GROWTH PREDICTION, DISEASES DETECTION & CLASSIFICATION SYTEM FOR ANTHURIUM PLANTS

Project Id: 17-082

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DECLARATION

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ABSTRACT

Anthurium is very popular as an exotic – cut flower plant and also it holds an important place as an economic flower in export market due to its attractiveness. So Anthuriums are planted in a large scale for business purposes as it is financially very profitable self-employment. Most of the time Anthurium planters report about common bacterial and fungal diseases that affects to the harvest of the plantation. Traditional naked eye observation is sometimes insufficient, inaccurate to identify the diseases in its early stage. Proposed system is capable of analyzing an image of the plantation which is randomly taken at a time during a day using segmentation techniques in image processing, and identify whether any disease is being spread through the plantation at the early stage of the disease. And also, Artificial neural network(ANN) is being trained with the data of diseased anthurium plant information and Artificial neural network is used to classify and detect the disease mentioning cause, disease and prevention methods to the user in a voice output. By considering factors like humidity, temperature and sun light inside the green-house environment, neural network predicts the growth abnormalities that can be happen to the plantation. Proposed system will be a helping hand for anthurium planters as it helps to detect diseases at earlier stages and also helps to maintain the healthy growth of the plantation through the predictions done by the neural network.

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LIST OF ABBREVIATIONS

Acronyms	Definition
Embedded system	computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. Here we refer embedded systems acronym for 'Raspberry pi'
IDE	Integrated Development Environment

1 INTRODUCTION

1.1 Background Literature

This proposed system is a growth prediction and disease detection system for Anthurium plant. Proposed system has the capability of analyzing an image using image segmentation techniques and, trained artificial neural network is used to classification and detection of the disease. And also system is capable of gathering information regarding humidity, temperature and sun light and neural network will predict the growth of the plants using past information considering those (humidity, temperature and sun light) factors. And system will warn the user by voice output and also giving the cause, disease and the instruction for prevention.

This proposed system is worthy of implementing due to so many reasons. Those reasons are Anthurium is very popular exotic – cut flower plant and also it is used for many occasions because of its attractiveness. Because of that Anthurium is very financially profitable plant not only in Sri Lanka, but also in export market as well. So most of the cultivators tend to cultivate Anthurium as a self-employment. In that because of the impossibility of identify the diseases affects to Anthurium plant at their earliest stages many cultivators lost their harvest. And it creates big financial losses to cultivators. So this proposed system is a great solution for that as it has the capability of identifying the diseases at earlier stages and also it can predict the abnormalities of the growth of the plant so that farmers can prevent the diseases before it spread across the whole plantation and so that this system is a great benefit for larger scale Anthurium planters.

1.1.1. Literature survey

Throughout the literature survey in the field of Agriculture and Information technology, there are several applications have been used for detection of diseases using image processing techniques and different classification systems for diseases diagnosis for various plants using neural network techniques and there are various researches have been done in plant growth monitoring systems also.

Many research papers have already been published for detection of diseases in leaves of plants which focus primarily on various segmentation techniques like Threshold method, Method of K-means clustering, histogram based method. [6]

No	Title	Publication	Year	Author
1	Potato Leaf Diseases Detection and Classification System	IJSMC	2016	Mr.Girish Athanikar, Ms.Priti Badar.
2	Leaf Disease Detection using Image Processing Technique	IJIREEICE	2016	Piyali Chatterjee, B. Harikishor Rao.
3	Plant Disease Detection Using Image Processing Techniques	IJIRSET	2015	Y.Sanjana,AshwathSivasam, SriJayanth.
4	Image Processing Techniques for Detection of Leaf Disease	IJARCSSE	2013	Arti N.Rathod, Bhavesh Tanawal, Vatsal Shah.
5	Automatic Detection and Classification of Plant Disease through Image Processing	IJARCSSE	2013	Mr. Pramod S. landge, Sushil A. Patil, Dhanashree S. Khot, Omkar D. Otari, Utkarsha G. Malavkar.
6	Fast and Accurate Detection and Classification of Plant Diseases	IJCA	2011	H.Al-Hiary, S.Bani-Ahmad M. Reyalat, M. Braik and Z. ALRahamneh.

Table 1. Published research paper review for detection of diseases in leaf plants.

In pattern recognition and image processing, feature extraction is a special form of dimensionality reduction. [8] Features can be classified as application independent features such as color, texture, and shape. [16] For an image, a feature can be defined as the "interest" part of the image. These features play a fundamental role in classification. [8]

There are several applications for classification of diseases using extracted features in the literature.

