mycosphaerella fijiensis (Morlet). Plants with leaves damaged by the disease may have up to 50% lower yield of fruit. Black Sigatoka, also known as black leaf streak, was named for its similarities with the yellow sigatoka caused by

Mycosphaerella musicola (Mulder), after the sigatoka Valley in Fiji where an outbreak of this disease reached epidemic proportions from 1912 to 1923.

M. fijiensis reproduces both sexually and asexually, and both conidia and ascospores are important in its dispersal. The conidia are mainly waterborne to short distances, while ascospores are carried by wind to more remote places (the distances being limited by their susceptibility to ultraviolet light). Over sixty distinct strains with different pathogenetic potentials have been isolated. In order to better understand the mechanisms of its variability, the "Genetic diversity of Mycosphaerella fijiensis Project" has been initiated. When spores of M. fijiensis are deposited on a susceptible banana leaf they germinate within three hours if there is a film of water present or if the humidity is very high. The optimal temperature for germination of the conidia is 27°C. The germ tube grows epiphytically over the epidemis for two to three days before penetrating the leaf via a stoma. Once inside the leaf the invasive hypha forms a vesicle and fine hyphae grow through the mesophyll layers into an air chamber. More hyphae then grow into the palisade tissue and continue on into other air chambers, eventually emerging through stomata in the streak that has developed. Further epiphytic growth occurs before the re-entry of the hypha into the leaf through another stoma repeats the process. The optimal conditions for M. fijiensis as compared with M. musicola are a higher temperatures and higher relative humidity and the whole disease cycle is much faster in M. fijiensis.

2.2 Effect of Leaf Spot on Production

Leaf spot or yellow Sigatoka, caused by the fungus *Mycosphaerella musicola*, is a very serious disease in tropical banana growing areas. Another form of the disease black Sigatoka, *Mycosphaerella fijiensis* , is a major threat to the industry. This note describes how yellow Sigatoka spreads and the important cultural and chemical strategies that you can use to control it. The leaf spot fungus produces two types of spores: sexual ascospores and asexual conidia. Ascospores are produced within the tissue and are forcibly ejected into the air currents. They can be carried over long distances and are responsible for spread of the disease into new plantings, new plantations and within the plantation. Ascospore infection results in tip spotting of younger leaves. Ascospores are only produced during warm moist conditions and are generally absent or in low numbers during winter and dry spring periods.Conidia are produced on the leaf surface and disperse in droplets of water, so their spread is only over short distances, generally within a plantation. Conidial infection usually results in line spotting or scattered spotting over the entire leaf.

Sigatoka leaf spot affects not only the banana leaves, but also bunch weight and fruit quality. Leaf spot will severely reduce yield when less than six viable leaves remain at harvest. Leaf spot will also cause early maturity and premature ripening of fruit. Bananas from leaf spot infected plants can ripen in the field. Field-ripe bunches harbour fruit fly and are unmarketable. Even unripe fruit from affected bunches are unsaleable, because they are likely to ripen in transit to market.

2.3 Development of Symptoms

Development of leaf spot symptoms can be divided into five distinct stages from the minute yellowish-green speck to the fully mature spot. The various stages are shown in the poster *Yellow Sigatok a*available from the DPI office at South Johnstone. With massive infections several stages are skipped, the leaf tissue dies rapidly (burns) and large areas of the leaf turn brown and then grey.

The classical diagnostic method of collecting and sending samples of the infected or damaged crop to extension services, where diagnoses are performed, are time consuming and can lead to delays in implementing control recommendations. Our objective is to develop a detection system that is robust and easy to adapt to different applications. Here we propose to automate identification and counting, based on computer vision. Computer vision methods are easier to apply in our system we simply use a consumer electronics scanner to get high-resolution images of leaves. Computer vision has a wider field of application such as disease and pest control.

III. IMAGE PROCESSING FLOW

Image Processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc.

3.1 Image Acquisition

Every image processing application always begins with image acquisition. The images can be captured using a regular digital camera with minimum 6 megapixels of resolution for better quality; maintaining an equal distance, equal angle and equal illumination to the object with uniform background. All the images should be saved in the same format such as JPEG, TIF, BMP, PNG etc.

For this study, Black Sigatoka was chosen because this bioagressor requires early detection and treatment to prevent durable infection. Samples were manually cut and scanned directly in the greenhouse as shown in Fig.1. Once the image is acquired and scanned the next step is to implement image processing technique in order to get the information about pest.

