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Determination of Soil pH using Digital Image Processing

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ABSTRACT

Image processing is one of the newly developed technologies for determining the soil pH. In Agriculture sector the parameters like quantity and quality of product are the important measures from the farmer's point of view. Soil is recognized as one of the most valuable natural resource. The soil pH property used to describe the degree of acidity or basicity which affect nutrient availability and ultimately plant growth. Here the soil pH is determined by the help of using digital image processing. pH of 7.0 is neutral, and soils above or below this value are either alkaline or acidic, respectively. Digital image processing is a technique that uses computer algorithms to perform image processing on digital images. A color characteristic of soil is analyzed using digital image processing for determining the soil properties. The proposed system is an Android application that makes use of image processing. Just by taking the image of soil sample, it computes the soil properties such as pH.

Key words: **Color, Digital images**, **Soil pH**

INTRODUCTION

The determination of soil pH is an important factor which helps to know the growth of plants and also understand the amount of nutrients present in the soil which is used for the plants growth. Knowing the pH of the soil will quickly allow user to determine if the soil is suitable for plant growth and what nutrients will be most limiting. Using this technology we can easily find the acidity and basicity [9]. Basically the pH scale value starts from 0 to 14.
A pH scale value 7.0 represents that soil is neutral. The scale values of soil below 7.0 are either acidic or alkaline respectively. A soil pH of 6.0 is ten times more acidic than the soil neutral soil [8]. The complete growth of a crop is depending on the soil pH. The pH meter is used for determination of the soil pH. Most of the plants can tolerate solution culture in soil pH, but if the acidity is increased the plants cannot adjust with it. Plant growth is depending on the soil pH. pH value ranges from 1 to 14, pH value below 7 is acidic whereas above 7 is alkaline. The most suitable range for many plants is between 5.5 to 7.0. Below a pH of 6.0, Some nutrients such as nitrogen, phosphorus, and potassium are less and above a pH of 7.5, iron, manganese, and phosphorus are less available. Most nutrients that plant needs are readily available when the pH of the soil solution ranges from 6.0 to 7.5. Soil colors are the parts of visual perceptual property where digital values of red, green and blue (RGB) provide a clue for spectral signature capture of different pH in soil [10].

2. LITARETURE SURVEY

In year 2011, the author M.A.A. Mashud [1] explained about the digital pH meter using microcontroller to measure the pH of blood. This design system is simple to use. 15 patients are tested among this developed system and found sound results. This work is mainly used to avoid the external oscillator circuit and MC14511B is used as a buffer and driver circuit.

M.A.A. Mashud, M. H. Uddin and Md. Serajul Islam [2] A digital pH meter is developed to measure the pH of soil using a fast response microcontroller PIC16F876. External oscillator circuits are used for the better performance. For quickly real time display MC14511B is avoided. Common cathode display is used for display

Vinay Kumar1, Binod Kumar [3] Determination of soil pH was based on digital image processing technique. Here digital photographs of the soil samples were used for the analysis of soil pH. Soil pH were analyzed from RGB value and plotted for result. Equation values (Soil pH index) of deep brown colors are different from light yellowish and greenish Soil pH values in deep brown color were different from yellowish and other grey colors. Ranges of soil pH and pH index values were 7.30-7.50 and 0.0070-0.0261, respectively in deep brown color. Similarly, soil pH range varies from 6.80-7.04 and 5.58-6.58 in light yellowish and greenish color respectively while their corresponding pH index values were 0.0071- 0.0451 and 0.0084-0.0239.

Makera M Aziz .Dena Rafaa Ahmed ,BanarFareed Ibrahim [4] Find the pH value of soil, according to the soil color by using neural network. The sample of soil is taken from many lands and its pH value was estimated according to

the sample color. That mean database is needed for this purpose to compare the current soil sample and find its pH value. 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 are (RGB). The two RGB values of the sample and database will compare to find the value of pH using neural network. Analysis of comparisons between real values of pH calculated using the chemical analysis and pH.

Persson.M [5] Estimated the water content of soil by using two color spaces of digital image (RGB) and (HSV). He discovered that the soil became darker when the water content increase and the soil wetted up, but this will be in a limited range. The regression analysis has been used to find the relation between the color of the soil and the water content of the soil. He found there is a strong relation between soil color and water content of soil, light color of the soil refers to that the soil has poor organic matter

Forrer.I, Papritz.A, Kasteel. R, Flühler. H, Luca .D[6] Determined the solute concentration of soil by developing model based on digital image. Chemical analysis and soil sampling were used to find the relation between the dye content of soil and the value of digital image color (red, blue and green). The pre-processing is used to detect some of the error that in digital image. The polynomial regression is used to build the model with a primary color (RGB) validation of the technique with independent data showed the methods estimated the concentration of the dye well.

