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Analysis of Agricultural soil pH using Digital Image Processing

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Abstract- Digital image processing has been evidenced to be an active tool for analysis in several fields and applications. In Agriculture sector the various parameters like quantity and quality of product are the essential measures from the farmers' point of view. Agricultural soil is considered as one of the most treasured natural resource whose soil pH should be property used to define the gradation of acidity or basicity which will affect the nutrient availability of the soil and also the growth of plants. With the pH Value 7.0, considered to be neutral, the values which are above and below are either alkaline or acidic in nature. This paper involves various methods and techniques from digital image processing to determine and analyze pH value from Agricultural soil.

Keywords- Feature Extraction, Principle component analysis (PCA), classification, matching.

1. INTRODUCTION

Determining the properties of soil to estimate its strength is one of the primary goals. Soil is recognized as one of the most valuable natural resource. Soils are considered as the integral part of the landscape and their characteristics are largely governed by the landforms on which they have been developed. For the capturing images, digital camera was used. Transformation of the multispectral image was carried out through TNT Maps spatial software [1]. The pH in soils is an important concerning part of the soil health. PH is a term that is used to describe the degree of acidity or basicity. Soil acidity or alkalinity directly affects plant growth. If a soil is too sour or too sweet, plants cannot take up nutrients like nitrogen (N), phosphorus (P) and potassium (K). Most nutrients that plants need are readily available when the pH of the soil solution ranges from 6.0 to 7.5. Below a pH of 6.0 (acid): Some nutrients such as nitrogen, phosphorus, and potassium are less available. Above a pH of 7.5 (very alkaline), Iron, manganese, and phosphorus are less available. Wide range of soil color; gray, black, white, red, brown and yellow is influenced by the content of organic matter, and due to the presence of water and oxidation state of iron and magnesium. Thus, due to concentration of organic matters, presence of water and oxidation are influenced factors of pH and color association [2]. However, soil is a part of an object and digital photograph of this object (soil) is taken through a camera, which receives wavelengths corresponding to red green and blue colors. Color is the byproduct of the

Spectrum of light, as it is reflected or absorbed, as received by the human eye and processed by the human brain. When light hits objects i.e. soil, water, vegetation some of the wavelengths are absorbed and some are reflected, depending on the materials characteristics [5]. However, digital camera receives the light in the terms of blue green and red bands. Red, green and blue are fundamental colors which is arranged in bands 321 (RGB), denote the wave lengths of electromagnetic radiation in spectrum band 3 (0.63-0.69 μm), band 2 (0.52-0.60μm) and band 1(0.45-0.52 μm) are distinctly represented by different wavelengths. Reflected energy (Blue, green and red) from the various materials which was captured by digital cameras is responsible for signature capture of the object. Soil colors charts were derived though digital camera is the part of visual perceptual property where digital values of red, green and blue (RGB) provide a clue for spectral signature capture [9][14] of pH in soil. Keeping above in view, the present investigation was conducted to determine the soil pH by using digital image processing technique.

2. LITERATURE REVIEW

A soil analysis is a process by which elements such as P, K, Ca, MG, Na, S, Mn, Cu, Zn are chemically extracted from the soil and measured for "plants available" content within the soil sample. Soil pH can be determined from soil color using digital image processing techniques. In which digital photographs

[2] of the soil samples were used for the analysis of soil pH. Soil colors are the parts of visual perceptual property [9] where digital values of red, green and blue (RGB) provide a clue for spectral signature capture of different pH in soil.

Digital soil morph metrics [1] is defined as the application of tools and techniques for measuring and quantifying soil profile attributes and deriving continuous depth functions. The application of such tools is compared to standard soil profile descriptions for 11 common attributes: Horizons, texture, color, structure, moisture, mottles, consistence, carbonates, rock fragments, pores and Roots. These attributes are extensively used in soil classification [10] and are indicative of many soil functions [12]. Commonly, a soil profile is divided into genetic horizons and the attributes are described, sampled and its properties analyzed in the laboratory [14]. The information is used to classify soils and for interpretations of soil functions [13]. Interpolative functions using the analytical data from soil horizons have been developed to estimate soil property values at any depth or depth class.

Apart from digital image processing soil pH can be determined by Potentiometric methods. Here principle of Potentiometric Method is based on the measurement of potential, developed across a glass electrode due to the difference activity of H+ ions in and out of the electrode. The potential difference between the glass electrode and calomel electrode is expressed in PH unit. It provides information on the potency of toxic substances present in the soil.

It is indicative of the status of microbial communities and its net effect on the neutralization of organic residue and the immobilization of available nutrients. Ascertaining the soil pH provides the most rational basis for managing soil for selected agricultural crops. The pH measure of soil in water and KCl systems [4] provides information on the nature of charge discharge on soil colloids which will have a far recharging effect on nutrient measurement and reaction.

