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Study of Reflectance Spectroscopy and Moisture Sensors for Estimation of Water Contents in Plant Species

Shrikant B. Bhosale[1], Assistant Professor, Dept of Botany, S.M.D.M.M. Kalamb, Dist.Dharashiv, (M.S), India,

Amarsinh B. Varpe[2], Assistant Professor, Dept of Computer Science, S.M.D.M.M. Kalamb, Dist.Dharashiv, (M.S), India,

Abstract : In the present study, water content in four types of plants species (Aloe Vera, Almond, Neem, Adulsa) have been measured through the ASD Field Spec4 spectroradiometer, where as the 150 SM soil moisture sensor has used for the moisture detection. It is found that there was a positive correlation with healthy (0.97) and dry (0.76). The research work was implemented using python open-source environment.

***Index Terms* - Plant Species, Spectral Analysis, Hyperspectral Data, Spectral Reflectance, Coefficient of Correction, Spectral Indices.**

1.INTRODUCTION

The water content is one of the most important properties of the plant species. Water content is responsible for plant productivity. Appropriate detection of such information provides an opportunity to make effective supervision results to improve plant quality [1]. Physical biological changes in plant canopy surface which can be used for detecting water status using remote sensing techniques. Plants have certain reflectance characteristics at different wavelengths of the spectrum [2]. Typically for a healthy plant leaves reflectance at visible spectrum about 900-980 nm is low due absorption of light by various plant species water [3]. The values of the general spectral reflectance can be analyzed by observing particular wavelengths but results can be more sensitive when information from different wavelengths are considered by calculating their ratios. Most of these studies used spectroradiometer for measuring spectral reflectance of plants in laboratory condition [4]. The ratio between the reflectance at 970 nm (R970) and the reflectance at a reference wavelength, 900 nm (R900), where there is no absorption by water concentration, has been used to determine water contents in the plants [5].

The water contents can also be determined by moisture sensor, which is based on the impedance of the sample. It is interesting to compare the results obtained by these two techniques. The objective of this paper is to report study done on four plants species, viz (Aloe Vera, Almond, Neem, Adulsa) by using these two techniques. The ASD Field Spec4 was used for the reflectance spectroscopy and the 150 SM soil moisture sensor was used for the importance measurement.

2. EXPERIMENTAIL SETUP

In this study hyperspectral non imaging was used estimating water content in plant species. Hyperspectral data were captured in a healthy leaf and then analyzed using python tool to evaluate spectral reflectance of these plants' species at different leaves of water content. Plant species data was also collected and correlated with water content

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2.1 Study Site and Experimental Setup

The location of the study area of Lord Yedshwari Devi Temple, Yermala, Dharashiv, Maharashtra, India. It is geographically site at 18° 37' 08'' N latitude and 75° 88' 32" E longitude of Yermala. Annual average rainfall is 396 mm with 29^0 C to 32^0 C annual temperatures.

The plant species samples of three types were collected from the Yermala Temple of Kalamb (MS) on 10 Feb 2021.These four types of plants were Aloe Vera, Almond, Neem, Adulsa ten samples of each variety have been collected and considered to be of healthy type. These samples were also dried in the laboratory for our study. Figure.1 shows proposed work of succeeding section for the estimation of water contents.