M.A.Abu. ,E.M.M.Nasir ,C.R.Bala[7] Use fuzzy logic method with matlab software for determining soil pH. A fuzzy system is successfully design to control the soil pH. The input for this system is temperature, light intensity, and humidity. 'By constructing fuzzy system the condition for the roses to grow is collected and analyzed.

3. PROPOSED METHODOLOGIES

The proposed system is android application with web server support that takes soil sample images as input and displays pH value and crop suggestions as output. This approach makes use of Digital Image Processing concepts [3]**.** Here the soil sample to be tested is captured in mobile camera. The input image undergoes preprocessing. The aim of preprocessing is an improvement of image data that suppresses unwanted distortions or enhances some image features. The input image undergoes filtering to remove unwanted noises. A histogram is an accurate representation of the distribution of numerical data. It is an estimate of the probability distribution of a continuous variable. It differs from a bar graph, in the sense that a bar graph relates two variables.

To construct a histogram, the first step is to "bin" (or "bucket") the range of values—that is, divide the entire range of values into a series of intervals—and then count howmany values fall into each interval. The bins are usually specified as consecutive, non-overlapping intervals of a variable. Thebins (intervals) must be adjacent, and are often (but are not required to be) of equal size. If the bins are of equal size, a rectangle is erected over the bin with height proportional to the frequency the number of cases in each bin. A histogram may also be normalized to display "relative" frequencies. It then shows the proportion of cases that fall into each of several categories, with the sum of the heights equaling 1. From the preprocessed image, features like RGB values are extracted. The RGB values extracted can be used for calculating the pH index and this pH index was compared with the database which we have stored. From database, pH values, it's possible nutrient content and crop suggestionscan be predicted. GLCM also helps to compute texture features like Correlation, Contrast, Homogeneity and Entropy which in turn is mapped with the values in the database and thus moisture content value is obtained.

4. PROPOSED SYSTEM

The Proposed System is an application, which can be used for finding pH value of soil sample. The main objective of the system is to provide availability of soil testing. This system is implemented using digital image processing. The steps involved are image acquisition, image segmentation and feature extraction

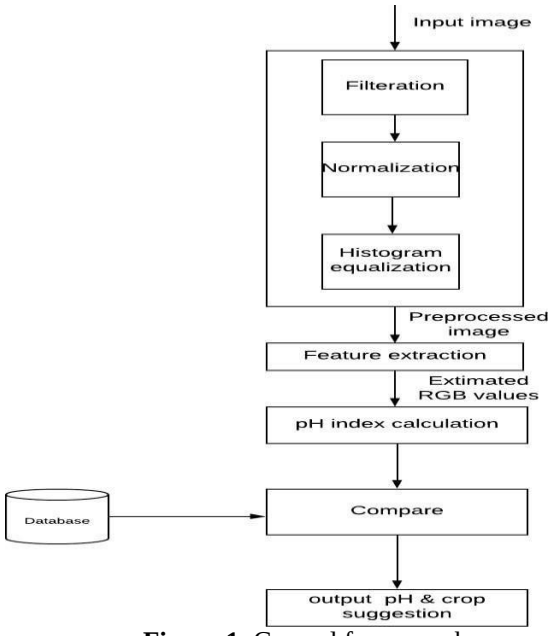

Figure 1: General frame work.

The System works as in Fig1 by providing the image file of soil sample as input and then RGB value of each image of soil sample will be calculated by using digital image processing and by comparing the data stored in database, we give soil pH and the constituents of soil as output.

Table1: Soil details

Soil Ph	Soil Type	Nutrients	Suitable crops are
3.5-4.0	Strongly Acidic	All nutrients	Not suitable for any crop
4.5-6.0	Moderately acidic	ca, mg,N,P, K,B,Mo.	Wheat, soybean, Rice, potato, Pea, Peanut.
6.0-6.5	Slightly acidic	Ca,Mg, S,N,P.	Wheat, soybean, Rice, sweet potato, corn, Beetroot.
6.5-7.5	Neutral	No Deficient Nutrients.	Wheat, soyabean,Barly,vegetables,oilseeds,Mushrooms,oats ,cotton.
7.5-8.5	Slightly Alkaline	Fe, Mn,P.	Vegetables, oilseeds,Mushrooms,oats ,cotten,Cucumber,Garlic.
8.5-9.0	Strongly Alkaline		Not suitable for any crop.

