Water Band Removal Process in Spectroscopic Data

V. Chudasama[1] Jimit A. Talati[2]
[1]M.E. Student [2]Assistant Professor
[1,2]Department of Applied Instrumentation
[1,2]Atmiya Institute of Technology and Science, Rajkot

Abstract— The reflectance spectroscopy is a widely used technique to interpret and understand the spectral features for various applications. The method also includes some important findings for the planetary research domain. For the purpose, the spectroscopic data must be free from radiometric and atmospheric effects. The noisy data may cause the changes in absorption features of the reflectance spectra. This method is very important to identify the mineral abundance and composition remotely. The data obtained by this method need some signal processing to remove the water band from it. But, the noisy data in reflectance spectrum causes due to water band calibration by spectroradiometer. Thus, the primary reflectance spectrum needs to correct by removing the peaks due to some reflectance spectrum.

Key words: Water Band Removal Process, Spectroscopic Data

I. INTRODUCTION

Reflectance is a measurement of light absorbing and reflecting properties. For the purpose, as prerequisite, we have to understand the basics of reflectance as per the type of surface. It has two types of reflectance as given below:

A. Specular Reflectance

The idea of Specular Reflectance could be understood with the help of given figure. The figure illustrates the incident and reflectance of light radiation. But, it is noted that, the angle of incident (θ_i) and angle of reflectance (θ_r) is similar to each other. Moreover, reflectance is totally dependent over type of surface. I.e. polished surface results into specular reflectance. For example, steady water surface results into specular reflectance. That can be shown by given illustration of steady water surface in natural scene. Figure 1 illustrates the concept of specular reflected beam [1].

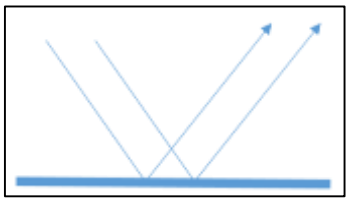

Fig. 1: Concept of specular reflected beam

B. Diffuse Reflectance

Diffuse surface has different incidence and emission angles. Thus, light incident at a certain angle, will encounter the surface particles and scattered by the unpolished surface of that irregular material. The concept of perfectly diffused surface is also called lambertian surface. These types of lambertian surfaces are used as reference panel in reflectance spectroscopy. For example, Spectralon panel has approximately 99% diffuse reflectance so it can be used as a reference panel for the measurement of mineral reflectance. Figure 2 illustrates the diffuse reflectance example by scattered illumination [1].

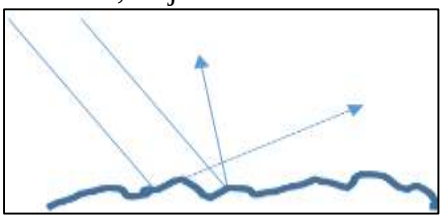

Fig. 2: Concept of diffuse reflected beam

II. EXPERIMENTAL SETUP OF REFLECTANCE SPECTROSCOPY

The technique of reflectance spectroscopy required a spectroradiometer to measure the reflectance properties of the mineral or material taken. There are various vendors available of the spectroradiometer in the market. But, the physical measurement criteria changes with the specifications of the spectroradiometer. Generally, spectral resolution, sampling bandwidth and stray light specification matters a lot while choosing a spectroradiometer [2].

The target surface is illuminated by artificial or natural illumination (sunlight). The sensing part of spectroradiometer includes a bare optic fiber with a default field of view in degree, it will sense the scattered light from the target placed over principal plane. The bare fiber includes several fiber strands to detect the reflectance measured and displayed on instrument controller or PC either via Ethernet or Wi-Fi [3].

The amount of light scattered is dependent on the types of target surface (isotropic and anisotropic). Several other factors also affects while we talk about artificial and natural illumination. Artificial illumination is generally used in laboratory environment, while natural illumination is generally used in field environment.