A. Menukaewjinda et al. [7] developed a system to identify diseases in grape leaves using color imaginary implementing a hybrid intelligent system. The system includes grape leaf disease segmentation, grape leaf color segmentation and classification of diseases. This has used a self-organizing feature map with a BPNN to recognize leaf colors. This has used SVM classification. This has also used Gabor Wavelet to analyze color features more efficiently. Then SVM is again used to classify grape leaf diseases. Girish Athanikar et al. [8] has developed a neural network based classification system for detecting diseases of potato leaves. Image segmentation is done through K-means clustering algorithm. Area, texture and color features are extracted for better implementation. The neural network is trained using BPNN algorithm. This is proved to have an accuracy of 92%.

N.Satya Priya et al. [9] has proposed a system for lemon leaf disease detection using knowledge based approach. This consists of feature extraction from the image of a leaf and identifying the type and disease stage. RGB images are converted to gray scale format. Disease portion is extracted using edge detection technique.

Artificial neural networks have used for different predictions in various systems as well as for harvest predictions. There are different approaches for various plants growth prediction by considering various other factors such as water in the soil. Although relative water contents a widely-used measure of water status that does not require sophisticated equipment, it is often argued that water potential, especially of the leaves is a more rigorous and more generally applicable measure of plant water status [1]. Number of instruments are available for monitoring of leaf thickness.

Approaches include direct measurement using linear displacement transducers [2]. Stem is another place where growth can be measured. Nevertheless, the diurnal dynamics of changes in diameter, especially of fruits, have been used to derive rather more sensitive indicators of irrigation need, where the magnitude of daily shrinkage has been used to indicate water status, and comparisons of diameters at the same time on succeeding days give a measure of growth rate. [3]

The use of expert systems, which integrate data from several sources, appears to have great potential for combining inputs from thermal or other crop response sensors and environmental data for a water budget calculation to derive a robust irrigation schedule. [4] Kacira and colleagues have developed and tested on a small scale an automated irrigation controller based on thermal sensing of plant stress. [5]

1.2 Research gap

Because of its attractive, long-lasting flowers, Anthurium is popular as both an exotic cut-flower crop and as a flowering potted-plant crop. As a crop-plant Anthurium is planted inside green- house environments by growers. [10] Anthurium is an economically beneficial plant for growers. Anthurium plant can affected by fungal, bacterial and viral diseases. These diseases cause heavy loss of the harvest of the plantation. So as a solution for that, proposed system is designed to reduce the risk of losing of harvest of the plantation.

When consider about the plant diseases detection systems, currently no any systems can be found on Anthurium plant disease detection. And it is economically very beneficial to have a system like that in case of Anthurium as it's very important economic flower in export potential as well.

Most of the researches that have been done on plant disease detection hasn't focused on the external factors such as humidity, temperature and sunlight level which affect for the healthy growth of the plant.

Currently implemented systems has only focused on disease detection of the plant. But proposed system is not only considering about the diseases that a plant has, but also proposed system is capable of predicting the growth of the plant by analyzing humidity, temperature and sunlight level inside the green-house environment. In current literature context, there are some researches have done on growth monitoring of the plants, but not growth and disease detection features together has implemented in any of those researches.

Disease detection is done by analyzing an image using image processing techniques. Most of the time currently done researches has taken images of leaf, stem or fruit. Image of a one plant is being analyzed and the disease detection is done.

So those systems cannot be used for plantations in real world. Since in a plantation taking one by one picture of plants are practically impossible, those systems are not real applicable solutions. But proposed system is applicable for real world applications. It can be used by growers to early detection of diseases and also for growth prediction purposes. By using a high-quality camera an image of whole plantation is taken then by analyzing each of the plant this proposed system can give the prediction.

Title	Publicat-ion & Year	Author	Crop/ plant	Consider Growth of the Plant	Possibility to use in a real plantation	External factors considered
Potato leaf diseases detection and classification system.	IJSMC, 2016.	Mr. Girish Athanikar, Ms.Priti Badar	Potato	NO	Weak	NO
An Overview on Detection and Classification of Plant Diseases in Image Processing.	IJSER, 2014.	Nikita Rishi, Jagbir Singh Gill	Cotton leaf spot, Rice plant, Wheat and sugar beet, Orchid leaf, Apple fruit, Chili plant	NO	Weak	NO
Leaf Disease Detection using Image Processing Techniqu e.	IJIREEICE, 2016.	Piyali Chatterjee1, B. Harikishor Rao2	Maize	NO	Weak	NO
Feasibility Study on Plant Chili Disease Detection Using	IEEE, 2012.	Zulkifli Bin Husin, Ali Yeon Bin Md. Shakaff,	Chili	NO	Weak	NO

