Growth Prediction, Diseases Detection & Classification System for Anthurium Plants

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***Abstract*—Anthurium holds an important place as an economically beneficial flower in export market due to its consumer demand. However, it has become a challenging task for large scale Anthurium growers to identify diseases in Anthurium plant with naked eye observation in its early stages. Failing the same can lead to a situation where the plant will remain untreated and the diseases might spread rapidly across the entire plantation. This will lead to a huge loss of revenue. "Agro" is a standalone application designed to help large scale Anthurium growers to maintain a healthy plantation. The application performs tasks such as warning the user about the outbreak of a certain disease, identifying the disease, providing causes and necessary treatments to minimize the diseases and predicting the growth of the plantation considering external environmental factors. Agro is beneficial for the researchers in botany field as it is capable of identifying the disease spreading rate according to the changes of the environmental conditions. Therefore, this paper presents an efficient solution for the difficulties that large scale farmers face when monitoring plantations. The application can also be used by researchers in botany field for their study purposes.**

Keywords— image processing; neural networks; embedded platform

I. INTRODUCTION

Anthurium is an important agricultural commodity that has high demand in floriculture. Because of its attractive, long-lasting flowers, Anthurium is popular as both an exotic cut-flower crop and as a flowering potted plant [1]. Anthurium is a very economically beneficial plant for floriculturists.

Therefore, this research is aimed towards increasing the productivity of Anthurium plantation and also to promise a solution to prevent serious disruption by plant disease that could cause heavy crop losses. So it can provide an efficient solution to prevent revenue losses for the planters.

In the development stage, Anthurium plantations are threatened by pests, fungal and bacterial diseases which could adversely affect plantation flower yield. Planters often need to observe the plants carefully several times a day in order to protect their plantations from above diseases.

Therefore, early detection of Anthurium diseases is essential to save the Anthurium plantation from excessive damage. It is also necessary to reduce human error in the disease identification process. Technology can provide precise analysis without the burden of tiredness in human visual inspection to reduce the risk of human error [2]. Some diseases of Anthurium show visual symptoms, for example bacterial and fungal diseases. Those diseases show typical visual appearance on the leaves [2]. To learn the visual pattern in the disease identification process, image processing and machine learning is being used [2]. "Agro" standalone application was built in a way that can be used inside greenhouse environments.

"Agro" mainly focuses on disease identification, determining the severity of diseases and identifying the disease spreading rate according to different environmental conditions with the capability of predicting the growth of the plants.

"Agro" not only focuses on disease identification as other traditional image processing software, but it focuses on the effect of environmental conditions on growth and out breaking of diseases.

It consists of humidity, temperature and sunlight sensors to collect environmental conditions data to the application. A neural network is used to predict growth and classification of diseases along with identification of the disease spreading rate.

Purpose of implementing “Agro” standalone application in an embedded platform, is to use it inside greenhouse environments conveniently even for the planters with little knowledge about technology.

II. RESEARCH METHODOLOGY

Automatic detection of diseases, prediction of the plantation growth and risk management are evolutionary topics in the research field as they help farmers to maintain a large scale plantation in a very effective manner avoiding conventional tedious techniques.

The proposed methodology can be categorized into following functions.

1) *Image acquisition*
2) *Image preprocessing*
3) *Image enhancement*
4) *Image segmentation*
5) *Feature extraction*
6) *Training the data set*
7) *Testing neural network for disease identification*
8) *Testing neural network for growth prediction*
9) *Testing neural network for risk management*

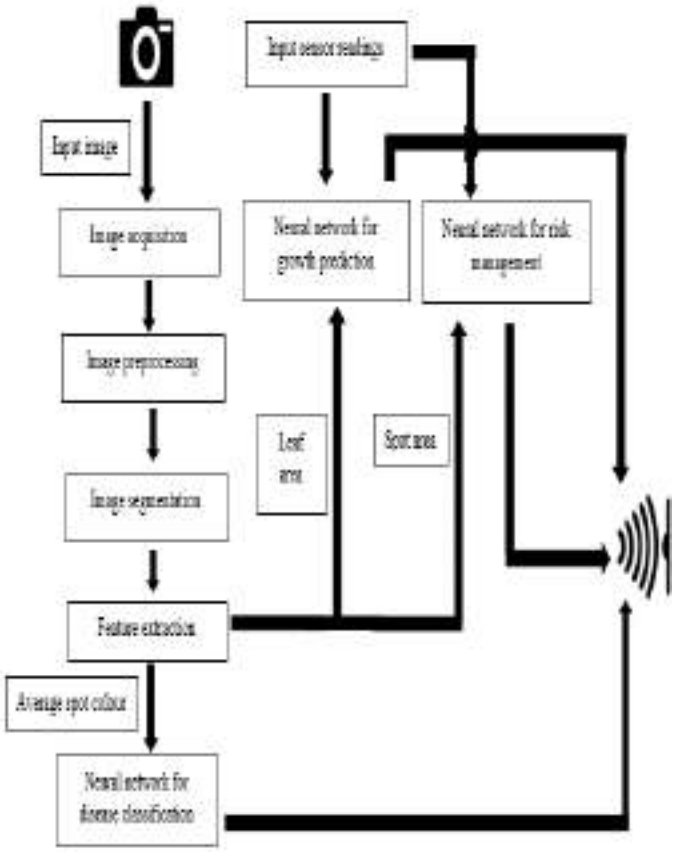

Fig. 1. High level diagram.

