Project Proposal

Portable Soil Detection System based on Image Processing for Agriculture

Team Colon

Name	Registration Number	Index Number
K.G. Rajapaksha	ICT/2016/2017/083	3946
G.T.S. Perera	ICT/2016/2017/050	3917
W.M.D.H. Bandara	ICT/2016/2017/008	3884
J.P.R. Thakshila	ICT/2016/2017/064	3929
T.L.U. Sudharshana	ICT/2016/2017/086	3948

Supervised By:

Mr. N.M.A.P.B. Nilwakke

Ms. Malithi Jayasooriya

Faculty of Applied Sciences

Rajarata University of Sri Lanka

2016/2017 Batch

1. Introduction

Soil is an important influence to plants as it not only provides an anchor for the plants, but the different properties of soil which also provides several other physical and chemical factors which affects the plant growth. Among such factors are the porosity, moisture content, cation exchange rate, electrical conductivity, pH level etc... These factors are manually identified using several chemical processes. If these factors could be identified precisely, easily and accurately, by combining these factors the best suitable crop/plant for a specific soil type can be determined.

Determining the properties of soil to estimate the strength of soil is one prime objective of geotechnical engineering. For this a range of traditional lab testing methods have been employed. But the data obtained from these tests are highly subjective, which even further complicates the existing variability of soil.

The field of Digital Image Processing (DIP) is continuously evolving and is finding many applications in several fields. Soil characterization is an important aspect of geotechnical engineering which has been given a great amount of attention since the past few years. By combining Digital Image Processing techniques, we are proposing to develop an application to suggest the best suitable crop to be grown in a specific soil type by the mere capture of a photograph of the soil sample.

2. Background and motivation

Agriculture could be considered as the key livelihood of Sri Lanka. For the people in Sri Lanka especially in the dry zone their daily income depends on the harvest they obtain from their cultivations. Hence their cultivations should have a profitable harvest. One of the major reasons for the lack of yield in their plantations is the incapability of the farmers to select the best crop which suits their land. Therefore, it is important to introduce a technique for the cultivators to select the best and the most profitable crop to be cultivated in their land.

Image processing has been incorporated with agriculture since recently. It is an emerging technology which has many practical applications within many key fields. Image processing in soil detection has been diploid in examining various features of the soil such as the pH value of the soil.

According to the research carried out by Vinay Kumar, Binod Kumar Vimal, Rakesh Kumar, Rakesh Kumar and Mukesh Kumar have proposed a system to determine the soil pH value using image processing techniques [1]. Kshitija S. Naphade of Lehigh University has published a thesis on soil characterization using Digital Image Processing where image processing techniques, the software review, hardware review, image acquisition and future scope is discussed in detail [2]. João F. C. dos Santos, Heider R. F. Silva, Francisco A. C. Pinto & Igor R. de Assis have used digital image processing techniques to determine the moisture content [3].

Magnus Perrson of Department of Water Resources Engineering, Lund University, Sweden has published a research article under the topic Image Analysis of Soil Science which presents different types of image analysis techniques present in soil science [4]. John Carlo Puno,Edwin Sybingco,Elmer Dadios,Ira Valenzuela of De La Salle University, Manila, Philippines and Joel Cuello of The University of Arizona,Tucson, Arizona, United States has performed a research on Determination of Soil Nutrients and pH level using Image Processing and Artificial Neural Network [5].

3. Problem

Even to date agriculture contributes to the national economy of our country at large scale. Cultivation of tea, coconut, paddy, vegetables and fruits, oilseed crops, spices etc. are among the most cultivated. When selecting a crop to be grown in a specific land most farmers tend to select a crop which commonly grows in the surrounding. This might lead to poor growth of that crop, pronging the crop to various deficiencies, reduction of harvest and they're by spending money to overcome these problems result in extra expenditure, wastage of resources and time and overall a loss.

To minimize these problems farmers are educated to test their soil sample and determine the best suitable crop for that soil type as the variety in soil is immeasurable. The traditional testing method used up to date in Sri Lanka is a laboratory mechanical testing which occurs when the farmer takes a soil sample to the lab. But this method is expensive, time consuming, involves much labor and also can be error prone as it's a mechanical process and is not very accurate. Hence the need of a method to make this process simple, more convenient and accurate for the farmers is seen as a gap.

4. Aims and Objectives

Most farmers now have access to a mobile phone with a camera. If they can take a photograph of the soil sample and if the crop is suggested by the app at that instance itself, much time and effort in taking them to a lab will be saved, accuracy of the result will be higher, the extra expenses which have to be borne in selecting an unsuitable crop will not have to be spent and overall increase the harvest and profit for the farmer.