Image Processing Techniques.		Abdul Hallis Bin Abdul Aziz, Abdul Hallis bin Abdul Aziz.				
Digital image processing techniques for detecting, quantifying and classifying plant diseases	Barbedo Springer Plus, 2013.	Jayme Garcia Arnal Barbedo	Vegetable pathology	NO	Weak	NO
Proposed System	Not yet published.		Anthurium	Yes	Excellent	Yes

Table 2. Checking of publications published for Anthurium plant with respect to different factors.

1.3 Research problem

Anthurium plantations are maintain as business at large scale. In plantations, most of the time bacterial, fungal and viral diseases are affects to Anthuriums. Growers most often report two bacterial diseases and three fungal diseases in their commercial greenhouse environments. [10] So when consider about identifying a disease in a large scale plantation, Farmers experience lot of problem in detecting and identifying the diseases. Traditionally farmers identify the diseases by naked eye observation method. [08]

Main reasons for the difficulties faced by naked eye observation method in larger plantations.

Abnormalities at very early stages might not be visible

Sometimes the abnormalities of the plant at the very early stages might not be visible to the naked eye observation method. So, most of the time when a disease is identified in the plantation it has spread up-to some extent in the plantation. So, proposed method has a very clear solution for that, there we use a high-quality camera (Fuji film Fine Pix S8300 compact camera) for image acquisition task.

It takes a photograph of whole plantation at a time on a day. And then it automatically processes and detect whether any disease is being spreading in the plantation. By a noise output system warn the users with state about the cause, disease and prevention methods

Naked eye observation cannot predict the plant growth by considering humidity, temperature and sun light.

Proposed system has the capability of predicting the disease by considering the factors such as humidity, temperature and sun light. So, if any kind of disability of above factors occur in greenhouse environment system identify it and then predictions done using the trained data of neural network. And warn the user by voice output giving predictions and instructions to avoid the unnecessary diseases to be occurred in plantation.

1.4 Objectives

1.4.1 Specific Objectives

- **Identify the effect for the disease spreading, according to the changes of the environmental conditions.(Risk Management functionality I)**
  Objective of this functionality to identify the effect of the environmental changes to the disease spreading rate and warn the user when a high disease spreading environmental condition occurs, to prevent the further damage to the plantation as environmental conditions are a huge factor for a productive healthy plantation. (This functionality not useful to Anthurium growers, But it can be useful for the researchers in botany field).

- **Identify the environmental conditions which causes the occurrence of a disease. (Disease outbreak detection)**
  Objective of this functionality is to identify the environmental conditions that cause the occurrence of a disease outbreak. And warn the user when in an environmental condition that has a high opportunity(risk) of occurring a disease.

2. METHODOLOGY

2.1 Methodology

The methodology of developing the Risk management functionality of 'Agro' application is described below.

