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Estimation of Moisture Content in Soil Using Image Processing

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Abstract*:*
Agriculture is the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food, wool, and other products. Moisture content in soil is one of the main component which plays important role in yield of crops. The paper aims to introduce software "Soil moisture Assessment". The software has revolutionized the method to find moisture content in soil. Approach is to turn the manual process to a software application using image processing. Image of the soil with different moisture content are captured and preprocessed to remove the noise of source image. The color and texture characters of moist soil are extracted. Color characteristics analyzed using the RGB and the HSV model. Texture features are analyzed using entropy, energy, contrast, homogeneity. A relationship between extracted features and moisture content is developed. The document goes further to discuss the process used by the authors to develop their engineering capstone project i.e. "Soil moisture Assessment Software".

Key words: *Moisture content, Image processing, Texture, Feature, Color*

1. Introduction

The main occupation of India is agriculture. Indian soil is composed of many minerals and organic elements. Moisture content in soil is one of the main components which play an important role in yield of crops. If the moisture content is more in soil it will cause respiration problem in the plants. If it is less it will cause dehydration problem. So the moisture content should be appropriate for the proper growth of plant. The present hardware method to generate moisture content of soil is TDR (Time domain Reflectometry). Traditional methods are manual and time consuming due to which farmers are looking forward to replacement for traditional way so as to yield the better and healthy crops. To overcome problem we are proposing a system which is aimed to find moisture content in the soil using image processing technique. Digital image processing is superior to manual process so we will be able to save time. Computer algorithms are used for texture analysis.

IT sectors help the agriculture in many different aspects such as India expands kissan call centre to help farmers, Online websites are available and online bidding of crops, Software which can predict the soil fertility of a land after harvesting a particular crop, Some farms now have tractors equipped with GPS that are able to drive themselves and used in Fields of Fingerprints such as DNA Testing for Crops etc.. Proposed system is other automation using software.

"Estimation of moisture content in soil" is the aim of the proposed system is to overcome the problems of traditional methods and to help agriculture system to re-organize the total system towards a low-input, higher-efficiency, higher profit in estimating the content of moisture in soil using image processing technique. Our project helps to determine moisture content without using hardware. By using images of soil moisture content can easily be determined. It helps the farming industry and the Agricultural universities.

2. Literature Survey

Traditionally, moisture content in soil is measured by a manual technique i.e. TDR -Time Domain Reflectometry.

2.1. Time Domain Reflectometry

It is a highly accurate and automatable method for determination of porous media water content and electrical conductivity. Water content is inferred from the dielectric permittivity of the medium, whereas electrical conductivity is inferred from TDR signal attenuation. Empirical and dielectric mixing models are used to relate water content to measured dielectric permittivity. Clay and organic matter bind substantial amounts of water, such that measured bulk dielectric constant is reduced and the relationship with total water content requires individual calibration. A variety of TDR probe configurations provide users with site- and media-specific options. Advances in TDR technology and in other dielectric methods offer the promise not only for less expensive and more accurate tools for electrical determination of water and solute contents, but also a host of other properties such as specific surface area, and retention properties of porous media. Fig 1 shows the existing system equipment

Figure 1: Fig existing system

Advantages of existing system:

- It is a manual procedure.
- Easy to use and understand.

Disadvantage of existing system:

- Process consumes longer time
- Sometimes not accurate in results.
- More number of soil samples is collected for the test.
- Requires skilled person to handle the process.

2.2. Paper Details

Paper titled “Surface soil moisture estimation from SAR data” by Petre VOICU, Roxana VINTILA ICPA Bucharest, Romania .

Surface (0-5 cm) soil moisture measurements were carried out concurrently to the SAR acquisitions, with either gravimetric sampling or TDR method. Over the 10 SAR acquisition dates, the surface soil moisture, expressed in volumetric units, varied between 0.10 and 0.35 m3/m3.

