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SOIL MOISTURE MEASUREMENT FROM HIGH RESOLUTION MULTI SPECTRAL IMAGERY- REVIEW

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ABSTRACT

Soil moisture content (SMC) is a key component of soil water balance, which addresses water and energy exchanges at the surface and atmosphere interface.The objective of this research is to measure the SMC using Multi Spectral Imagery UAV Image data or remotely sensed image data which are processed for extraction of the median values in the RGB color space.To obtain the median values the images has to be processed for enhancement and filtering techniques and to obtain accurate Digital Numbers (DN). The darkening of the soil is increased with the moisture content of soil. The obtained DN values the type of soil is compared with the standard values for the SMC of the particular soil type.
Keywords— Soil Moisture, Digital Numbers, RGB, Median Cut, Image Processing

I. INTRODUCTION

In the agricultural field, soil moisture parameter directly influences the yield of a crop. Soil moisture is the measurement of the amount of water in liquid or gaseous state, present in the soil. The adequate irrigation management depends on the good knowledge about soil moisture [1].

Various techniques for retrieving soil moisture content [SMC] have been the subject of research for decades. Gravimetric measurements of soil moisture are very reliable but are laborious. Measuring SMC with embedded sensors, such as time and frequency domain reflectometers, does not require a huge investment of time or facilities; but most of these methods suffer from many disadvantages. In situmeasurements can be exhaustive and expensive if large areas are involved, as these measurements are mainly "local," with a particular footprint representing moisture conditions in only a fraction of a cubic meter of soil. Because of the spatial heterogeneity of soil moisture due to different soil conditions, vegetation, topography, or impact of human activities, local measurements when are carried out on a larger scale such as fields or watersheds, might result in inaccuracies[2].

Moisture is also a factor that influences the spectral response of the soil. SMC is an important factor in managing irrigated farms. Many current crop production management decisions that are made by growers, production managers, and crop advisors in precision agriculture are already based on observation from remotely sensed data such as satellite imagery [3].

The objective of this research is to generate surface SMC estimate using high-resolution UAV-Image data or remotely sensed image data acquired by the IIHR, India to obtain the median RGB values and obtain the SMC of the captured image area. The results will contribute not only to efficient and reliable high-resolution multi-spectral remote sensing validation, but also to better utilization of remotely sensed soil moisture calculation for enhanced irrigation modeling and scheduling[1][4][5].

II.LITERATURE REVIEW

[1]João F. C. dos Santos, Heider R. F. Silva, Francisco A. C. Pinto& Igor R. de Assis, "Use of digital images to estimate soil moisture".

The objective of this paper is to analyze the relation between the moisture and the spectral response of the soil to generate prediction models. Samples with different moisture contents were prepared and photographed. The photographs were taken under homogeneous light condition and with previous correction for

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the white balance of the digital photograph camera. The images were processed for extraction of the median values in the Red, Green and Blue bands of the RGB color space; Hue, Saturation and Value of the HSV color space; and values of the digital numbers of a panchromatic image obtained from the RGB bands. The moisture of the samples was determined with the thermo gravimetric method. Regression models were evaluated for each image type: RGB, HSV and panchromatic. It was observed the darkening of the soil with the increase of moisture. For each type of soil, a model with best fit was observed and to use these models for prediction purposes, it is necessary to choose the model with best fit in advance, according to the soil characteristics. Soil moisture estimation as a function of its spectral response by digital image processing proves promising.

[2] Leila Hassan-Esfahani, Alfonso Torres-Rua, Austin Jensen and Mac McKee. "Assessment of Surface Soil Moisture Using High-Resolution Multi-Spectral Imagery and Artificial Neural Networks"

In this study, an artificial neural network (ANN) model was developed to quantify the effectiveness of using spectral images to estimate surface soil moisture. The model produces acceptable estimations of surface soil moisture (root mean square error (RMSE) = 2.0, mean absolute error (MAE) = 1.8, coefficient of correlation (r) = 0.88, coefficient of performance (e) = 0.75 and coefficient of determination (R2) = 0.77) by combining field measurements with inexpensive and readily available remotely sensed inputs. The spatial data (visual spectrum, near infrared, infrared/thermal) are produced by the AggieAir platform, which includes an unmanned aerial vehicle (UAV) that enables users to gather aerial imagery at a low price and high spatial and temporal resolutions. This study reports the development of an ANN model that translates AggieAir imagery into estimates of surface soil moisture for a large field irrigated by a center pivot sprinkler system.

[3] Bhawna J. Chilke,Neha B. Koawale,Divya M. Chandran, "Determination of Soil pH by using Digital Image Processing Technique-A Review"

This paper discusses the various methods and techniques involved in the field of image processing to detect Soil pH. Image processing has been proved to be an effective tool for analysis in various fields and applications. In Agriculture sector the parameters like quantity and quality of product are the important measures from the farmers' point of view. Soil is recognized as one of the most valuable natural resource whose soil pH property used to describe the degree of acidity which affect nutrient availability and ultimately plant growth pH of 7.0 is neutral, and soils above or below this value are either alkaline or acidic, respectively.