RGB values in deep brown colored soil were 113-98-30 to 207-186-157 and its value in light yellowish soil 128-105-27 to 229-210-152 where as in greenish soil RGB value ranged 152-122-52 to 189-164-113. Ranges of soil pH and pH index values were 7.30-7.50 and 0.0070-0.0261, respectively in deep brown color. Similarly, soil pH value ranges from 5.58-6.58 to 6.80-7.04 in light yellowish and greenish color. The corresponding pH index values were 0.0071-0.0451 and 0.0084- 0.0239. Thus soil pH range varies from 7.30-7.50,6.80 -7.04 and 5.58-6.58 in deep brown color, light yellowish color and greenish color respectively. On the basis of RGB gray values, their pixels property and digital correlations, soil pH are analyzed. The Table1 shows the suitable crops for the identified soil.

5. RESULT

Based on the material of object, when light falls on objects, some of wave lengths are absorbed and some are reflected. Using digital photographic snap the images of soil and it received wavelengths corresponding to red green and blue colors in Fig1.The result is calculated as pH using digital image processing. Then separate the color bands for given information about the intensity of light in red, green, and blue (RGB) wavelength regions. The Fig2 shows the different color band. In whole images, colors of soil samples were taken through digital camera are different from one to another i.e. deep brown, light yellowish or greenish. The outcome will provide the result of the qualitative level of soil pH.

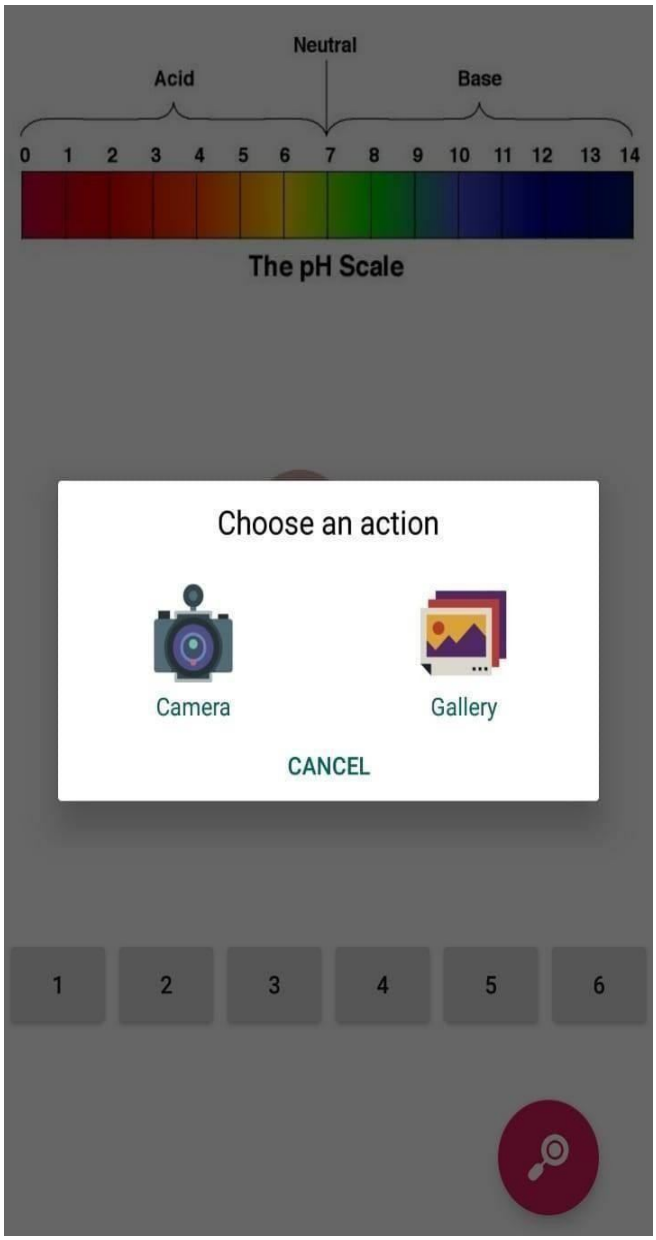

Figure 2: Image input to the database

Finally we get an approximate value. Compare this value with values which already stored in the database. After the comparison it return soil pH factor and according to it we return the soil pH. If the value is comes same it produce the pH of the soil correctly as in Fig3. On the basics of pH we can suggest the suitable crop for the soil on the basis of pH value. The Fig 4 represent the flow chart of the entire system.