The roughness of the soil was determined on 4 of the calibration units having different topographic properties. Roughness measurements were made with a 1 meter long profilometer, at the beginning and at the end of the experiment. Rms heights were found to be in a narrow range: between 1.4 and 2.1 cm. Correlation lengths were found to be between 4 and 8 cm.

3. Proposed System

Fig 2 shows the architecture of proposed system. The detailed explanation of each block is given below.

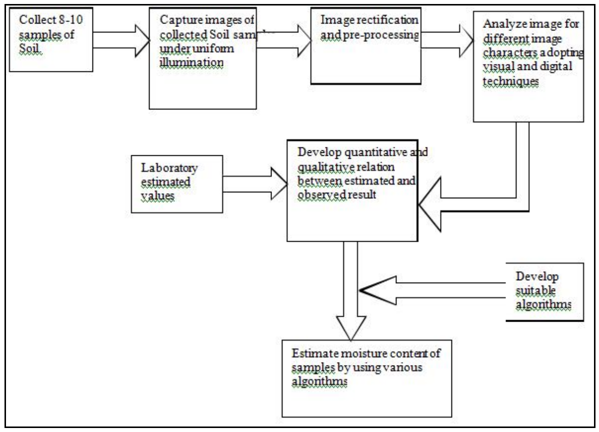


Figure 2: Architectural Design for estimation of moisture content

3.1. Sample Collection

Collect the sample of Soil with different moisture content. Capture the image of collected samples under the uniform illumination with a light background. The camera should be of Minimum of 16mega pixel. Moisture content of soil collected is calculated from laboratory using manual process which becomes the reference for development of proposed system.

3.2. Image Preprocessing

Outside interference will cause a variety of noise in the process of image acquisition, which will significantly affect the quality of the image [1]. In order to remove unwanted clipping and make analysis easy we need to preprocess the image, such as removing noise and enhancing image.

The noises of collected image often show as the mutation of the isolated pixel in the image that is the small particles in the image, which is called as grain noise. Grain noise show High frequency characteristics and it has great gray difference. Also the spaces are not interrelated [2]. The commonly used methods of smoothing were the median filter, Neighborhood mean, spatial low pass filter and frequency low pass filter.

In this study, we use the method of the median filter. There are significant gray differences between enhanced image and background.

3.3. Gray Level Cooccurence Matrix

A GLCM is a square matrix which consists of the same number of rows and columns as the number of gray levels in an image. Each matrix element P $(i,j|\Delta x,\Delta y)$ represents the relative frequency with which two pixels, separated by a pixel distance $(\Delta x,\Delta y)$ occur within a given neighborhood, one with intensity i and the other with intensity j. GLCM's are very sensitive to the size of the texture samples. So the number of gray levels is reduced. For the reliability of the statistical estimate, the matrix must contain a reasonably large occupancy level. To achieve this either the number of gray level values is reduced or a larger window is used. A compromise of the two approaches is generally used. Properties of GLCM are used for texture feature extraction.

3.4. Texture Analysis

Texture is a feature used to partition images into regions of interest, and to classify those regions. It provides information in the spatial arrangement of colors or intensities in an image. It is characterized by the spatial distribution of intensity levels in a neighborhood. It is a repeating pattern of local variations of image intensity. Texture consists of texture primitives or texture elements called texels. Such features are found in the tone and structure of a texture. Tone is based on pixel intensity properties in a Texel while the structure represents the spatial relationship between texels. If texels are small and tonal differences between the texels are large, a fine texture results. If texels are large and consist of several pixels, the resulting texture is coarse [3].

3.5. Estimation of Moisture Content

From the texture and color analysis the various values of extracted features are stored in database. Feature values extracted for the test image is compared with the database values to build a correlation. Moisture content is obtained for the test soil.

4. Texture Features

Texture features like Intensity, correlation, homogeneity, energy, entropy and contrast are extracted along with color features.