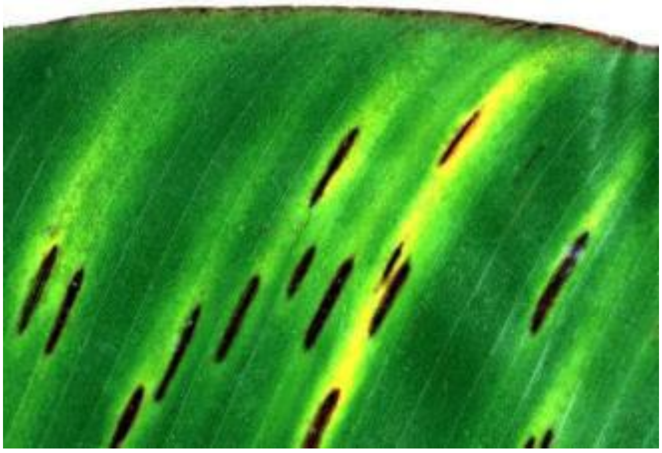

Fig1: Acquired image

The output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. In any image processing application the important input is IMAGE. An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. For the purpose of automatic detection of pests on scanned leaves the algorithm has to be followed. This algorithm is shown in fig.2. It is executed as follows.

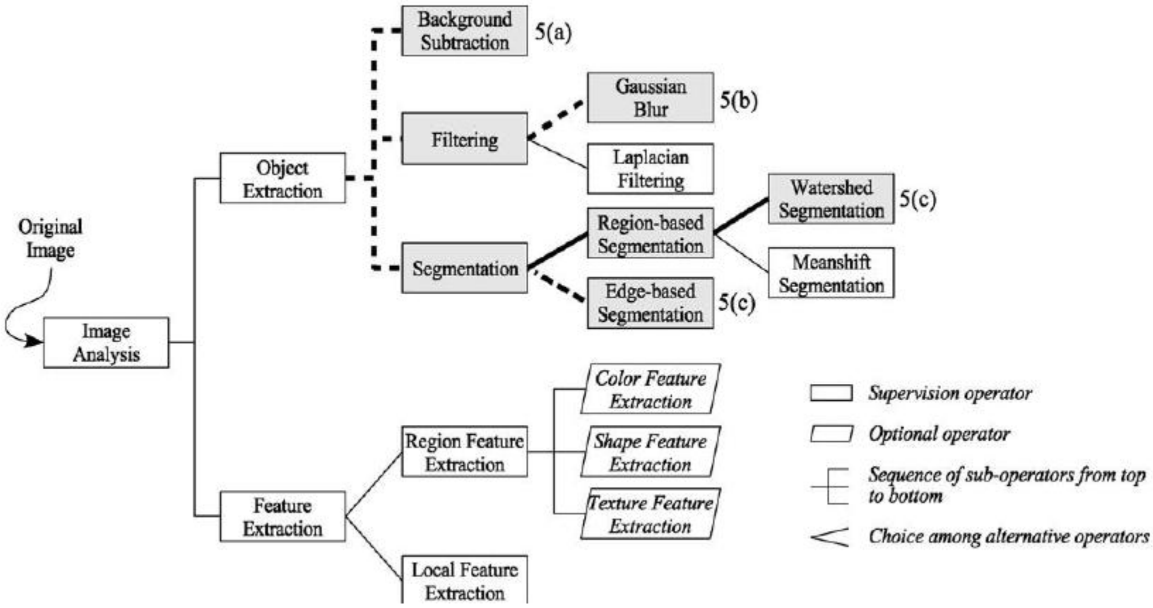

Fig.2 Flow of image processing operation

Object extraction is followed by feature extraction. Object extraction itself decomposes into a sequence background subtraction, then filtering, and finally segmentation). Since background subtraction appears on the top and corresponds to a concrete program to execute, the system invokes it. This program automatically extracts a leaf from its background image. The second sub-operator, filtering may be performed in several different ways (Gaussian, Linear, Low pass, High pass, Median or Laplacian filtering). It runs the corresponding denoising program.The next operator, segmentation, also corresponds to a choice between two alternative sub-operators: region-based and edge-based.. Similarly, once the objects extracted, the second step of image analysis, feature extraction, computes the attributes corresponding to each region, according to the domain feature concepts (e.g., color, shape and size descriptors) and to the operator graph. The process runs up to the last programming the decomposition (in the example, it appears to be shape feature extraction). Finally, through this we get the information about pests and its features which is useful data for the preventive measures that has to be undertaken.

3.2 Image Pre-Processing

Image pre-processing creates an enhanced image that is more useful or pleasing to a human observer. Pre-processing uses various techniques like image resize, filtering, segmentation, morphological operations etc. In most of the image processing applications the initial captured images are resized to a fixed resolution to utilize the storage capacity or to reduce the computational burden. Since images may be captured from the fields it will be unavoidable that some due drops, insects' excretes and dust might appear on the captured images. In image processing these are treated as image noises. They must be removed or weakened before any further image analysis. Filters like Gaussian, Median, Linear, Laplacian filters etc can be used to remove the image noise. Once the image has been enhanced, the next process is to extract region of interest in the image i.e. diseased portion of the image. This can be achieved by image segmentation.