3. PROBLEM DEFINITION

To develop an efficient system to determine and analyze the pH value of Soil for various agricultural purposes by using Digital Image Processing (DIP) Images of soil samples. These samples will be acquired using a camera, preprocessed and then color features will be extracted to measure the soil PH. Inherent factors affecting soil pH such as climate, mineral content and soil texture cannot be changed. Natural soil pH reflects the combined effects of soil-forming factors (parent material, time, relief or topography, climate, and organisms). The pH of newly formed soils is determined by minerals in the soil's parent material.

3.1 Objective

The main objective of our work is to find out the pH value of given soil and to analyze the obtained results for taking corrective measures.

4. DESIGN MODULE

The processing scheme consists of image acquisition through digital camera or scanner or mobile phone. Image processing includes image enhancement, filtering of image to remove noise etc., feature extraction and Detection.

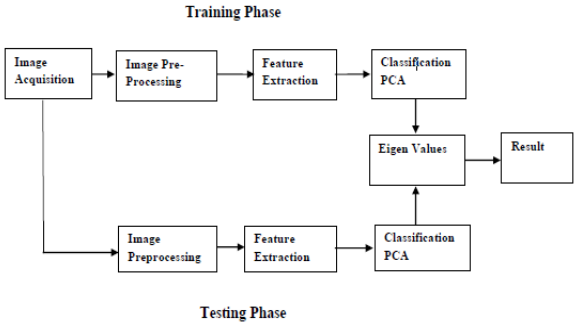

Fig. 4(a): Flow diagram of proposed module

4.1. Image Acquisition:

Firstly, the images of various area of soil captured using digital camera with required resolution for better quality or by scanner. After the image, has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement. The construction of database is clearly dependent on application. The images of database are responsible for better efficiency which decides the robustness of algorithm.

Fig. 4.1(a): Sample images aquired by camera

4.2 Image Preprocessing

Second step is to improve the database of images that suppress undesired distortion. Enhance image feature is important for further processing and analysis task. It includes color space conversion, image enhancement for contrast improvement, image resizing, filtering to

remove noise etc. When converting an RGB image to grayscale, we must take the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel. One such approach is to take the average of the contribution from each channel: (R+B+C)/3. However, since the perceived brightness is often dominated by the green component, a different, more "human-oriented", method is to take a weighted average, e.g.: 0.3R + 0.59G + 0.11B.

4.3 Feature Extraction

Feature extraction plays important role for identification of object. After preprocessing, the area of interest is Image feature which includes color, texture. Image transformation option is used for RGB analysis using PCA. Equation values and measured soil pH values are correlated. Determination of soil pH was based on digital image processing technique, in which digital photographs of the soil samples were used for the analysis of soil pH. Texture means how the color is distributed in the image, roughness, hardness of the image. There are various methods for feature extraction such as color co-occurrence method, leaf color extraction using H and B components, gray level co-occurrence matrix, Gabor filter, wavelet transform etc.

The color values (RBG) of the soil will compare with the color values of the samples that already store in database and find the minimum error to determine the pH value of the current sample. That means the value that need to store in the database is the basic color value (RBG) and the pH value of each sample that already collected. And the data needed for the sample that we want to find its pH RGB.

The two RGB values of the sample and database will compare to find the value of PH. In this study, the secondary data that already is collected by another study. These data include 30 samples of soil with different color. Each sample of these samples is analyzed to its basic color values, RGB and found the pH value for each one, and then we have the color values of soil and its pH value. This data is used to store in a database to use in our research. The table below shows the values of RGB and the pH that collected by [13]. The training is done with known value of these data to train the neural network. Now these data will cover the requirements that we need to build database to be ready to use for comparing with the soil sample that we need to find its pH value. And these data have the RGB values that need to compare and the pH values.

4.4 Classification

A classification technique deals with classifying each pattern in one of the distinct classes. There are so many classification techniques such as k-nearest neighbor classifier, probabilistic neural network, genetic algorithm, support vector machine(SVM), principle component analysis (PCA), artificial neural network, fuzzy logic etc. Selecting a classification method is always a difficult task because quality of result can vary for different input data. So, for our application we can select the classifier used to classify pH value of soil.

4.5 Matching

Matching of different types of soil images is the primary issue used in soil constituents. A PCA based classification system has been presented to classify the different types of soil images. PCA is a feature based classification technique that is characteristically used for image recognition. PCA is based on principal features of an image and these features discreetly represent an image. Classifier system has also been designed to exhibit this enhancement. In testing phase, a new soil image is classified by comparing using the PCA algorithm. The system presented in this work exemplifies the concept of Eigenvectors. These eigenvectors are a small group of characteristics extracted by the designed classifier system using PCA. Eigen values are compared of both the images here matching is done of soil images and the pH value is extracted.

5. PROPOSED SYSTEM

The aim of the study is to provide a conceptual model that can assist in defining and analyzing the interactive documentary. A soil image as an input during training phase, and performs image pre-processing on it. In the Image Pre-processing we are extracting the main features as the RGB index-values and compute the mean values by applying PCA analysis. In testing phase, classification of images takes place using PCA analysis and index values are compared with the trained values. As the result, we obtain the final pH value.

