Soil Nutrient Analysis using Texture Features

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Abstract— Soil is the key elements of agriculture, Because of this reason we can determine the nutrients of soil like pH, texture features by using image processing. Soil pH is used to describe the degree of acidity or basicity. This property is directly affected by the nutrient availability. The soil samples are collected from different farms with the help of digital camera and their pH value is determined with the help of pH meter. Texture is term commonly used to designate the proportionate distribution of the different sizes of the mineral particle in the soil. It does not include any organic matter.
Keywords: Agriculture, Soil, Nutrients, Pre-Processing, Filtration, Feature Extraction, Texture, Statically Analysis

I. INTRODUCTION

Soil is a key element of agriculture. It is organic material that is on the surface of the earth in which we grow plants. The pH in soils is an important concerning part of health of soil. The latest process for testing of soil is chemical based which is too much expensive method and it is not affordable for all the farmers. This process is expensive as well as it requires the time to calculate the results. So to avoid this problem we go for image processing technique. The image processing is the method of analysis of digital image. Digital image is full of information in the form of digital values. This analysis is used to reduce the human efforts and time consumption. It helps the immediate action of the soil source. Some of the nutrients that plants need are readily available when the pH of the soil solution ranges from 6 to 7. Below a pH of 6.5 (acid) some nutrients such as nitrogen phosphorus and potassium are less available. Above a pH of 7.5(very alkaline), iron, manganese, phosphorus are less available.

A. Soil Properties

Soil is made up of different sized particles. Soil texture refers to the size of the different soil particles that make up the soil and depends on the proportion of sand, silt and clay sized particles and organic matter in the soil.

- Soil particles are quit big. The pore spaces between the particles in sandy soils are also quit large. It allows water to drain quickly and air to enter the soil.
- Silt particles are so small to be seen by naked eyes.
- Clay soil are poorly drained and hold on to the water in their pore spaces for much longer. However, it can become very hard if they dry out.

B. Soil pH

Soil pH is measurement that indicates the basicity or acidity of soil. It is calculated by finding the logarithm of the concentration of hydrogen ions in the soil, and ranges from 0 to 14. The higher the pH of the soil, more acidic it is, and the lower the pH of the soil it is basic. The pH of the soil solution ranges from 6 to 7.5. Below a pH of 6 some nutrients such as nitrogen, phosphorus and potassium are less available. Above a pH of 7.5 Iron, manganese and phosphorus are less available. Wide range of soil colours 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 manganese. Thus due to concentration of organic matter, presence of water and oxidation are the factor that influenced the pH of the soil. A soil pH of a 6 has 10 times more hydrogen ions than a soil with a pH of 7, and a soil with a pH of 5 has 100 times more hydrogen ions than a soil with a pH of a 7.

C. Factors Affecting the Soil pH

The reaction of a solution represents the degree of acidity or basicity caused by the relative concentration of H ions or OH ions present in it. Acidity is due to the excess of H ions over OH ions and alkalinity is due to excess of OH ions over H ions. A neutral reaction is produced by an activity of H and OH ions. According to dissociation, activity is due to ionization of compounds into ions.

1) Soil Solution

The more dilute the solution, the higher is the pH value. Hence the pH value tends to drop as the soil gets progressively dry. Soil reaction is also affected by the presence of CO_2 in soil. As the CO_2 concentration increases, the soil pH falls and increases the availability of the nutrients of soil. Under field conditions, plant root and micro-organism librate enough CO_2 which results in lowering the pH appreciably.

2) Climate

Rainfall plays an important role in determining the reaction of soil. In general, soils formed in regions of high rainfall are acidic, while those formed in regions of low rainfall are alkaline.

3) Nitrogen Fertilization

Nitrogen from fertilizer, organic matter, and manure and legume N fixation produces acidity of soil. Nitrogen fertilization speeds up the rate at which acidity of soil develops. At lower N rates, acidification rate is slow, but is accelerated as N fertilizer rates increases.

4) Flooding

The overall result of submergence is an increase of pH in acid soils and a decrease in basic soil. Regardless of their original pH value, most soils reach to 6.5 to 7.2 within one month after flooding and remain at the level until it dries.

