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DETERMINATION OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOIL USING DIGITAL IMAGE PROCESSING

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***Abstract*-Soil is the most valuable natural source for all the soil usage field. Digital image analysis is used to minimize the manual involvement. Different soil samples are taken from the various places. It determined both physical properties(water content, coefficient of curvature, liquid limit, plastic limit, shrinkage limit, coefficient of uniformity, field density) and chemical properties (pH and pH index). This system helps to mainly reduce the human errors involvement and time consumption. Samples are taken by digital camera. Physical recognition is based on fractal dimension calculation using box counting method. Soil pH recognition is based on Red-Green-Blue values of the image or Intensity-Hue-Saturation model of the samples. It also helps to nutrition level of the soil. It has the great potential in the agriculture management.**

KEYWORDS : Digital Image, Fractal Dimension, RGB Model, LABVIEW 2014

I. INTRODUCTION

Soil uses source material in many places. Laboratory approach is the traditional method of analysis. It has lots of time consumption and human errors. Image processing is the method of analysis using digital images. Digital image is full of information in the form of digital values. This analysis is used to reduce the human errors and time consumption. It helps the immediate action of the soil sources. Samples are taken in the suitable weather condition by digital camera. This analysis split into two ways: i. physical characterization of soil ii.Chemical characterization of soil.

This analysis of soil already depicts the physical characteristics in box counting method [6].The box counting method of analysis using LabVIEW 2014. This analysis of soil already depicts the pH and pH of soil in RGB model of soil sample [3].The RGB method of analysis the acidic and basic characterization of soil using LabVIEW 2014. Images are captured by the sony digital camera. These capture the place with three different positions with the specific light condition. These images are in the pixel value of 150x150 resolutions.

II. METHODOLOGY

A. Physical characterization

Physical characterization analyzed by using fractal dimension. This fractal dimension is calculated in various methodologies like area perimeter method, line divider method, skyscraper method and Box counting method. Box counting method is widely used to calculate the fractal dimension. This method is used to estimate the fractal dimension in the form of binary images. To cover the number of 1's present in the binary image. Depending upon the box size and number of 1's present the fractal dimension is

$$FD = \log(N(s))/\log(1/s) \quad (1)$$

FD- Fractal Dimension of sample. N(s)- Number of 1's present in box.

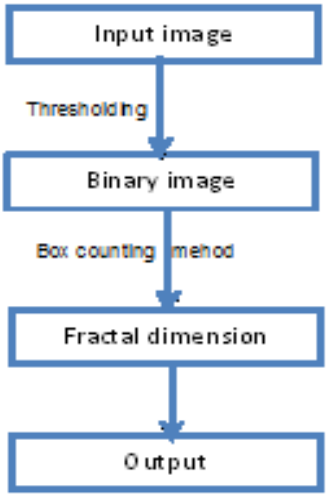

Fig .1: Flow chart for Physical characterization

Average Fractal dimension are calculated with varying threshold values of the image. Depending upon the fractal dimension correlated with the physical properties of the soil. Correlate with the curves obtained by the laboratory to give specific polynomial equation of each character. These equations are used to determine the all the above physical characteristics [6].

B. Chemical characterization

This characteristic analyzed in the following method of RGB-model analysis. Using LabVIEW to convert the 24-bit input color image is converted into 8-bit RGB image and extract the pixel values of each planes are Red-Green-Blue. This pH index of the digital image is calculated by using the following equation [3],

Soil pH index = Red/ Green/ Blue (2)

Where Red, Green, Blue represented the pixel values of corresponding plane.

Using this pH index formula is used to calculate the pH index value of each pixel value. Depending upon the pH index value of the soil is used to calculate the pH of the soil of each pixel value.

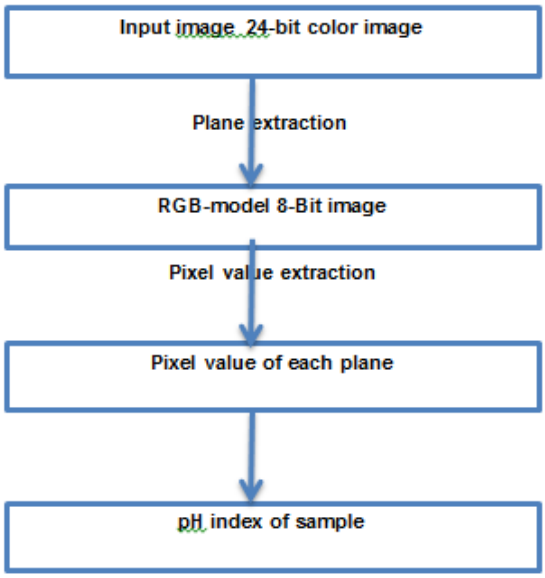

Fig .2: Flow chart for Chemical characterization

These pixel values are extracted in Centre of the image because of purity of intensity value. Averaging the pH values and get the pH value of the sample.

C. Input samples

These samples are prepared by the capturing with the resolution of 150x150. These are all 24-bit depth square images. Image is taken in watrap, virudhunagar district in fig 3. This place is used in the field of paddy cultivation.

Fig 3: Input sample

These images are captured by the sony digital camera and the specified weather condition.

D. Thresholding

Thresholding is the process conversion of 24-bit color image into binary image. It is used to conversion of pixel values into 0's and 1's. This type of representation is used to box counting method.