A. Image Segmentation and Feature Extraction

For testing purposes, a digital camera (Fuji film Fine Pix S8300 compact camera) is used for image acquisition. It provides the captured image to the system for further analysis.

This compact camera has a high quality lens which provides zooming. Images of healthy and infected plants were taken at least 3 times per day under natural environmental conditions like sunlight, humidity and temperature. The images are saved in JPG format. Then the images are used for further processing.

Image pre-processing is done for having better images as the quality images affect for having accurate results and detect features accurately. Morphological methods are used for having better shape of a spot which need to be identified clearly. According to this research methodology, images are taken in natural environment. So it’s a bit difficult task to identify spots on leaves and green area of the plantation accurately.

The concept behind the image processing part is can be explained as below.

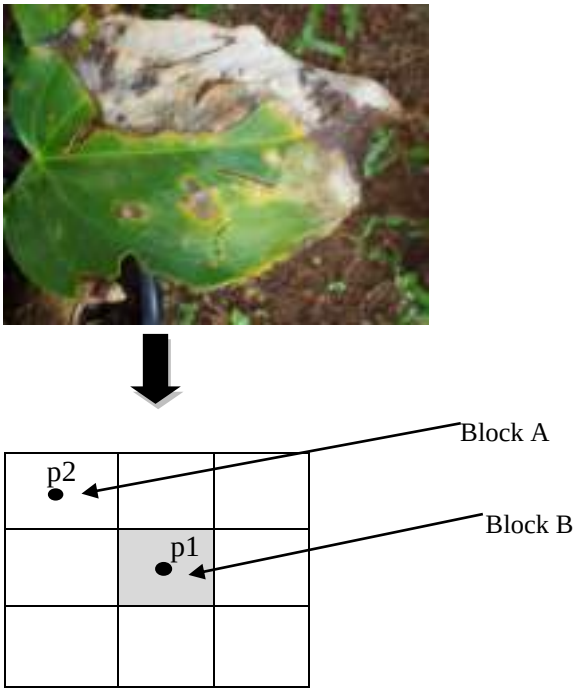

Fig. 2. Pixel level diagram of an image taken by a camera

To identify the green area and spots of leaves that are needed for feature extraction purpose, the image can be divided into smaller blocks for further simplification of the image. This is the concept behind clustering of an image using colour property of an image.

By taking mean pixel values of blue, green and red colours of the smaller blocks of an image, user can cluster the image by using its colour distance as follows. *a.*

$$MT = |R1-R2| + |G1-G2| + | B1-B2| \quad (1)$$

where

R1 -Average pixel value of red colour of block B of an image
R2 -Average pixel value of red colour of block A of an image
G1-Average pixel value of green colour of block B of an image
G2-Average pixel value of green colour of block A of an image
B1-Average pixel value of blue colour of block B of an image

Finally, necessary features like spot colour, leaf area and spot area needed to train and test the neural networks for disease detection, growth prediction and risk management are extracted from these captured images of healthy and infected plants.

B. Identifying the Diseases and Providing with Necessary Guidelines to Minimize the Diseases

Generally, Anthurium plants show early disease symptoms on the leaves. Therefore, this system mainly focuses on Anthurium leaves. Identifying diseases is done using an artificial neural network created in the embedded platform. Artificial neural networks (ANNs) are computer-based algorithms and can be trained to recognize and categorize complex patterns [3]. After extracting the features from the diseased leaves of the plants, created neural network is trained using the features. Neural network is trained using back propagation algorithm. Backpropagation is a popular form of training multi-layer neural networks, and is a classic topic in neural network courses. It has the advantages of accuracy and versatility [4].

Then the neural network is tested and validated in order to observe the response for new inputs. Finally, after clearly identifying the disease using neural network outputs, the user is informed to educate with different treatments and pesticides that can be used to minimize the spread of a particular disease using voice outputs. Following are the diseases identified through the system.

Fig. 3. Flea disease

Fig. 4. Early leaf spot disease

Fig. 5. Fungal disease

Fig. 6. Bacterial wilt disease

C. Risk Management of the Disease.

a. Identify the Effect for the Disease Spreading According to the Changes of the Environmental Conditions.

From image segmentation, diseased area is identified. Then respective temperature, sunlight, humidity sensor readings at that moment and the area (Number of pixels in diseased area) of the diseased spot will be given as inputs for this method. Neural network has been trained using back propagation algorithm. Neural network will identify the relation between the changing of the area of the diseased spot, with respect to the changes of the environmental conditions.

