NIR In Leaf Chlorophyll Concentration Estimation

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Abstract - ***Near-infrared (NIR) spectroscopy is a robust analytical and versatile methodology. It is a less time consuming and use of NIR is Ease has led to the development of many applications in a broad array of agricultural fields. The evolution, widespread application and analytical technology development of NIR spectroscopy in the past several decades is one of the great success stories. An accurate quantitative estimation of crop chlorophyll content is of great importance for monitoring crop grow health condition and estimating biomass, The demand of accurate estimation of chlorophyll content traditional inversion techniques can not satisfied. Alternatively, random forests are able to provide with the strong nonlinearity of the functional dependence between the observed reflected radiance and parameter of biophysical; The aim of this Report is to explore the feasibility of using field imaging spectroscopy and random forests for taking example of soybean for the estimating leaf chlorophyll concentration.***

Key Words: *NIR, Random Forest, Field image Spectroscopy.*

1. INTRODUCTION

Image processing is one form of signal processing for which the input is an image, such as a photograph or video frame; image processing output may be image or a set of characteristics or parameters related to the image. Sufficient information about the structure of a compound can be found out by Infra red spectrum. In recent years, NIR spectroscopy used in analysis of process and raw material testing, product quality control and process monitoring in pharmaceutical industry and wide range of application in biotechnology, genomics analysis, proteomic analysis, inline textile monitoring, food analysis, plastics, textiles, detection of insect, forensic lab application, various military applications, crime detection, and is a major branch of astronomical spectroscopy and so on. Typically broad range NIR absorption bands are observed.NIR spectroscopy is a vibrational spectroscopic method which is belongs to the infrared light spectrum which is very close to the visible region (from about 750 to 2500 nm), where shows good reflectance or transmission properties for the most of organic and some inorganic compounds. That means they are exhibiting good absorption of light at the NIR region [1]. Figure 1 expresses the range of electromagnetic radiation.

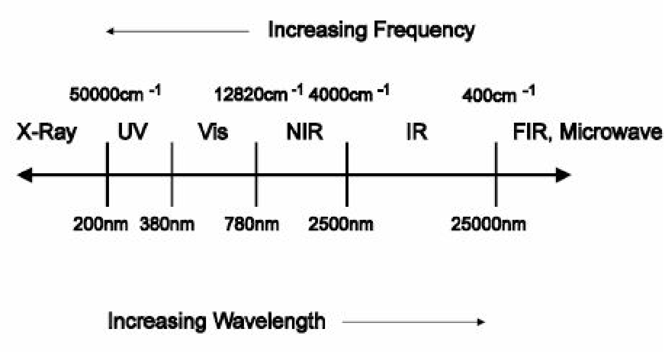

Figure 1 Range of electromagnetic radiation.

1.1 Near Infrared Spectroscopy

Near-IR (NIR) is a spectroscopic method is based on molecular over tones and combination vibrations of O-H, N-H and CH and the three techniques (MIR, NIR & RAMAN) are very different in several aspects, their basic physical origin is same. NIR is comprised of combinations and overtones that is anharmonic oscillation. Covalent bonds between most of molecules which share electrons between atoms. They are Frank principle and Hooke's law are basic laws of vibrational spectroscopy.

1.2 Chlorophyll Estimation using NIR

In Earth most important resource is Plants which cover more than 70% of the global land surface; their distributions are also extremely related to human activities. The chlorophyll content in leaf is an indicator of grow health condition and the soybean yield. Therefore, it is very important to estimate accurate chlorophyll content in soybean. The traditional methods for retrieval of chlorophyll content in plants are complex, time-consuming, and expensive. Chlorophyll content can be estimated through regression function or model based on the response relation between the hyperspectral reflectance and chlorophyll content of plant. In recent years, a random forest has been widely applied in the classification of remote sensing image. The objective of this report is to combine random forests and field imaging spectroscopy for estimating chlorophyll content in soybean at leaf scale.