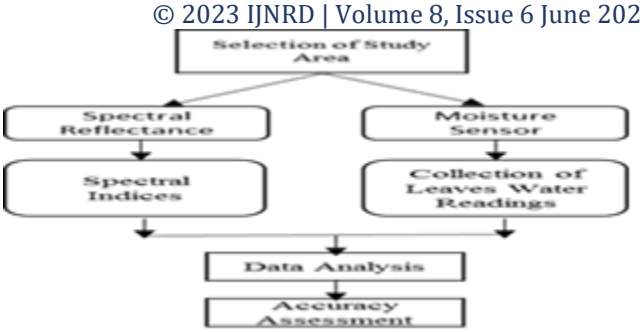

Figure.1 *Methodology of water contents estimation study*

2.2 Hyperspectral Datasets

The ASD Field Spec 4 Spectroradiometer instrument was used to acquire spectral signature of the samples. The wavelength range of the ASD Fieldspec4 spectroradiomter is 350-2500 nm. The spectral resolution of ASD is 3 nm to 10 nm, for 350-1000 nm and 1000-2500 nm sampling interval is 1.4 nm and 2 nm respectively. White reference panel was used for optimization and calibration of device to achieve absolute reflectance in lab conditions before samples recording [6].
The ASD Fieldspec4 spectroradiometer uses halogen lamp with 75w as a source of light energy. It was used to record the plant samples by zenith angle of 600 from the distance of 45 cm above the samples. The field of view (FOV) was 8 degree and fiber-optic cable was set as off nadir where plant samples were 15 cm long. Each sample was recorded by ten times for receiving spectra and then averaged as a pure spectrum. The RS3 (Version 6.3) inbuilt software was used for recording the reflectance spectra of leaves.

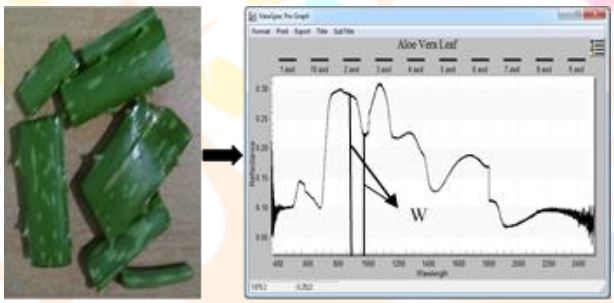

Figure.2 *Healthy plants species Aloe Vera leaves plotted using view spec pro*

The Figure.2 show one example of spectral signatures acquired from the ASD field spec 4 spectroradiometer for healthy and dry leaves respectively.

2.3 150 SM Soil Moisture Sensor

The SM150 measures soil moisture content. Its wrapped plastic body is attached to two sensing rods which insert directly into the plant leaf for taking readings. A water proof plug connects to a choice of signal cables. Both extension cables and extension tubes can be used. The soil moisture output signal is a differential analogue DC voltage. This is converted to soil moisture by a data logger or meter using the supplied general leaves calibrations. It can also be calibrated for specific plant leaves [7].

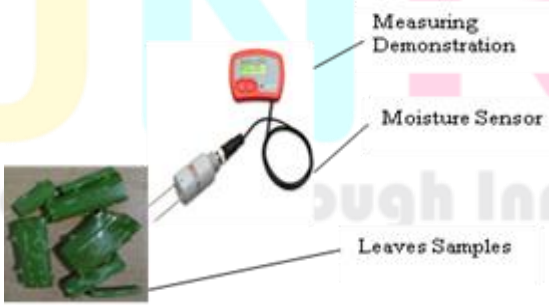

Figure.3 *Sample collected reading using SM150 soil moisture sensor instrument*

3. DATA PROCESSING TECHNIQUES

This section contains filtering algorithm to collected spectral response curve and analysis techniques.

3.1. Spectral Indices

Hyperspectral data research works with the group of spectral indices based on aims of researchers. WI is one of the well calibrated algorithms for estimation of water contents of leaves samples [8]. WI works with the spectrum ranging in SWIR region including reflectance of 900 nm and 970 nm wavelengths.

$$\text{Water Index} = R\ 900 / R\ 970 \qquad (1)$$

Where, R is denoted by reflectance at the ith wavelength.

3.2. Analysis of Variance (ANOVA)

ANOVA method applies for testing where the hypothesis founds to be there is no difference between two or more population means considering spectral response value and soil moisture readings. ANOVA test works if there is no difference in a number of treatments of samples [9].

$$SS^2 = n\sum_{i=1}^{I} \frac{(\overline{Xi} - \overline{X})^2}{I-1} \qquad (2)$$

Where, n is a total number of samples, is mean of all spectral indices categories, I be the samples size of the group as shown in Equ.2

4.RESULTS AND DISCUSSION

Four plant species were selected for study including Aloe Vera, Almond, Neem, Adulsa for estimation of water contents with their family. Data were analyzed in two comparative study of spectroradiometer and moisture sensor.
Table.1 provides statically measured for plant species with healthy and dry leaves samples. Preprocessed reflectance spectra were considered for further analysis with average of 10 leaves samples of each plant species with in two categories for calibration and one way ANOVA followed by a sum of squares prediction, where alpha = 0.05. The ANOVA for healthy leaves ranging from 1.01 to 1.131 based on spectroradiometer and 1.02 to 1.11 using moisture detection sensors. The Dry leaves resultant values were ranging from 0.612 to 0.720 and for soil moisture sensor 0.61 to 0.70 respectively. The sum of squares (SS) in ANOVA consists of 0.20, 0.25, 0.19 and 0.28 to analysis plant species identification.

