

SMART TEA LEAVES DISEASE ANALYSER: MOBILE BASED DISEASE DETECTING AND SOLUTIONS PROVIDING SYSTEM

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Abstract - Sri Lanka is well-known for its excellent TEA and as the 3rd largest tea manufacturing nation internationally. Sri Lanka is one of the main world's top TEA exporters with a high global demand attracting millions of foreign exchanges, which strengthens the backbone of the economy of the country. Tea is grown in the whole country including central highlands and southern inland areas, resulting in a lot of diversity in the taste of Sri Lankan tea. Although TEA is an important agricultural field, the lack of attention, lack of resources, high cost of production has reduced its productivity and quality. One of the main reasons for this low productivity can be identified as tea leaf diseases due to changes in weather, infertile soil, pests, etc. This research paper suggests an automated and economical methodology to draw-up the current inefficient manual process of disease detection of tea leaves in tea cultivation by new trends of computing field such as image processing and machine learning techniques. The steps such as Image Acquisition, Image Segmentation, Image Pre-processing, Feature Exaction and Classification and Detection of tea leaf diseases are developed into an android application to provide effective, efficient, cost-effective and highly accurate system which will establish safer growing conditions. Also, the suggested solution will reduce the environmental and ecological impact due to usage of chemicals only in necessity to approved amounts to recommendations of the mobile application.

Keywords- image processing, leaf disease detection, mobile technology, smart agriculture

I. INTRODUCTION

Tea plantation is a main source that brings foreign exchange to Sri Lanka, Sri Lanka produces 2% of Gross domestic product (GDP) of tea, donating billions to the economy of Sri Lanka. (EDB, 2014) Today, there is a high demand for Ceylon tea both locally and internationally. However, Ceylon tea plantation is endangered due to various plantation diseases occurring as a result of different environmental circumstances and Sri Lanka's farming efficiency stays low contrasted with different countries at comparable levels of advancement. (Oxford business group, 2018) Due to environmental changes such as rainfall, temperature, pests, the crop yield gets affected severely. Development of automatic detection system of tea leaf diseases using advanced computer technology such as image processing helps to support the farmers in the identification of diseases at an early or initial stage and provides useful information for its control. Therefore, the present study was carried out on automatic disease identification of tea leaf using image processing and machine learning techniques, which includes Image Acquisition, Image Segmentation, Image Pre-processing, Feature Exaction and Classification and Detection of tea leaf Diseases.

With regard to the development of technology people try to make things easier. Considering this situation, it is important to develop a method to facilitate the issues with

agricultural sector, tea plantations. To overcome those issues of tea leaves(diseases) in the current agricultural field, An Android Application, which can be used as a self-usable tool can be produced.

Over a decade, the mobile technology, such as smart-phones, tablets, different applications, etc. has become a requisite part of the human life in all over the world. With the time development of the mobile technology, the uses and the services of the mobile device have increased. The mobile technology went beyond the traditional telecommunication. It changed the way of communicating, sharing information and how their works are done. With that development, many other fields such as education, agriculture, healthcare, business, also developed.

Likewise, with the combination of mobile technology and the generation's new cognitive new solutions for the current concepts on agriculture have changed dramatically. As one prospective solution this paper suggests an Android based mobile application that detects the diseases at an early or initial stage and provides useful information for its control or extinction.

Whenever, user is having an issue with tea leaves they can input those images to the application using its image recognizable scanner. Then it will provide the solution with all the necessary steps. It will also provide appropriate diagrams and other similar solutions.

Because of this proposed system, farmers do not want to refer many reference books and online tutorials or wish for the assistance of tea inspectors. They can manage to find the solution using their fingertips. It will reduce the high time consumption, that they have spent on waiting.

The proposed system is a, system which contains the graphical symptoms of tea leaves and other parts of the tea plant, so that the users will be able to use their mobile device whenever necessary to scan the relative infected leaf and diagnose the disease in a much effective, less time consuming and a very much cost-effective way

A study done by (Deshmukh, n.d.) states that professional detection of plant diseases can be excessively high in cost through naked eyes, specifically in developing countries. As a solution paper discusses providing a fast, programmed, cost-effective and precise solution which

makes the image processing as the base. For the leaf disease detection field, it can be a great idea which could be developed using relevant techniques.