2. LITERATURE SURVEY

D.Sathis Kumar et al /Int.J. ChemTech Res.2011: Spectroscopy is the experimental technique of physics which includes atomic and molecular part of physics and determining their energy states.;[1]**Michael E. Schaepman:** Three centuries ago Sir Isaac Newton mention the concept of dispersion of light in his 'Treatise of Light'. The term spectroscopy was first used in the late 19th century and provided the foundations for atomic and molecular physics. Different Reviews of spectral indices developed for estimating chlorophyll content are offered by He et al. (2006), Bannari et al. in the year of 2007 and Haboudane et al. (2008). The science of spectroscopy has existed for more than three centuries, and imaging spectroscopy for the Earth system for three decades. We demonstrate these efforts using four examples that represent progress due to imaging spectroscopy, namely (i) radiative transfer models are used in bridging scaling gaps from molecules to ecosystems (ii)surface heterogeneity(iii) physical based (inversion) modeling, and iv) with the Earth surface assessing interaction of light [2].**Jesu´s Delegido:** The Normalized Area Over reflectance Curve (NAOC) is proposed for remote sensing estimation of the leaf chlorophyll content of heterogeneous areas with different canopies ,different crops and different types of bare soil[3].**Xiaowei Yua,, Juha Hyyppa:** This paper depicts an approach for mentioning individual tree attributes, like tree height, diameter at breast height (DBH) and stem volume, based on both statistical features and physical are derived from airborne laser scanning data utilizing a new detection method for finding individual trees together with random forests as an estimation method[5].**Pall Oskar Gislaso:** Random Forests are considered for classification of multisource remote sensing and geographic data. The most widely used ensemble methods are boosting and bagging. The Random Forest classifier uses bootstrap aggregating or bagging, to form an ensemble of regression tree (CART)and classification like classifiers. In the paper, the use of the Random Forest classifier for land cover classification is explored.[8].**Bo Liu , Yue-Min Yue :** A field imaging spectrometer system was designed for agriculture applications. In this study, To gather spectral information from soybean leaves used FISS method. The chlorophyll content was retrieved using a partial least squares (PLS) regression multiple linear regressions (MLR) and support vector machine (SVM). The objective was to verify the performance of FISS to determine a proper quantitative spectral analysis method for processing FISS data and also quantitative spectral analysis through the estimation of chlorophyll content[9].**S.R. Krishnayya:** Imaging spectroscopy is an appropriate technique to address some of these vital issues. Data acquisition of imaging spectroscopy can be done across different spatial and spectral ranges according to the needs of the user [11].

3. MATERIALS AND METHODS

A. Study Site

In 2009 Study of Field spectroscopy was carried out using Soybean as research target area. Three fields of farmland were selected to measure soybean spectral data and the chlorophyll content of soybean. Leaf chlorophyll concentration in soybean was measured by SPAD502. Figure 3.1 shows SPAD 502 plus chlorophyll Meter. Each sample sites was recorded with a Global Position System (GPS).

Fig 3.1 SPAD 502 Plus Chlorophyll Meter

Measuring Principle:

The values measured by the chlorophyll meter SPAD 502 Plus corresponds to the amount of chlorophyll present in the plant leaf. Based on the amount of light transmitted by the leaf the values are calculated in two wavelength regions in which absorption of chlorophyll is different.

B. Field campaign data

Field campaigns in the soybean field were carried out under clear sky conditions. Reflectance of soybean was collected by ASD3 spectrometer, with a 350-2500nm spectral range.

C. PROSPECT model

PROSEPCT is a radiative transfer model to simulate the leaf reflectance spectra. PROSPECT model can simulate reflectance spectra with the range of 400 to 2500 nm. The input parameters of PROSEPCT are chlorophyll content, moisture, dry matter content and structure parameter. The PROSPECT model has been applied in a lot of plant type, and compared with other plant leaf models, it only needs a small amount of input parameters.

D.RANDOM FOREST

A random forest is a classification and regression algorithm. This algorithm is increasingly being applied to satellite and aerial image classification and the creation of continuous fields data sets. A random forest has several advantages when compared with other image classification methods. It is capable of using continuous and categorical data sets, easy to parameterize; good at dealing with outliers in training data, and it calculates ancillary information such as classification error and variable importance.

Random forests is a statistical machine learning method, which is created by Breiman. Random forests can achieve comparable results with boosting algorithms and support vector machines. Random forests has been applied in a large number of remote sensing researches for image classification of hyperspectral data [6], SAR data, LiDAR[7] and multi-source data.

Advantages and limitation

There are a number of advantages to using random forests. It has been found to be comparable to other machine learning algorithms such as support vector machines and boosting, but with the advantage that random forests is not very sensitive to the parameters used to run it and it is easy to determine which parameters to use (L. Breiman 2001). Random forests makes easier to use effectively for the ability of automatically producing variable importance, accuracy and information. Especially when Random forest using it for regression facing some Limitation. Due to the way regression trees are constructed it is not possible to predict beyond the range of the response values in the training data.