Table 1. Coefficient of correlation between spectral response curve and 150 soil moisture sensor for four plant species

Plant Species	ASD Field Spec4 Average of 10 samples		Moisture Sensor α=0.05		ANOVA (SS) Average of 10 samples
	HL	DL	HL	DL	
Aloe Vera	0.92	0.50	1.04	0.42	0.20
Almond	1.02	0.60	1.02	0.50	0.25
Neem	1.04	0.40	0.81	0.32	0.19
Adulsa	1.04	0.55	1.4	0.50	0.28

Table 1.2 Coefficient of Correction with plant species growth pattern and R^2 values

Correlation Analysis	Equation	Accuracy
Healthy Leaves	Y=0.860x+0.140	0.97
Dry Leaves	Y=0.836+0.102	0.76

Table 1.2 shows R2 of spectroradiometer and 150 soil moisture sensors with the strong positive correlation between HL and DL leaves. As per the objectives of our research, the correlation signifies that both of procedure meets the positive results. HL were correlated better with accuracy 0.97, DL gives 0.76 accuracy. This research analyzes that soil moisture sensor also provides details of water level from leaves with exact analyses.

4.CONCLUSION AND FUTURE SCOPE

Present work highlights the effective use of the spectral data recorded from ASD Fieldspec4 spectroradiometer and 150 SM soil moisture dataset for accurate estimation of water content present in the leaves of four plant species (Aloe Vera, Almond, Neem, Adulsa). The overall estimates had shown HL with accuracy 97 % and DL 76 %. Hence, we conclude that this nondestructive method for the estimation of water contents gives fruitful results.

In future we explore this study, for the accurate estimation of other useful contents of the plant species by using spectral response of those species.

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REFERENCES

[1] G.A.Blackburn. Spectral Indices for estimating photosynthetic pigment concentrations: A test using senescent tree leaves. International Journal of Remote Sensing 19, 2016, pp.657-675.
[2] J.Penuelas, J.Pinol., R. Ogaya and I.Filella. Estimination of plant water concentration by the water index WI (R900/R970). International Journal Remote Sensing, vol.18, No.13,1997, pp.286-287.
[3] Suraj, Amatya, Manoj, Karkee and Ashok, K.Alva. Identify Water Stress in Potatoes using Leaf Reflectance as an Indicator of Soil Water Content. Jounral on Agriculture Eng, vol.1, 2014, pp.53-55.
[4] Carol, L.Jones, Paul, R. Weckler, Niels, O.Maness, Marvin, L.Stone. Estimating Water Stress in Plants Using Hyperspectral Sensing. The Canadian Society for Engineering in Agricultural, Food and Biological Systems, 2004, pp.11-14.
[5] Penuelas, J., Filella. I, Serrano, L. and Save, R. The reflectance at the 950-970 nm region as an indicator of plant water status. International Journal of Remote Sensing, 1993, pp.1887-1905.
[6] Zhi, Liu, Flemming, Moller, Bread. Water Content Measurment Based on Hyperspectral Imaging. Department of Information and Mathematical Modelling. Technical University of Denmark, 2015, pp.2-4.
[7] Edward, J. Milton, Michael, E. Schaepman, Karen, Anderson, Mathias, Kneubuhler, Nigel Fox. Progress in filed spectroscopy. Remote sensing of environment, 2009, S92-S109.
[8] Amarsinh, B.Varpe, Rupali, R. Surase, Amol, D.Vibhute, Sandeep, V.Gaikwad, Yogesh, D. Rajendra, K.V.Kale, S.C.Mehrotra. Synygium Cumini Plant Photosynthesis Pigment Detection from Hyperspectral Datasets Using Spectral Indices. (MAMI) Man and Machine Interfacing, International Conference, IEEE, 2017, pp.1-4.
[9] Eleisa Heron, Analysis of Variance ANOVA, 2009.