4.1. Contrast

Contrast is the difference in luminance and/or color that makes an object (or its representation in an image or display) distinguishable.
Contrast is calculated using the formula below:

$$\sum_{i,j} |i - j|^2 p(i,j)$$

4.2. Entropy

E = entropy(I) returns E, a scalar value representing the entropy of gray scale image I. Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image.
Entropy is defined as sum (p.*log2 (p))

4.3. Correlation

Correlation is a measure of gray level linear dependence between the pixels at the specified positions relative to each other.
Correlation is calculated using the formula below:

$$\sum_{i,j} \frac{(i - \mu i)(j - \mu j)p(i,j)}{\sigma i \sigma j}$$

4.4. Homogeneity

Homogeneity Returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Range = [0 1] Homogeneity is 1 for a diagonal GLCM.
Homogeneity is calculated using the formula below:

$$\sum_{i,j} \frac{p(i,j)}{1 + |i - j|}$$

5. Color Features

Color features such as RGB and HSV are extracted.

5.1. RGB

RGB colour system can change color value through changing the base color and color equation, which can be used to denote the color that has mixed.

5.2. HSV

HSV colour system is directly described by brightness (or lightness), tonality and saturation, which are suitable for the human habit of the color description. It is easy for human visual system to distinguish different tonalities, but it is difficult to distinguish different color through brightness and saturation. In the system, H is defined as tonality; I and S are defined as light intensity and saturation respectively. For the above characteristics correlation model is developed to analyse the dependency of moisture over the characteristics.

6. Procedure

Collect the samples of soil and capture the image under uniform illumination. Moisture content of soil collected is calculated from manual process in the laboratory which becomes the reference for the development of proposed system. Image is preprocessed and texture features are extracted. Next the image is converted to gray scale for GLCM calculation. The image is resized to form a square matrix. GLCM is calculated. Next all the texture feature values are calculated using the formulae mentioned above. All these texture feature values are loaded into a matrix. The same procedure is followed on a number of leaves and all the texture and color feature values are loaded into a single matrix. Next test image is taken and its texture feature values are extracted using a similar procedure. MATLAB software is used for the implementation of algorithm. The reason for the choice of software is it provides a good number of tools for image processing which can be easy to use. A correlation is developed from the values extracted and the laboratory values to determine the moisture content in soil. Proposed system allows user to load image of size 512 X 512. User can view moisture content along with the report generated. Report contains details about the deficiency or excess content of moisture in soil. This helps formers to plan to get appropriate moisture.

7. Advantages of Proposed System

Process consumes less time than existing system and is accurate giving instant results for users. Economical and consumes less number of sample soil images for testing.

8. Result and Discussion

First the software opens a dialog box for selecting the test image from anywhere in the computer. When the selection is done the image is resized and preprocessed. For train images texture and color features are extracted and their value is stored in the database. Test image texture and color features are extracted and are compared with database. Based on the correlation the moisture value is extracted and report is generated. Table 1 gives the detail of soil images along with the moisture content obtained from laboratory using TDR method. Table 1. Image and respective moisture content

9. Conclusion

Proposed system is an automated technique to estimate the moisture content in soil. System finds the moisture content along with report generation that gives information about whether the input soil is deficient moisture or correct moisture content. It gives proper suggestion based on the result and report generated. Use of image processing makes it accurate and error free.

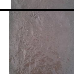
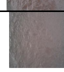
Soil image	Moisture content (in %)
	20.67
	23.23
	25.25
	30.43
	31.38
	34.56
	33.78
	40.98
	41.56

Table 1

10. Acknowledgement

We express our heartfelt gratitude to our guide Prof. Karibasappa K.G. of Computer Science & Engineering Dept. BVBCET, for their valuable guidance, co-operation and timely help. We also thank Prof. V.B.Kuligod associate professor, University of Agricultural Sciences, Dharwad for his invaluable support and guidance.

11. References

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