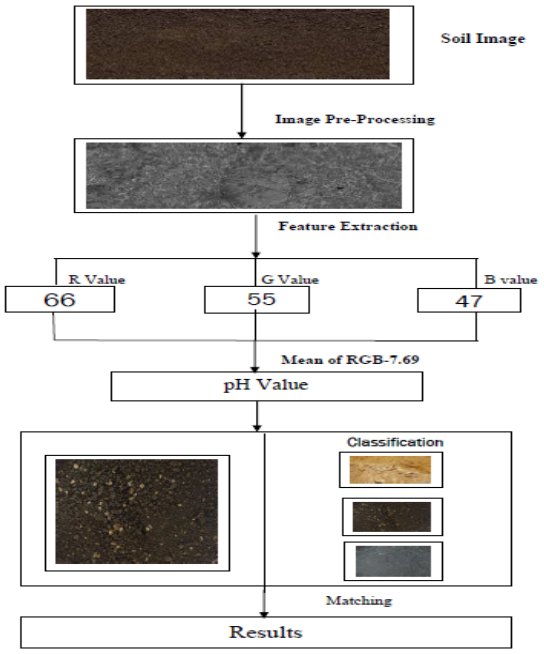

Fig. 5(a): proposed model

6. EXPERIMENTATION

Initially the main GUI for Training the images and obtaining the pH values. The set of images are stored in a folder to train the system. Colors features are extracted and stored in a matrix. Principle Component Analysis is used for classification a set of images used for the testing purpose. At the end Eigen values are used for matching.

6.1 Dataset

Basically, there are two set of data. One is for training the system and other set is for testing. Some samples are shown below.

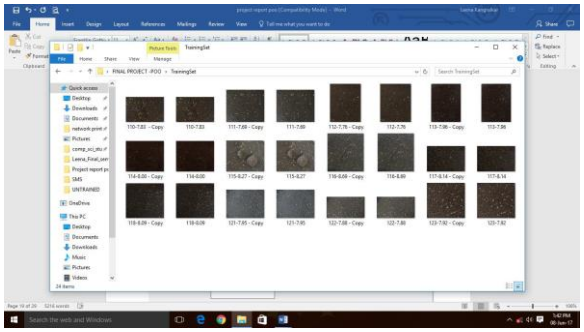

Fig. 6.1 (a): Training Datasets

6.2 Implementation

Implementation of the proposed module has been done in the MATLAB software. The below diagram shows the main GUI of the proposed model. The GUI contains different options like training dataset, testing, classification and extracting the classified images. In training phase, for training the file containing the images, we browse the file and select the image. During Training Phase, the extraction of features of all the images takes place rapidly.

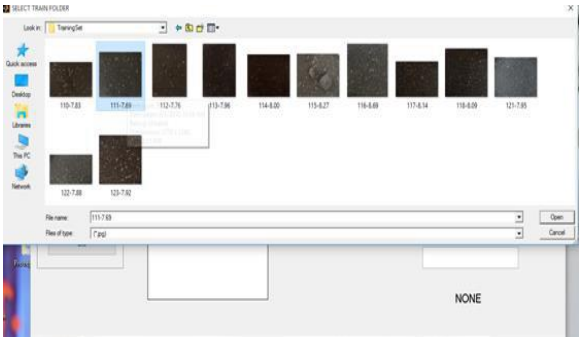

Fig 6.2 (a): Browsing of images from training dataset

The different features are extracted while training the input dataset. Here red, green and blue features are extracted and stored in the matrix. Those features will be compared with the image to be tested. Once the training set is done for all the images, we can move further for the Testing Phase.

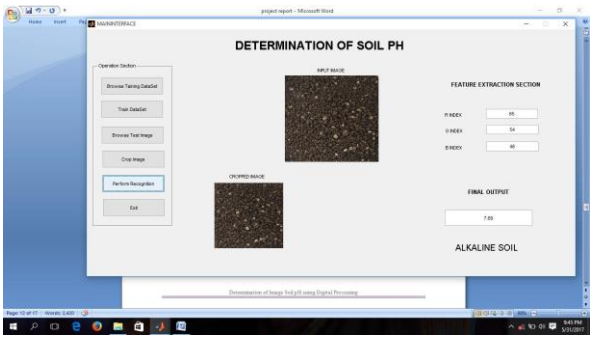

Fig. 6.2 (b): Obtaining the final output pH value.

After training phase, will go for testing. The image is being extracted and the technique of Cropping is applied for removal of the noise in the image. After Feature Extraction of the R, G, B index values, we obtain the pH value of an image. Extraction of R, G, B index values and Matching the image along with the values is been displayed at the command window.

6.3 Result Analysis

The proposed system has been used to test the two types of images. Those are trained and untrained. The proposed system gives 100% result for the trained images, whereas for untrained images it gives around 91% result. The statistics are shown below the table.

Table 1: Result analysis

Image	Accuracy
Trained (%)	100
Untrained (%)	91

7. CONCLUSION

The proposed system has given the good result when compared with the existing systems. The soil images are taken as the input. With the help of color image processing, soil image PH index is calculated and using with its respective pH Value. Amount of acidic and basic nature is also calculated by comparing it with already given laboratory values.

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