[4] Makera M Aziz . Dena Rafaa Ahmed, Banar Fareed Ibrahim," Determine the Ph. of Soil by Using Neural Network Based on Soil's Colour,"

This paper finds 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 with, 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.

[5] Persson.M, "Estimating surface soil moisture from soil color using image analysis,"

The paper 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 thereis 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.

III.OBJECTIVE

The objective is to measure the SMC using Multi Spectral Imagery. High-Resolution UAV-Image data or remotely sensed image data are acquired by Indian Institute of Horticultural Research, an autonomous organization acting as a nodal agency for basic, strategic, anticipatory and applied research on various aspects of horticulture in India.

These Digital images are processed for extraction of the median values in the Red, Green and Blue bands of the RGB color space[1][5][6][7]. To obtain the median values of RGB a median cut algorithm [8][9] is been implemented and digital numbers is obtained by these RGB values. To obtain the median values the images has to be processed for enhancement and filtering techniques to obtain accurate Digital Numbers (DN). Digital image consists of discrete picture elements called pixels. Associated with each pixel is a number represented as DN that depicts the average radiance of relatively small area within a scene. The size of this area

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effects the reproduction of details within the scene. As the pixel size is reduced more scene detail is preserved in digital representation. The darkening of the soil is increased with the moisture content of soil. With the obtained DN values the type of soil is noted and the compared with the standard values for the SMC of the particular soil type and the SMC is measured.

IV.METHODOLOGY

The processing scheme has acquisition of Multi Spectral Imagery and these images are processed as follows: image enhancement, filtering of image to remove noise, feature extraction and Detection [3].

1) Image Acquisition-Firstly the images of various area of soil captured with required resolution from the *Indian Institute of Horticultural Research***,** an autonomous organization acting as a nodal agency for basic, strategic, anticipatory and applied research on various aspects of horticulture such as fruits, vegetable, ornamental, medicinal and aromatic plants and mushrooms in India is acquired. These images are of high resolution which is acquired through UAV and remotely sensing.

2) Image Preprocessing- The next step is to suppress undesired distortion, enhance image feature for processing and analysis task of the images. It includes color space conversion, image enhancement for contrast improvement, filtering to remove noise etc.

Image data collected restrain errors related to geometry and brightness values of the pixels. Using appropriate mathematical models which are either definite or statistical models the errors are corrected. Image enhancement is the modification of image by changing the pixel brightness values to improve its visual impact. Image enhancement involves a collection of techniques that are used to improve the visual appearance of an image, or to convert the image to a form which is better suited for human or machine interpretation.

Images obtained lack in contrast and brightness because of the limitations of imaging sub systems and illumination conditions while capturing image. Images may have different types of noise. In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display. Image enhancement is useful in feature extraction, image analysis and an image display. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics.

3) Feature Extraction-The next step is the partitioning of images into various part or region and extracting meaningful region known as region of interest (ROI). With the ROI the required features from the image is to be extracted. Feature extraction plays important role for identification of object. The area of interest Image feature includes color, texture. Texture means how the color is distributed in the image, roughness, hardness of the image. Image processing feature detection includes methods for computing abstractions of image information and making local decisions at every image point whether there is an image feature of a given type at that point or not.

[8][9]The median-cut algorithm is implemented for the feature extraction. The algorithm is an image-based, color-quantization algorithm that gives good results for many images. The premise behind median cut algorithms is to have every entry in the color map represent the same number of pixels in the original image. In contrast to uniform sub-division, these algorithms divide the color space based on the distribution of the original colors. The process is as follows:

- Find the smallest box which contains all the colors in the image.
- Sort the enclosed colors along the longest axis of the box.
- Split the box into 2 regions at median of the sorted list.
- Repeat the above process until the original color space has been divided into 256 regions.
- The algorithm then divides the color space in a manner depicted below.
- The representative colors are found by averaging the colors in each box, and the appropriate color map index assigned to each color in that box.

From the median cut algorithm the obtained median RGB values are processed for DN as follows [1][5]:

$$DN= 0.2989 \cdot R + 0.5870 \cdot G + 0.1140 \cdot B$$

4) Comparison-Final step is to compare the features extracted with the standards to know the soil moisture. The processed output that is the DN will be computed and compared with the historical data for its consistency and analysis. The DN values for different types of soil and its moisture content is standardized by IIHR. The result from the above algorithm will be compared with the soil type and then it's SMC. The end result will be a fully automatic monitoring of agricultural areas for the soil moisture.

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V.CONCLUSION

In above survey we focus on the SMC measurement using RGB values. In the proposed methodology we different methods of image acquisition, pre processing, feature extraction, classification and detection. The median cut algorithm implementation can give a good accuracy and efficiency in measurement of SMC. By monitoring soil moisture, farmers can now optimize their water usage, increase produce yield, produce high quality crops, reduce water resource degradation and save a lot of money. Estimating soil moisture gives us a better idea of the plant species we can expect to find in a habitat. Estimating soil moisture gives us a better idea of the plant species we can expect to find in a habitat.

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