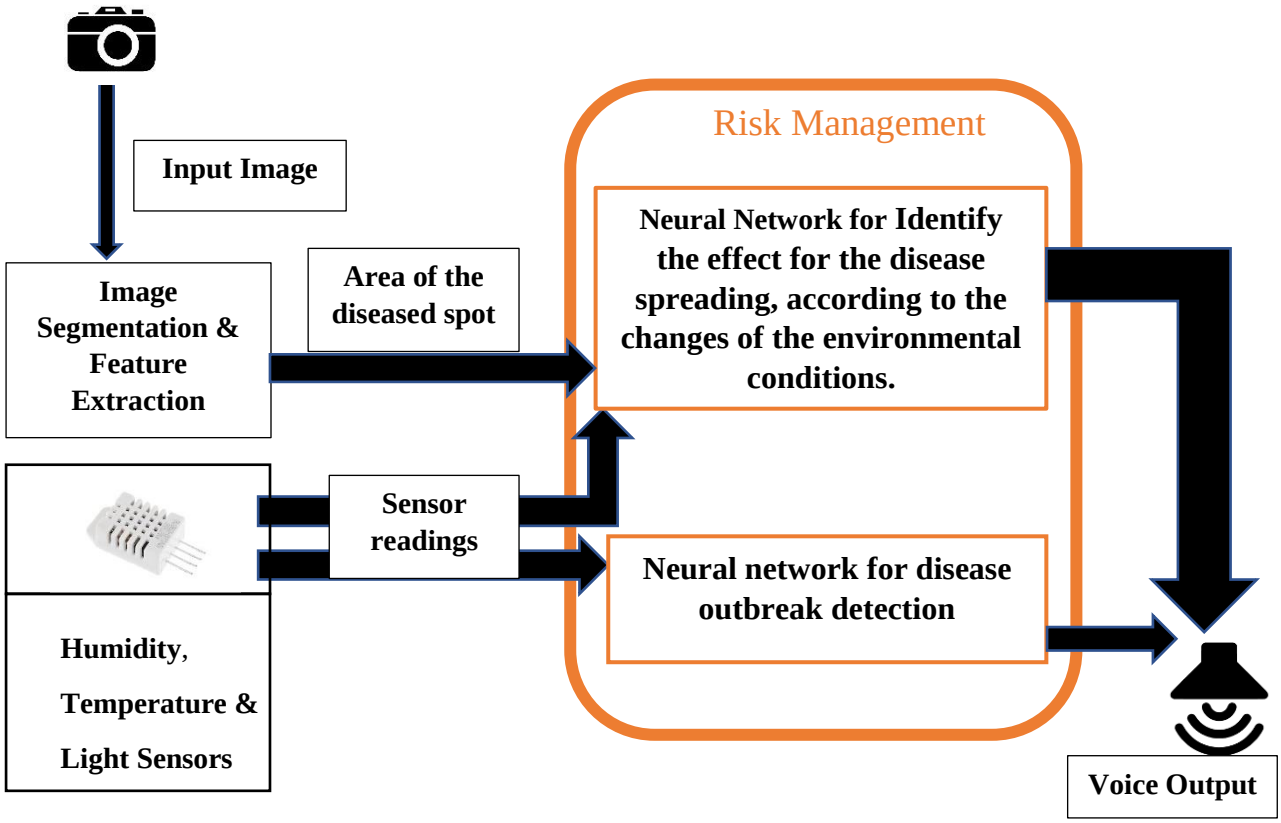

Figure 1 High Level Diagram Of Risk Management Functionality

Incremental modal is used as software development methodology in order to develop ‘Agro’.

Requirement gathering

Requirements were gathered using by,

- Reading online materials such as tutorials, research papers, web articles, python programming codes and e-books on neural networks and raspberry pi integration technologies etc.
- Reading research papers regarding leaf area measurement using Image processing techniques.
- Meeting the workers and agriculture Instructors at Gampaha Botanical garden and collected information regarding Anthurium diseases and talked about how useful will be this system for the Anthurium growers and also meeting the Anthurium growers and collected information on diseases that regularly they see at their plantations and talked about usefulness of the system for them, Since the main target users of Agro application is Anthurium growers, time to time we gathered requirements from them.

Agro standalone application runs on an embedded platform (raspberry pi), which is a tiny computer that can provide all the expected abilities that implies, at a low-power consumption level. Methodology used to implementation of the risk management functionality described below.

- **Identify the effect for the disease spreading, according to the changes of the environmental conditions.(Risk management functionality I)**

From image segmentation, diseased area is identified. and then at that moment respective temperature, sunlight and humidity sensor readings will be taken as inputs for this method. And also, the area (Pixel count in the diseased area) of the diseased spot will be given as the inputs for this method. Four-layer neural network will be used for this functionality. And it has trained using backpropagation algorithm.

Neural network will identify 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 into 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 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).

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

Table 3. Categorization of each risk level

b. Identify the environmental conditions which causes the occurrence of a disease. (Disease outbreak detection- Risk management functionality II)

Purpose of this functionality is to identify the environmental conditions that cause the occurrence of a disease. A separate four-layer neural network has been used for this functionality. And it has trained using back propagation algorithm.

Humidity, Sunlight and Temperature sensor readings has taken as the inputs to the neural network. Environmental conditions that caused to, occur a disease in plants and also the environmental conditions that plants did not show any disease symptoms has been fed to the neural network, in the training phase of 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 current environmental conditions. It will be notified to the user by an alarm.

2.2 Testing & Implementation

2.2.1 Implementation

Each module of the system is implemented independently and tested independently (unit testing). Each module was tested on the embedded platform (raspberry pi) also. For the development of risk management functionality, Python 2.7 has been used. Numpy was the library used for implementation purpose of the application. Python and numpy was used as those are compatible with the raspberry pi platform. Since the application is mainly based on voice output, we used 'Pygame' python module for the implementation of voice outputs. Pycharm is the IDE(integrated development environment) used for the development of the application as it provides all the tools for a productive python development. And also Pycharm is a cross platform IDE with Windows, macOS and Linux. Since our implementations are done in Windows platform and final product will run on Linux platform (Raspberry pi), Pycharm was selected as the IDE for the development of Agro.