Smart mobile phone has become an essential thing for the people today. Therefore, using an application like this would be much more useful than using human assistance. This solution will be user-friendly and will perform in an effective and efficient manner.

The importance of this system is mainly to the tea inspectors and farmers whose field is tea cultivations. This system will identify and categorize the infected leaves and will provide solutions to the diseases. It will be an effective, less time consuming and a very much cost-effective way.

Mainly the system will Greater efficiencies and lower prices of the tea cultivations, Safer growing conditions will be established and the reduced environmental and ecological impact due to usage of chemicals only in necessity to approved amounts to recommendations of the app. The main significance is that this provides solutions to inefficient process of disease detection of tea leaves in tea cultivations.

The paper is incorporating with several sections. Section 2 is the literature survey for the topic; Section 3 presents the research findings and Section 4 describes the conclusion along with the references.

II. LITERATURE REVIEW

The old and classical naked eye observation-based tea leaf disease detection systems are very inefficient, slow and also give less accuracy. And also consulting experts to find out plant disease is expensive and time consuming due to unavailability of experts.

Tea leaf disease is one of the critical reasons that decreases quantity and degrades value of the tea. (Karmokar et al., 2015) at his study has shown that the leaf disease of a plant can interrupt the normal functions of the plants like photosynthesis, fertilization, growth, transpiration etc. badly. The main indicator of a leaf disease is the colour of the tea leaf, they change colour when the leaves are diseased. Also, the study shows that the plant leaves show normal colour until a plant leaf get affected by any sort of pathogen after that it changes gradually.

Review paper by (Raut and Ingole, 2017) states the basic steps of image processing is image storing and keeping them for the future use.

In this study conducted by (Qin et al., 2016), observes and identifies four types of alfalfa leaf diseases using image-processing techniques and uses pattern recognition algorithms as the base.

As in the many cases (Chaudhary et al., 2012) has identified the plant diseases using computer vision. In this study the diseases were detected by extracting colour feature. The colour models they have used are YcbCr, HSI, and CIELB. They were successfully able to detect diseases without the noises by different sources such as camera flash.

Although there are many plant disease detection methods via automation or computer vision there are no marketable resolutions found according to the paper by (Sladojevic et al., 2016). They also have found a new method of using deep learning which decides and detects plant diseases from leaf images by itself. The established prototype was able to detect leaf presence and differentiate between healthy leaves and 13 different diseases successfully.

In the paper (Padmavathi and Thangadurai, 2016) Image Pre-processing has been identified as an effective and consistent way to identify leaf diseases which includes an assortment of methods which are used in progress of improving graphical presence of an image. The extraction of colour and texture feature extraction in the leaves are the most significant factors according to the authors. According to this paper, diseases as they have given noise free images which are well suitable for human or machine understanding when compared with grayscale colour images.

(Arivazhagan et al., n.d.) has created processing system that consists of four basic stages, where colour transformation structure for the input RGB image is created as the first step, After the segmentation process as the second step the green pixels are masked and removed, the texture numbers are added for the beneficial parts, As the last step a classifier is used to pass the mined features.

(Varshney and Dalal, 2016) states that some of the most popular plant leaf sorting techniques are, Genetic Algorithm, Neural Network, Principal Component

Analysis, Support Vector Machine and k-Nearest Neighbour Classifier. In the process of plant leaf classification most important factor that the paper identifies is the morphological features in the plant leaf.

The study by (Deshmukh, n.d.) shows that usage of K means clustering and neural network which is used for segmentation and classification of diseases pave the way to detect the leaf disease accurately and speedily. They have conducted the study around the paddy leaves and the approach presented in the paper is image processing based.

A paper presented by (Al-Hiary et al., 2011) proposes an algorithm containing the following eleven steps for plant disease detection which uses techniques such as K-means clustering, Masking, RGB to HIS Translation, Neural Networks for Recognition.

Also (K. Singh and Chetia, 2017) has developed a working software on Identification and Arrangement of Plant Leaf Diseases in Image Processing using MATLAB. The paper discusses on automatic disease detection of "Phaseolus vulgaris" and "Camellia assamica" plant leaf using image processing techniques.