D. Soil Texture Analysis

In the image, texture feature is an important low level feature, and it can be used to describe the contents of the image or a region in additional to color features. As color features are not sufficient to identify the image since different images may have similar histograms. Texture feature is helpful to clarify what the term segmentation, classification and feature measures.

II. LITERATURE SURVEY

In this paper, samples of soil are collected and after processing soil, pH values are determined by using pH meter and NPK values are also determined by using chemical analysis. It is based on color image processing. By using color image processing they R, G, B value of soil sample is determined. After that both the values were collected and result will be finding. Nutrients in the soil are based on acidity and basicity of soil. The nutrients like NPK were calculated. It is considered that if PH is in range of below 7, then soil is considered to be acidic, If PH is 7 then soil is neutral, if PH is above 7 then soil is basic. Dark black or brown colors of soil indicate the soil has high organic matter. [1]

This paper helps to determine the amount of fertilizer and pH of soil .Soil testing is the way to know quantity of fertilizers required and it will also help to overcome problems in the soil. PH value if the soil indicates the acidicity as well as basicity present in the soil because if soil is very acidic then it affect to the growth of the plants. On the basis of RGB values and their digital correlation, results showed that pH value where approximately matching with result of government testing lab. [2]

This paper reveals image processing can be defined as the analysis and manipulation of digitized image, especially in order to improve or enhance its quality. The samples of soil and estimate the soil type is obtained by using segmentation technique. Soils not only reflect natural processes but also record human activities both present and in the past. Various algorithms were implemented for the detection of soil features basically color and texture. [3]

III. METHODOLOGY

In this method of soil nutrient analysis, first of we collect the soil samples by using the digital camera in JPEG format. This JPEG format of images is converted into image file for the extraction of digital values. Determination of soil pH is based on digital image processing technique. We determine R, G, B values of a soil samples in which the digital photographs of soil samples are used for the analysis of soil pH. Then the pH of soil is determined by using texture feature.
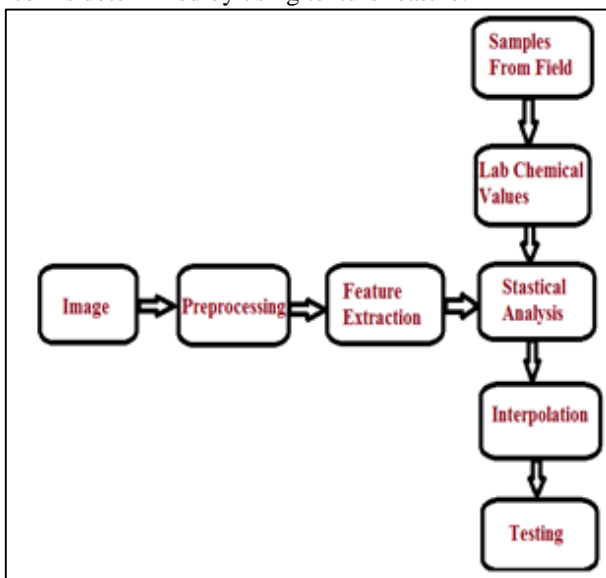

Fig. 1: Block Diagram

A. Samples from Field

The soil samples are collected from the different fields from the various locations. The soil samples from the field are collected by digging the ground at 1 meter down. Then the soil samples are collected as square of fixed size.

B. Image Acquisition

The image of the soil is captured with the help of android phone which has higher pixel value. The image should be in the standard format like JPEG. The image is resized in the form of 720X960 pixels.

C. Preprocessing

The pre-processing is nothing but the filtration. Preprocessing means data cleaning, smoothing, grouping. The preprocessing technique is to ensure efficient or meaningful analysis. In the filtration process the noises, blurred images or the resolution, hue, intensity is checked.

D. Feature Extraction

Feature extraction handles the most important role in the field of image processing. Various techniques like Binarization, thresholding, resizing are applied on the sampled images for analysis of soil nutrients. It is the critical step in most of the computer and image processing solution because it makes the transition from pictorial to non-pictorial data representation.