For that, when a diseased spot is identified in a leaf, that spot area is recorded in the system. When the application runs, (this application runs every other day) it will detect how much area has changed under the environmental conditions of that specific moment.

Then the neural network will predict the risk level for the changed rate of the area according to the past history of trained data. Risk level will be the output of the neural network. Then system will notify about the risk level to the user by using an alarm. Below table shows how each risk level is categorized. (This functionality is not useful for growers, but it can be useful for botanical researchers).

TABLE 1. DESCRIPTION OF EACH RISK LEVEL

Risk Level	**Description**
0	Very Low
1	Low
2	Medium
3	Very High

b. Identify the Environmental Conditions which Cause the Occurrence of a Disease.(Disease outbreak detection)

Purpose of this functionality is to identify the environmental conditions that cause the outbreak of a disease. A separate neural network has been implemented for this functionality. It is trained using back propagation algorithm.

Humidity, sunlight and temperature are taken as the inputs to the neural network. Environmental conditions that caused a disease as well as the environmental conditions that did not cause any disease symptoms are fed for process of training the

neural network. Then according to the trained data, neural network will predict whether the outbreak of a disease will occur or not under the environmental conditions of that moment. It will be notified to the user by an alarm.

D. Growth Prediction of the Plant with Respect to Environmental changes.

Using a neural network, the growth is predicted considering temperature, humidity and sunlight. For the training of the neural network photos of the plants are taken and the increased area of plant leaves with respect to those environmental factors are recorded. Then the increased value of the plant and the three factors are used to train the system. Sensors are used to get the environmental factors. This will be in progress to take pictures several times a day to keep monitoring the environmental factors and its effects on the growth. If it affects the growth, owner will be informed and warned to take necessary actions.

III. RESULTS AND DISCUSSIONS

The system was tested under environmental conditions and it obtained the strengths and the weaknesses of the application. The team observed the system under different conditions and obtained results from the outputs given. This research leads to create the system with less user involvement and makes it easier for the user to handle and get more familiar output. Main intension was to detect the diseases occurring in plants, monitor the growth and to predict the risk of getting a disease. Embedded platforms with video processing capability can be used for this kind of work easily and efficiently. The target users can depend on the system with the development of the technology rather than trying different manual methods to detect the problems. It can be cheap compared to employing human labor for visual inspection.

The results of Anthurium disease detection, growth prediction and real-time disease outbreak detection are shown below.

A. Disease Detection and Classification

Diseases identified with causes and treatments are shown in table 2. Diseased plant images were taken into consideration when training and testing. Identification of the above diseases using training and testing sample data showed good accuracy.

TABLE 2. RESULTS OF ANTHURIUM DISEASE IDENTIFICATION

Disease	**Causes**	**Treatments**
Flea disease	High temperature	Reduce the temperature inside the green house
Early leaf spot disease	High humidity	Reduce the humidity inside the green house
Fungal disease	Plant is too close to a source of heat or exposed to dry air	Move the plant to a cooler place with bright but not direct sunlight
Bacterial wilt disease	Temperature of the green house is low	Use fungicides that contain phosphorous acid

Above diseases are the most common Anthurium diseases that can be noticed inside Sri Lankan greenhouse environments. All these diseases can spread rapidly across the whole plantation causing huge revenue loss if not identified in early stages.

B. Growth Prediction

Following details are some of the testing records taken under different environmental conditions and area is calculated using image processing.

TABLE 3. RESULTS OF GROWTH PREDICTION

Plant	**Humidity**	**Temperature (℃)**	**Sunlight**	**Predicted growth**
A	69%	29	4566	0.38
B	67%	29	4302	0.13
C	71%	27	5623	1.52
D	65%	31	4952	0.42
E	70%	28	5174	0.99

C. Risk Management

Following details are some of the outputs of tested data. Each record contains input data, that are taken under different environmental conditions. Predicted risk level is given as the output as shown below.

TABLE 4. RESULTS OF RISK MANAGEMENT(a)
(DISEASE SPREADING)

Inputs					**Output**
Plant-Leaf No.	**Humidity**	**Temperature (C^0)**	**Sun light (Lux)**	**Diseased spot area(pixel count)**	**Predicted Risk level**
A-1	83	29	273	112345	0
A-2	68	30	706	3456787	1
A-3	73	33	985	3456765	2
B-2	58	32	971	5646775	3
B-3	61	34	970	7868791	3

TABLE 5. RESULTS OF RISK MANAGEMENT(b)
(DISEASE OUTBREAK DETECTION)

Humidity	**Temperature(C^0)**	**Sunlight(Lux)**
78	34	971
88	32	963
69	35	955
89	35	940

IV. FUTURE WORK AND CONCLUSION

This research work can be adapted for other plants/crops as well. This is a better solution compared to conventional methods such as naked-eye observation. It provides more accurate and reliable output for disease detection and growth prediction rather than naked-eye observation. The overall concept can be used for the betterment for agriculture.

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