III. METHODOLOGY

The complete process of finding the model for tea leaf disease recognition from many literatures and the interview is described further in detail below. The complete procedure is divided into some essential steps in subsections below;

A. Data Gathering

Data that is essential to conduct the research were collected through an interview and literature and article reviews. The interview was directed with a tea inspector to get the full idea on the manual leaf disease detection process.

C. Data Analysing

The data which was gathered during the data collection process was analysed in this phase to define the problem and to identify the limitations with the existing process.

Suggestions of the users to improve the current process could be identified through the collected data. Consuming much time and cost, limited number of resources, lack of experience and training to the tea inspectors are some of the drawbacks with the manual procedure which could be identified through data analysis.

D. Approach

Users of this system are farmers, tea inspectors and tea. Inputs for the system are the images of diseased tea leaves taken by the user of the app using android mobile phone. Outputs from the system are basically a report that states the matching disease and available remedies for the relevant disease and the further steps that could be taken to future spreading of the disease or the bug. The system receives inputs and executes user requests to generate a report containing the disease information and remedies.

E. Technology adopted

The developed system consists of a mobile application. The mobile application has been developed using MATLAB Simulink which is developed by MathWorks, where the design signal or image processing algorithms and applications for Android devices are supported. Image enhancement process was designed through image processing filters and functions in MATLAB Simulink. An Artificial Neural Network that is known as a supervised machine learning prototype which identifies the patterns based on a previously trained dataset, has been integrated in order to develop this disease detection and providing solution on the basis of the disease.

As for the development platform of database SQLite will be used. The main reasons to use SQLite are Zero-Configuration, Serverless, Stable Cross-Platform Database File. Which will be most suitable as the developing solution is an android based application

F. Design

The overall architecture of the system can be defined based on three main layers; client layer, application layer and database layer.

High level architectural perspective of the developed system is shown in figure 1 below.

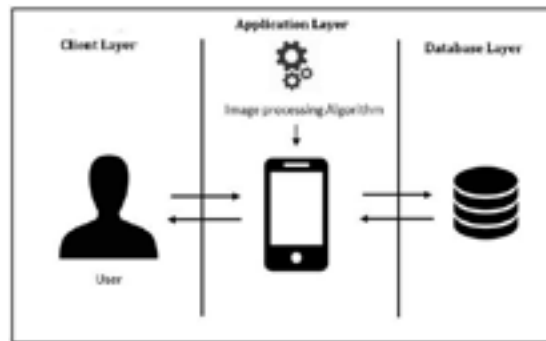


Figure 1. High Level System Architecture

- 1) Client Layer: The client layer will receive input from the Interface modules. This layer allows the admission to the users of this system. The two main user levels are tea inspectors and farmers. Access levels vary from one user level to the other in the system due to the technical knowledge barrier between the two different users. In this section, the authorized users will be predefined.
- 2) Application Layer: The application layer contains an android mobile application. This is to be further described through the below discussed modules.
 - i. Login Module
This module confirms the username and password that are entered by the clients and gives the entrance to the system for the predefined approved clients. It has given an option to recuperate username and password if forgotten.
 - ii. Insert Information Module
In this module Authorized Tea Inspectors can provide the information on leaf diseases and images to the system. Then a verification process of the inserted information is done to make sure that the entered details are accurate before adding them to the system.
 - iii. Update Information Module
Only authorized users are allowed to update information on diseases. Then a verification process of the inserted information is done to make sure that the entered details are accurate before the changes are applied to the system.
 - iv. Delete Information Module
Only authorized users are allowed to delete the information on diseases. Then a verification

process of the deleted information is done to make sure that the entered details are accurate.

- v. The Identical Disease Matching Module
The “image enhancement” option has been provided to improve the quality of the image. Then the enhanced image is used to search against the database to find a full match or a partial match for the disease. A report will be generated indicating the disease information, suggested remedies and matching probability and other relevant details.
 - vi. Email Sending Module
The generated reports will be sent to the relevant personals through emails in this module.
 - vii. SMS Sending Module
This module allows to send SMS alerts automatically to inform about the emails.
- 3) Database Layer: The Database Layer is accountable for handling the database of the system. The database will keep the data that are given to the system by the applications. And also, this layer is responsible to retrieve the necessary data when requested.