4. FIELD IMAGE SPECTROSCOPY

A field imaging spectrometer system (FISS) which contains 380–870 nm and 344 bands and was designed for agriculture applications. In this study, FISS was used to gather spectral information from soybean leaves. The application of small field imaging spectroscopy systems are the strong interest Topic for the Chinese Scientific Community.

FISS AND EXPERIMENTAL DESIGN

FISS consist of a multi-purpose platform, electronic system, computer system, opto-mechanical system, and auxiliary equipment (Figure 4.1).The opto-mechanical system, which is the key component of the FISS, consists of a optical lenses, spectroscopic devices (ImSpector V9, Spectral Imaging, Ltd., Qulu, Finland) scanning mirror, and a charge-coupled device (CCD) camera.The motor control circuit is a part of electronic system and the rotation of the scanning mirror can be controlled, synchronize the beam splitter and receiver and collect and store the data. Figure 4.2 shows the basic principle of FISS. The computer system includes hardware and software: the hardware part mainly as a portable laptop computer, and the software includes the FISS operating software, acquisition software for data and data processing software. The instrument operating software and data acquisition software are used for setting the instrument parameters (integration time, aperture, field of view, cooling temperature, *etc.*) and can display images and spectra in real time.

Fig 4.1 Photograph Of The Field Imaging Spectroscopy System (FISS)Components.

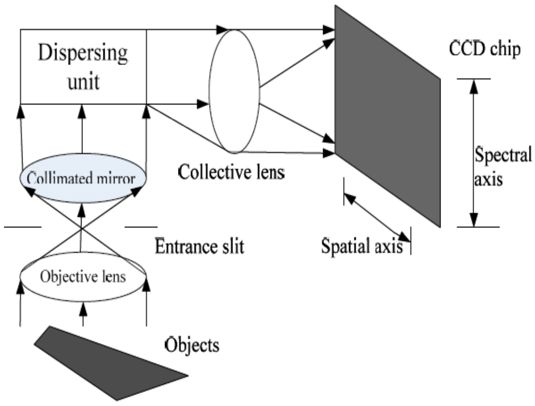

Fig 4.2 Basic Principle Of FISS

The FISS acquires data by rotating the scanning mirror, and the spatial resolution varies with the platform height. The optimal resolution is greater than 2 mm. Figure 4.3 shows the whole system, and the main technical specifications are listed in Table 4.1 [9].

Fig 4.3 Actual photograph of FISS field measurements

5. SUMMARY

Firstly, PROSPECT was used to training data set for established to link soybean spectrum and the corresponding chlorophyll content. Secondly, random forests were accommodated to train the training data set, in order to establish leaf chlorophyll content estimation model. Thirdly, based on proximal hyperspectral data a validation data set was established, and the leaf chlorophyll estimation model concentration was applied to the validation data set to estimate leaf chlorophyll content of soybean in the research area.

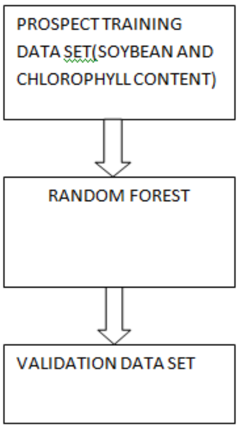

Fig 5.1 Basic block diagram of estimation of leaf chlorophyll concentration

6. CONCLUSIONS AND FUTURE WORK

This research established the soybean chlorophyll content estimating model based on random forests and PROSPECT, the estimation model was applied to retrieved chlorophyll content of soybean. The estimation model can be used as an effective tool for rapid retrieval tool for estimation of soybean chlorophyll content, and can be adopted to precision agriculture management.
Future study will concentrated on progression of steps of the field estimation model to satellite remote sensing level, which can be used to monitor the soybean's health condition in a large scale.
Globally, imaging spectroscopy has come of age in the past 15 years. NASA is coming up with HyspIRI (http://hyspiri.jpl.nasa.gov/). By 2018 ISRO is planning to launch a hyperspectral sensor. Additionally, making The use of unmanned aerial vehicles (UAVs) as platforms for better technical features and superior cost benefit ratios are carrying miniaturized sensors (optical and hyperspectral cameras) more user friendly.

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