The main aim of this project is to develop a mobile application to address the above problem so that once the farmer takes a photo of the soil, he's planning to cultivate it automatically analyses the soil and suggests the most suitable crop to be grown in that soil so that the problems mentioned above are minimized. We plan to fulfil this aim under two objectives using digital image processing

1. Determine the type of soil by analyzing the soil sample
    - 1.1 Determine the soil type using color
    - 1.2 Determine the soil type using porosity
    - 1.3 Determine the soil type using grain size
    - 1.4 Determine the soil type using moisture
2. Suggest the best suitable crop for that soil type instantly.

5. Methodology

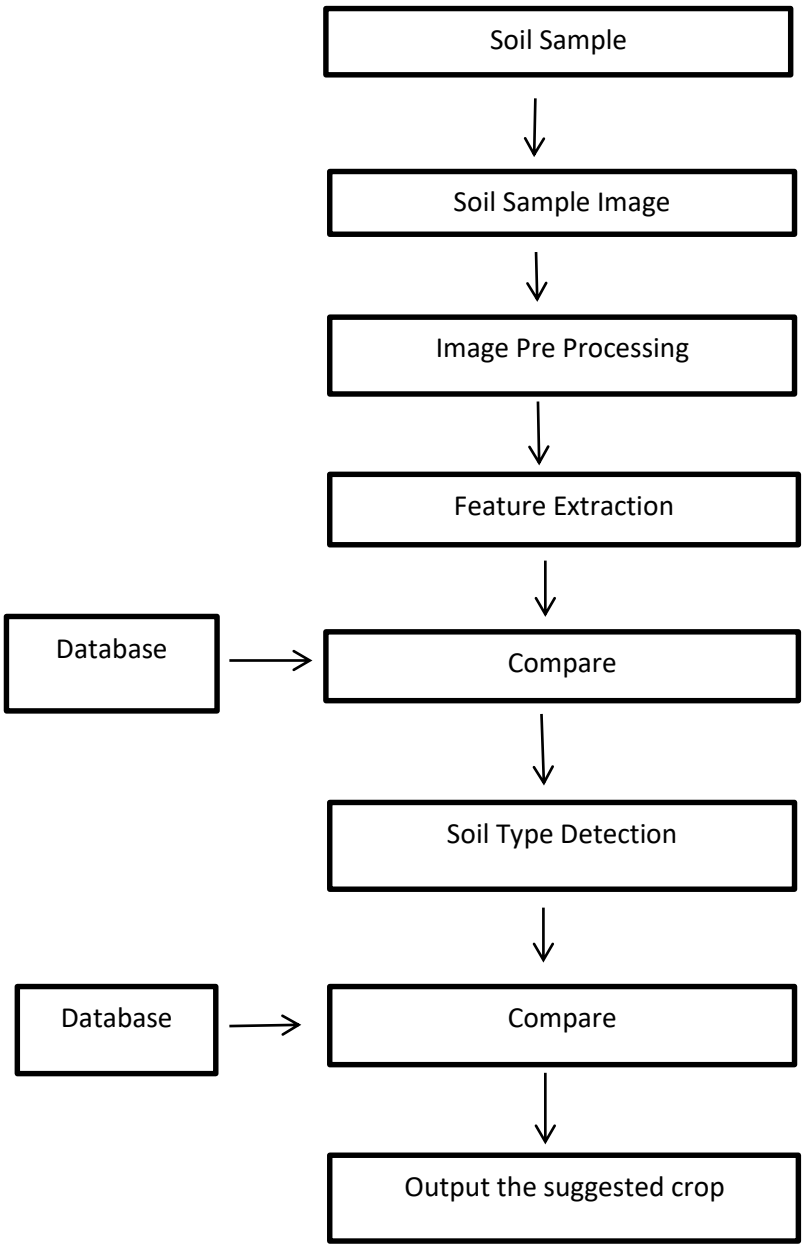
In Sri Lanka there is a wide variety of soil types available. Therefore, it is an impossible task to detect all of them from scratch as they have almost the same look and feel. Hence, we have adopted a methodology where we can allow the users to select their district, the divisional secretariat and the Grama niladhari division and the available soil types in that region is filtered using the Soil map of Sri Lanka.

Then the digital photograph of the soil taken by the user is enhanced and the soil type of that land is recognized by using image processing techniques such as color detection. However, there is a practical loophole in this method as the color of the soil will be changed due to the rainfall and the deposition of an organic layer in the topsoil. Hence, we are using a methodology to determine the moisture of the soil by using image processing techniques and performing control experiments by varying the amount of moisture present in that soil.