2.2.2 Testing

Software testing is an investigation conducted to provide stakeholders with information about the quality of the product or service under test. Software testing can also provide an objective, independent view of the software to allow the business to appreciate and understand the risks of software implementation. Test techniques include, but are not limited to the process of executing a program or application with the intent of finding software bugs (errors or other defects).

It involves the execution of a software component or system to evaluate one or more properties of interest.

2.2.2.1 Module Testing

Unit testing, also known as component or module testing, refers to tests that verify the functionality of a specific section of code, usually at the function level. Risk management functionality I & II were tested up to unit testing level.

2.3 Research findings

Currently there is no system available for Anthurium plant which runs on an embedded platform. And also currently there are no any researchers have done to identify the effect of the environmental conditions to the disease spreading, using image processing techniques. And also, no any researchers have done so far, to identify the environmental conditions that causes for a disease outbreak.

3 RESULTS AND DISCUSSIONS

3.1 Results

This section provides evidence to the implementation results and the solutions provided for the identified research problems. Below figures shows the results of the risk management functionality I and the results of the risk management functionality II (disease outbreak detection).

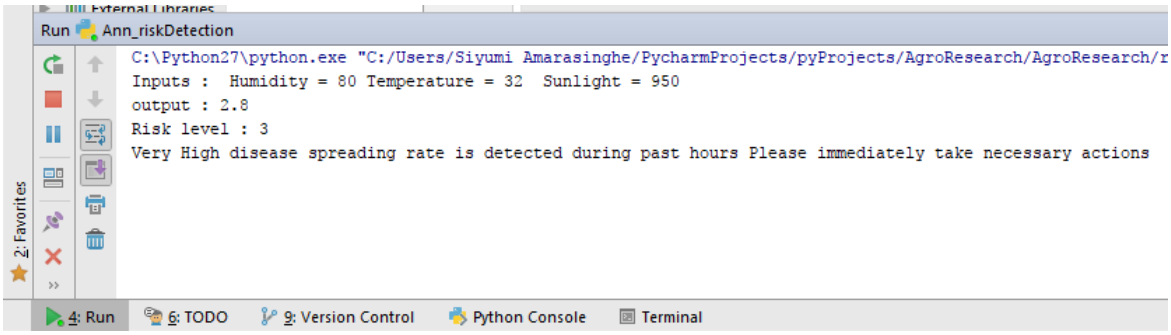

Figure 2 Results of Risk Manage ment functionality I

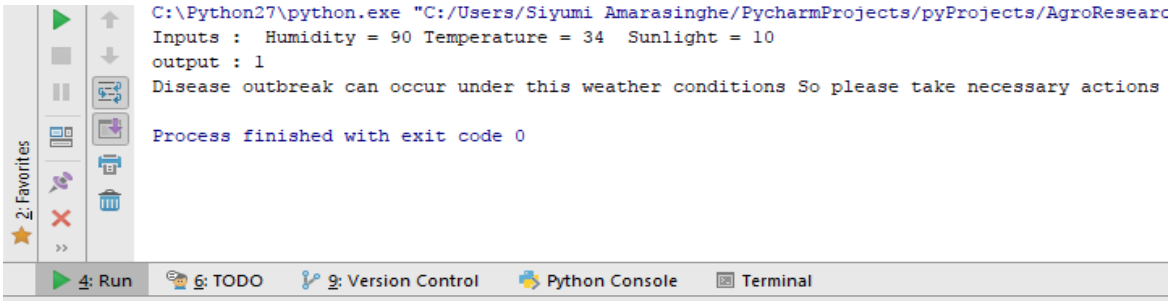

Figure 3 Results of Risk Management functionality II

4 CONCLUSIONS

According to the literature survey, there are available products which focus separately on disease detection and classification, growth prediction and predicting the disease outbreak. But we could not find a research article or application which includes all the functionalities mentioned above. Therefore, we discussed and came up with an idea of building a product which is beneficial to large scale Anthurium growers in monitoring their plantations efficiently.

Key focus was on developing a user-friendly application which can be used by people with less amount of technological knowledge. This application does not need any internet connection and runs perfectly once the user downloads and installs the application in the raspberry pi.