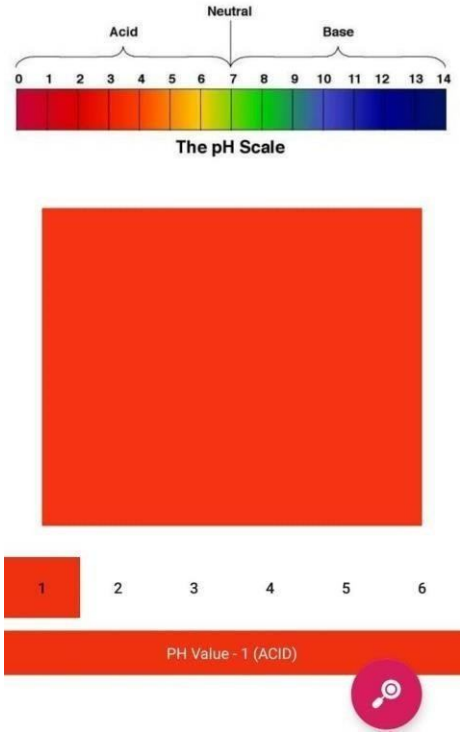

Figure 3: pH scale value

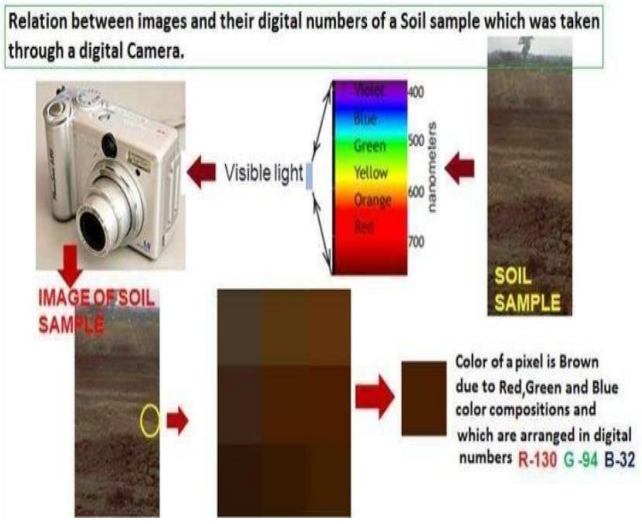

Figure 4: Flow chart representation from the input an image to final stage.

6. EXPERIMENTAL ANALYSIS

Initially, a soil image is set as input and obtained corresponding pH value as output as Table2. The set of images are stored in the database. Colors features are extracted and calculate pH index. Image Processing is used for the classification of a set of images used for the testing purpose.

Dataset

In this system there are two set of data. One is for training and other set is for testing. Some samples are shown in the Fig 5.

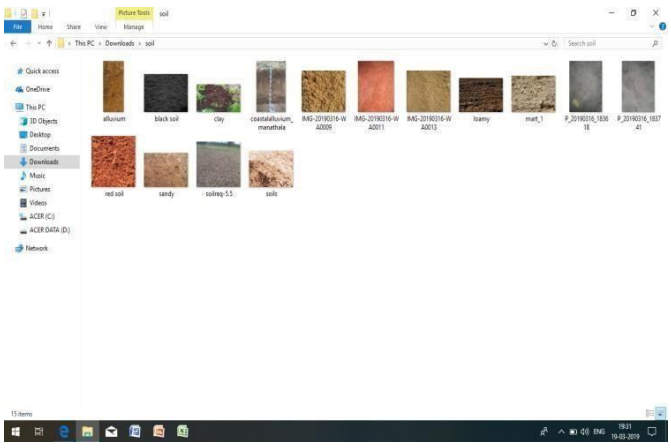

Figure 5: Training dataset

Implementation

During training process, the feature of the given image is extracted. Image processing technique is used for feature extraction and removal of noise in the image. Here red, green and blue features are extracted and calculate the pH index. After training phase will go for testing. Extraction of R, G, B index values and Matching the image along with the values is been displayed at the command window.

Table 2: pH value analysis from soil image.