E. Lab Chemical Values

Soil samples are collected from different fields. With the help of these samples we calculate the pH values using pH meter. Following steps were followed to calculate the pH value with the help of pH meter. Soil samples of 10 mg are formed by weighing on the weight balance. Then this measured soil is poured into 100ml of distilled water into beaker. This mixture is continuously stirred with distilled water for 20-25 minutes. After that the pH meter is turned on and after cleaning the probe, the probes are inserted deep into the beaker. The display of the pH meter displays the pH value. And finally the pH value is determined by using the laboratory apparatus.

F. Stastical Analysis

Stastical analysis between lab chemical values of soil and the values obtained by using image processing can be obtained after feature extraction step.

G. Interpolation

Interpolation is simply defined as zooming in and zooming out of the images. By using the pixels are obtained in the correct forms. Interpolation is used to rearrange the image contents. If there is any missing information it can easily found by using interpolation. Interpolation is a technique within a range of set of known data points. Interpolation in MATLAB is divided into techniques for data points on a grid and scattered points.

H. Testing

Testing is the final step in the analysis of digital images. In this step the values taken in the lab that is chemical values of the nutrients is compared with values calculated by image processing with the help of MATLAB.

IV. RESULT

The images are filtered with the help of different filters such as Mix, Min, Median and Adaptive median filter. It was observed that adaptive median filter gives better result than other filtering methods.

Original Image

Max Filter

Min Filter
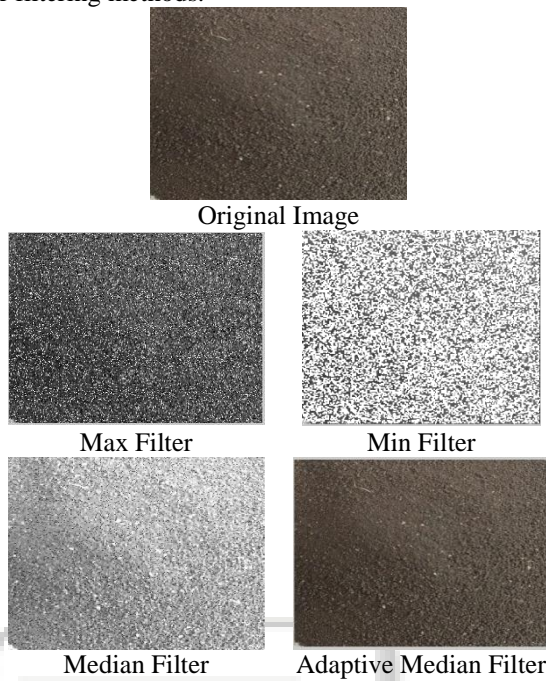

Median Filter

Adaptive Median Filter

Fig. 2: Filtered Images

The above figure indicates the result of Max, Min, Median, Adaptive Median filter. The result of Adaptive Median Filter is more accurate and contains less noise as compared with than other filter.

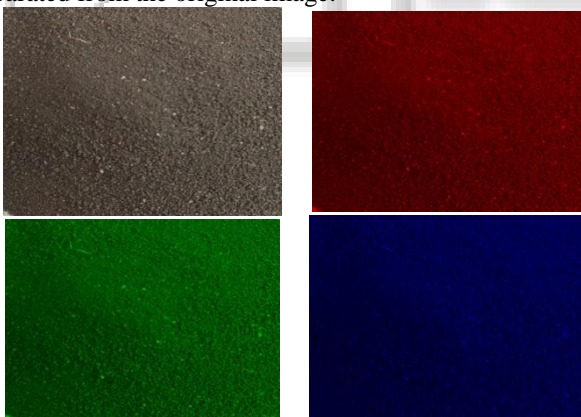After filtering R, G and B components were separated from the original image.

Fig. 3: R, G and B components

After finding R, G, B components we of R, G and B values calculated and result is stored in excel sheet. After that we these values were correlated with pH values calculated in the laboratory.

Fig. 4: Correlation of R, G and B values (1)

After correlating R, G and B values with the pH values calculated in laboratory, we observed that an accuracy of 75% is obtain as shown in below figure.

Fig. 5: Correlation of R, G and B values (2)

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