3.3 Image Post-Processing

Once the image has been enhanced and segmented, there may be some stabs, empty holes etc remained in the images. Hence to remove these noises morphological operations, region filling can be applied. Further, the interested part can be extracted and its features can be analyzed. For an image, a feature can be defined as the "interest" part in an image. The name feature is often used in the pattern recognition literature to denote a descriptor. The desirable property for a feature detector is *repeatability*; i.e., whether or not the same feature will be detected in different images. Features play a fundamental role in classification. In image processing, image features usually include color, shape and texture features.

3.4 Disease Classification and Grading

Once the features are extracted, next step is to find to which disease class the query image belongs to and in which stage the disease is. Once the disease stage is identified, appropriate treatment advisory can be provided by seeking the help from agricultural experts so that the disease can be prevented from further spreading. For this purpose we can make use of the different machine learning techniques.

IV. OBJECT EXTRACTION

4.1 Background Subtraction

Background Subtraction is a type of image segmentation which goal is to separate the parts of the image that are invariant over time (background) from the objects that are moving or changing (foreground). The simplest techniques use frame differencing and more advanced techniques require using statistical methods. For example, a moving leave of a tree would be considered foreground using simple frame differencing but with a proper statistical method it can be considered background as the leave is always there, moving periodically.

4.2 Filtering

An image has to be filter for smoothing, sharpening, removing noise, edge detection. A filter is defined by a kernel, which is a small array applied to each pixel and its neighbors within an image. The process used to apply filters to an image is known as convolution.. The filtering process of a digital image is carried out in spatial domain. In linear spatial filtering the response of a filtering is given by sum of products of filtering coefficient and the corresponding image pixels. Within the spatial domain, the first part of the convolution process multiplies the elements of the kernel by the matching pixel values when the kernel is centered over a pixel. The elements of the resulting array (which is the same size as the kernel) are averaged, and the original pixel value is replaced with this result. The convolution function performs this convolution process for an entire image.

4.3 Segmentation

Segmentation of an image entails the division or separation of the image into regions of similar attribute. The basic attribute for segmentation is image amplitude- luminance for a monochrome image and color components for a color image. Image edges and textures are also useful attributes for segmentation. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Segmentation does not involve classifying each segment. The segmentor only subdivides an image; it does not attempt to recognise the individual segments or their relationships to one another. There is no theory of image segmentation. As a consequence, no single standard method of image segmentation has emerged. Rather, there are a collection of ad hoc methods that have received some degree of popularity. Because the methods are ad hoc, it would useful to have some means of assessing their performance. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

IV. FEATURE EXTRACTION

A feature is a cluster or a boundary/region of points that satisfy a set of pre-defined criteria. The criteria can be based on any quantities, such as shape, time, similarity, orientation, and spatial distribution. Transforming the input data into the set of features still describing the data with sufficient accuracy.In pattern recognition and image processing, feature extraction is a special form of dimensionality reduction. It is used when the input data to an algorithm is too large to be processed and it is suspected to be redundant (much data, but not much information).

VI. CONCLUSION

By using image analysis we can calculate the percentage of infected area. The given output is in form of pixels. So the infected area in percentage can be calculated by simple formula:
Percent infection= (Infected area ÷ total area) × 100
From this results we can calculate the total infection on leaf which in turn gives us information about intensity of pests infection on leaf.

Calculation of size of each pest is also done. This gives us idea about the growth of pests and also its life stage whether it is mature stage or is in pre mature stage. The given output is in form of pixels.

TABLE 1. Results for banana leaf (black sigatoka)

No. of pests		1	2	3	4	5	6	7	8	9	10
Size	Width	571	1	0	32	14	44	32	29	25	39
	Height	47	102	60	71	18	0	72	51	0	81
Area of infection of each pest		588	103	61	145	54	45	149	105	26	167

All over the world agriculture experts working on eradication of bioagressors and Banana tree diseases are one of the challenge out of it. Image Processing technique plays a vital role in it. Our first objective is to detect black sigatoka on banana tree and other bioagressors (aphids) or plant diseases are planning for future work. Cognitive approach introduce new objects to detect or new image processing programs to extract the corresponding information. We propose an original approach for early detection one of the type of pest on banana leaf. To detect biological objects on a complex background, we combined scanner image acquisition, sampling optimization, and advanced cognitive vision. It illustrates the collaboration of complementary disciplines and techniques, which led to an automated, robust and versatile system. The prototype system proved reliable for rapid detection of Black sigatoka. It is rather simple to use and exhibits the same performance level as a classical manual approach. Our goal is rather to better spot the starting points of bioagressors attacks and to count these so that necessary action can be taken.

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