Soil image with RGB value	Stored pH value	Analysed pH value	Interpretation
 (247 59 12)	6.6 – 7.5	7.1	The given soil is slightly alkaline. It is suitable for growing cotton, wheat, rice, pulses, tobacco, oil seeds, potatoes, and fruits.
 (255 178 102)	2.5 – 6.2	3.6	The given soil is strongly acidic. It is suitable for tomatoes, peppers, carrots and potatoes.
 (117 108 108)	6.3 – 6.5	6.4	The given soil is slightly acidic. It is suitable for wheat, soybean, rice, sweet potato and beetroot.

Figure 6 : Comparison between stored and analysed data.

The above Fig: 6 shows the comparison between stored pH values and analysed pH values of soil. The graph represents the deviation of analyzes data from stored data. Here orange color represents the stored value and blue color represents analysed pH value. For example, give a soil image as input. After processing we get a value like 3.2. The value is compared with stored value. 3.2 are come under the range 2.5 to 6.2. So the given soil is sandy soil.

7. CONCLUSION

The 8 types of soils found in Kerala namely, Coastal alluvium, mixed alluvium, Acid saline soils, Laterite soils, Black cotton soils, Red soils, Hill soils and Forest soils are planning to implement in this system. Ordinary Smartphone camera can be used for soil pH determination. This makes the proposed system more feasible. This system can be used for commercial farming purposes as well as residential sting backyard farming instead of travelling back and forth to a soil testing center; soil pH determination can be done easily within our palms. Thus making it user friendly and accessible by anyone from anywhere.

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REFERENCES

[1] M. A. A. Mashud, M. A. Masud, Md. SerajulIslam,"**Design and development of microcontroller based digital PH meter***",ULABJounal of Science and Engineering, 2011, vol.4 pp31-34*

[2] M.A. A. Mashud, M. H. Uddin and Md. Serajul Islam," **Design and Implementation of Microcontroller Based Digital Soil pH Meter**", *ULAB Journal Of Science And Engineering Vol. 5, No.1, November 2014 (Issn: 2079-4398*)

[3] VinayKumar,Binod Kumar Vimal ,Rakesh Kumar ,RakeshKumar , Mukesh Kumar, **"Determination of soil pH by using digital image processing technique**," *Journal of Applied and Natural Science, vol. 6, no. 1, pp. 14-18, 2014* https://doi.org/10.31018/jans.v6i1.368

[4] **Makera M Aziz . Dena Rafaa Ahmed , BanarFareed Ibrahim,"** Determine the Ph. of Soil by Using Neural Network Based on Soil's Colour**,"** ***International Journal of Advanced Research in Computer Science and Software Engineering Volume 6, Issue 11, November 2016 ISSN: 2277 128X .***

[5] Persson.M, "**Estimating surface soil moisture from soil color using image analysis**,*" Vadose Zone Journal, vol. 4, p. 1119–1122, 2005.* https://doi.org/10.2136/vzj2005.0023

[6] Forrer. I, Papritz.A, Kasteel. R, Flühler. H, Luca .D, "**Quantifying dye tracers in soil profiles by image processing**,"*European Journal of Soil Science, vol. 51, pp. 313-322, 2002.* https://doi.org/10.1046/j.1365-2389.2000.00315.x

[7] M.A.Abu. ,E.M.M.Nasir ,C.R.Bala ,"**Simulation of soil PH Control system using fuzzy logic Method** ",ICETCIP Dec 2014

[8] F. J. Sikora , P. Howe , D. Reid , D. Morgan & E. Zimmer,"Adopting a Robotic pH Instrument for Soil and Soil-Buffer pHMeasurements in a Soil Test Laboratory**,"** ***Communications inSoil Science and Plant Analysis, vol. 42, pp. 617-632, 2011.*** https://doi.org/10.1080/00103624.2011.550371

[9] Zhenyu Du , Jianmin Zhou , Huoyan Wang , Xiaoqin Chen &Qinghua Wang, "**Soil pH Changes from Fertilizer Site as Affected by Application of Monocalcium Phosphate and Potassium Chloride,**" *Communications in Soil Science and Plant Analysis, vol. 41, p. 1779–1788, 2010.* https://doi.org/10.1080/00103624.2010.492064

[10] **Karisiddappa, Ramegowda, "Soil Characterization Based on Digital Image Analysis,"***Indian Geotechnical Conference – 2010, IGS Mumbai Chapter & IIT Bombay.*