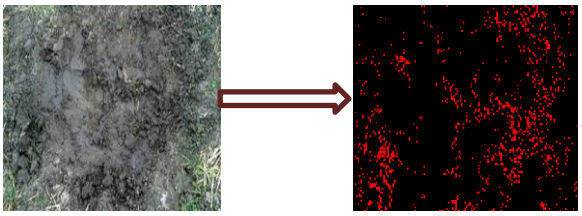

Fig 4: Thresholding- conversion of Binary image

Background represented as red color and darkness of the objective as block color shown I fig 4. The pixel values of red and block is 0 and 1. Threshold value varies from the component of RGB is 80-120.

E. Fractal dimension

Fractal dimension (FD) is defined as a mathematical descriptor of image feature which characterizes the physical properties of soil images. The fractal, introduced in 1975 by Mandelbrot (Buczko 2005) provides a framework for the analysis of natural phenomena in various scientific domains. The fractal is an irregular geometric object with an infinite nesting of structure of different sizes. Fractals can be used to make models of any natural object, such as soil, islands, rivers, mountains, trees, clouds.

E. Plane extraction

Input color image is extracted the three different planes of RGB with their pixel values. These pixel values are used to compute the pH index of the soil. Using pH index of soil, the pH value of samples are determined.

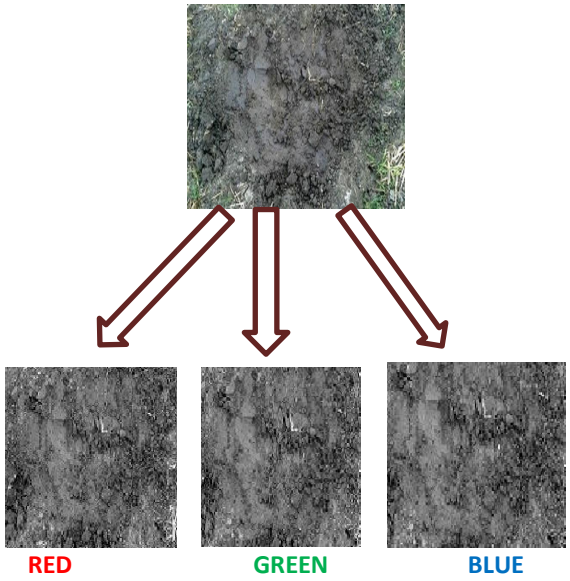

Fig 5: Plane Extraction

This single RGB image is extracted into three different components of Red-Green-Blue with own pixel value shown in fig 5**.**

III. RESULTS AND DISCUSSION

Initially, input samples are converted into binary image using thrsholding. This pixel value of binary image is taken under the box counting method and the formula (1), to find the average fractal dimension of the sample. liquid limit, plastic limit, shrinkage limit, coefficient of uniformity, field density are determined. Threshold value varies from 80-120. Depending upon the threshold value, N(s) calculated by Box Counting method. The average fractal dimension was calculated and given in table 1.

Threshold value	N(s)	Fractal dimension
80	3	0.63093
90	4	1.46497
100	6	1.63093
110	7	1.63093
120	8	1.89279
Average fractal dimension		1.51136

Table 1: Fractal Dimension of Single Sample

PARAMETERS	Value
Water content	9.2267
Liquid limit	55.8993
Plastic limit	24.0568
Shrinkage limit	19.3408
Coefficient of curvature	0.625636
Specific gravity	2.65885
Coefficient of uniformity	7.07502
Field density	1.61507

Table 2: Physical Parameters of Sample

S.NO	RGB VALUE	PH INDEX	PH OF SAMPLE
1.	71-71-69	0.0144928	7.537
2.	54-54-52	0.0192308	7.419
3.	79-79-79	0.0126582	7.596
4.	125-131-129	0.00775194	7.809
5.	99-99-99	0.0103093	7.685
6.	91-91-91	0.010989	7.658
7.	108-108-106	0.00943396	7.724
8.	82-82-80	0.0125	7.760
9.	114-114-114	0.0087713	7.755
Average pH value			7.64277

Table 3: pH of single soil sample

In table 2 shows all the physical parameters of soil sample of fractal dimension 1.511.

Using the fractal dimension all the parameters was calculated. These are all the parameters used in the field of civil Engineering and where the soil used in the field of Engineering.

The correlation between the fractal dimension and physical parameters represented as graph [6]. Using the plane extraction, the pixel value of each plane is calculated. Using formula (2), pH index of sample was calculated. Depending upon the pH index and color of sample, pH of the sample was calculated shown in table 3.This pH of soil determines the chemical characteristics of the soil.

IV. CONCLUSION AND FUTURE WORK

A. Conclusion

Determination of soil physical and chemical properties was calculated successfully. These output of pH value of the sample compared with the laboratory report. The percentage of error between conventional laboratory and image analysis approach varies from 1%. These soil physical properties is used in the field of civil and agriculture management. Soil pH value is used to identify the acidic and basic nature of the soil. This system reduces the manual assessment and time. It also reduces human errors and delay of testing.

B. Future work

In this system, further analyzed more samples of various places and improves reliability of the system with various resolutions. And also estimate soil nutrition distribution such as Mg, Ca, K, Na using image processing. The whole system implemented into FPGA processor.

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