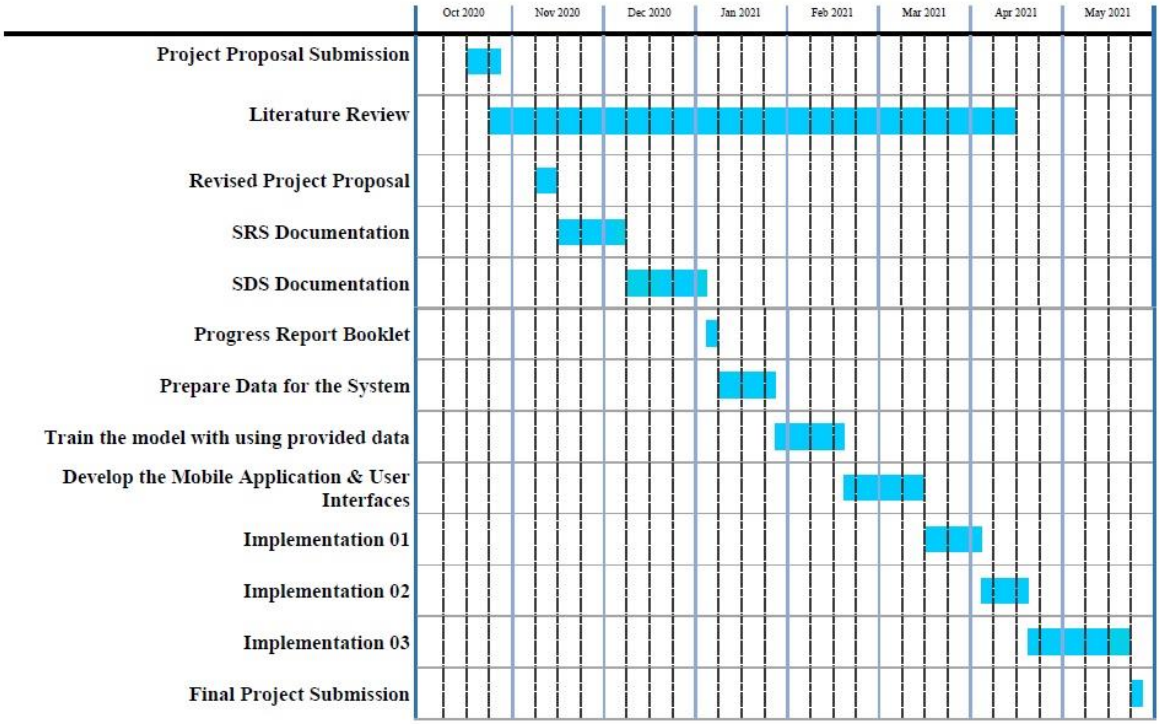
In order to increase the accuracy of our readings we are using other parameters of soil such as the porosity and grain size.

The color of the soil and the porosity could be slightly changed according to the amount of soil considered. That is because when we are gathering the samples to a tray to take images the soil could be tightly packed but when a user takes a photograph of the land where the soil contains the soil particles could be loosely bound. In order to minimize this minor flaw the users are advised to take the fixed tray size we recommend which we use to gather soil samples.

The topsoil of each and every land mostly contains an organic layer which will result in an erroneous result since the color is a major parameter, we use to determine the soil type. Hence in order to minimize this error the users are advised to gather a soil sample which is at least 2 inches below the surface. We will have to collect multiple soil samples to carry out this research successfully.



6. Project Time plan



7. Resource Requirements and Budget

In order to implement our soil detection system, we need the following resources,

1. A computer with a minimum RAM of 8 GB and a minimum processor speed of 1.99 GHz
2. A digital camera with a minimum resolution of 12 Mega Pixels
3. A smart mobile phone with an Android Operating System with a minimum RAM of 3 GB
4. Internet connection

8. References

[1] Vinay Kumar , Binod Kumar Vimal , Rakesh Kumar and Mukesh Kumar, ” Determination of soil pH by using digital image processing technique”.

[2] Naphade, Kshitija S., "Soil characterization using digital image processing" (1999).

[3] João F. C. dos Santos, Heider R. F. Silva, Francisco A. C. Pinto & Igor R. de Assis, ” Use of digital images to estimate soil moisture”., v.20, n.12, p.1051-1056, 2016.

[4] Magnus Persson. “Image Analysis in Soil Science”.

[5] John Carlo PUNO, Edwin SYBINGCO, Elmer DADIOS, Ira VALENZUELA, Joel CUELLO. “Determination of Soil Nutrients and pH level using Image Processing and Artificial Neural Network”.

Signatures of team members

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Date: 11/11/2020

Recommendation of the supervisors

Name: Mr. N.M.A.P.B. Nilwakke

Department: Department of Computing

Signature: ……..

Name: Ms. Malithi Jayasooriya

Department: Department of Computing

Signature: ……..