Primary steps for tea leaf disease detection and identification can be mentioned as follows;

G. Image Acquisition

Diseased tea leaf images were captured with a mobile phone camera and stored for the future use in MATLAB Simulink in RGB format.



Figure 2. Diseased tea leaf from ‘Blister blight’ (A plant pathogen)

H. Image Pre-Processing

The image Pre- processing is performed to enhance the quality of the current RGB image and to remove the noise in the image. Image is converted to greyscale from RGB. This task is mainly performed by clipping and smoothing the image. Also, the increasing contrast of the image is done by image enhancement.

I. Image Segmentation

Image segmentation is used to alter the digital image into different segments which look alike. This method helps in identification of borderline of the leaf.

J. Feature Exaction

This is the step where all the facts texture, colour, breed and arrangement of the leaf are considered. Each and every simple detail is important to the disease detection process by using considering similar occurring colour methods features and diseases are separated.

K. Classification and Detection of Tea Leaf Disease

As in the above step features are separated and, in this step, the retrieved diseased leaf parts are matched with the database and the infected disease is provided by the database for the closest match.

IV. RESULTS AND DISCUSSION

The previously developed systems with reference to the literatures have standalone applications mostly. In the practical usage of these systems the users have to scan and photograph the diseased leaf using a digital camera and then upload it to the application. In this system the android application allows to scan the infected tea leaf using the app itself, so this application is more convenient, fast and accurate to use.

The above identified novel system follows primary steps for tea leaf disease detection and identification as Image Acquisition, Image Segmentation, Image Pre-processing, Feature Exaction and Classification and Detection of tea leaf Diseases. The importance of this system is mainly to the tea inspectors and farmers whose field is tea

cultivations. This system will identify and categorize the infected leaves and will provide solutions to the diseases. It will be an effective, less time consuming and a very much cost-effective way. Mainly the system will Greater efficiencies and lower prices of the tea cultivations, Safer growing conditions will be established and the reduced environmental and ecological impact due to usage of chemicals only in necessity to approved amounts to recommendations of the app. The main significance is that this provides solutions to inefficient process of disease detection of tea leaves in tea cultivations.

The main objectives of the application are Identifying diseases in tea cultivation before crop yield gets affected severely, reducing the time wastage in finding the disease and necessary remedies and the make the tea leaf disease detection process more accurate and reliable, reducing the waiting time for tea inspector's expertise knowledge, and to make the complex process of identifying disease process simple easy and convenient.

The issues and challenges of the system can be identified as the technology Upgrades which is one of the biggest concerns of developing the solution as technology is growing and developing fast day by day. Also, as the farmers and general public are the targeted audience of the application, the technological knowledge barriers will arise when using the solution. Needing a large trained dataset to identify diseases on the basis of the previously identified patterns is another challenge. Also, failure to capture the images of the leaves to the required quality can also be identified as an issue of the application.

V. CONCLUSION AND FURTHER WORK

In this research work, the authors could develop an efficient and accurate Tea Leaf Disease Detection System by integrating novel advancements in computer science field in order to speed up the traditional Tea Leaf Disease Detection process. It will help in quick and accurate identification of diseases that leads to enhance the efficiencies and lower prices of the tea cultivations where safer growing conditions will be established and the reduced environmental and ecological impact due to usage of chemicals only in necessity to approved amounts to recommendations of the app. The main significance of the newest system will be that this provides solutions to inefficient process of disease detection of tea leaves in tea cultivations.

The images taken by mobile phone cameras may be different in size, focus, quality and also the distance between the leaf and the mobile phone can vary from person to person even though there are standards that are established. For this the authors infer to use a drone to take pictures in the tea estate section wise from a certain distance and analyse the images for the diseases in the whole area for the further work. This will change the whole idea on disease detection process on tea leaf. By analysing the tea leaves in the drone photographs the users will able to check the amount of sunlight, fertilizer and water that the tea plant gets. Finding a novel, accurate and efficient mobile solution for tea leaf disease detection system using drones will be an interesting future direction that will help to lead a great upheaval agriculture and export fields in Sri Lanka.

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