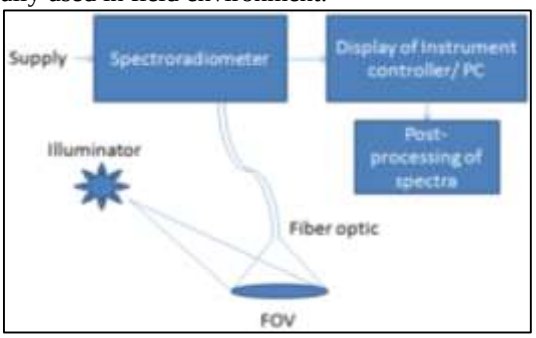

Fig. 3: Experimental setup for reflectance spectroscopy

III. APPROACH FOR CORRECTING THE UNNECESSARY PEAKS

The figure illustrates the algorithm for removing the spikes due to water bands. Generally, water bands spikes generate the inherent noise in the spectra due to the natural illumination irradiance. The spectra obtained in a particular software need to convert as an ASCII data format which is reliable without any loss of information of the spectra. ASCII data then imported in MATLAB for the post-processing, and then the spectra are divided into subsets of the wavelength, near 1400nm and 1900nm [4].

The region of spike can be removing by applying the NaN in the arrays of the spectral data. The subset of the spectra. Generally reason behind the removing water band is, the fiber optic cable is very sensitive to water features, and the water content will strongly scatter the photons from the surface of the material that reduces the signal to noise ratio which is undesired. The spikes of water bands are not at all useful as we know the water absorption features occurring at specific wavelength in vegetation, organic or any application.

MATLAB will generate struct array as per the number of spectra imported in ASCII format. The data have a large number inside the array that will plotted as a spectrum with high precise absorption features. Thus, the post-processing will help to identify the features of the mineral sample taken for reflectance measurement. The generated array can be handle as traditional methods of post-processing or we can use the external toolbox which is vendor specific. The water bands represent the high absorption of water from the environment if we are doing experiment in the field. While in laboratory, the amount of light reflected is represented. The generated peaks are treated as noise and can be remove by applying NaN (not a number) data into the arrays of the specific wavelength described. The algorithm of the same is described in Figure 4 for the removal of spikes inside the spectra [5].

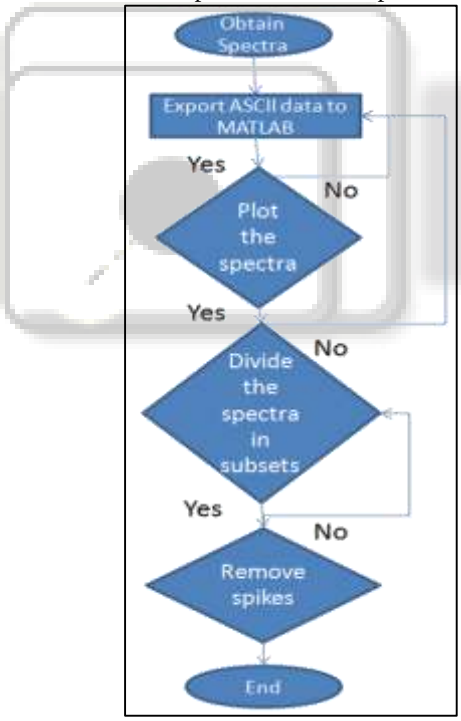

Fig. 4: Algorithm for removing water bands and unnecessary peaks

IV. RESULTS AND DISCUSSION

It is not easy to understand the reflectance spectra of any mineral because the olivine group minerals have the general formula M_2SiO_4, where M is a divalent cation such as Ca, Mg, Fe, Mn or a mixture of such cations. The olivine structure may be described as tetrahedral SiO_4 groups bonded together by divalent cations. An alternative description is that of an array of hexagonal close-packed oxygen atoms with silicon in tetrahedral holes and divalent cations in octahedral holes. The structure is characterized by an orthorhombic symmetry, a tetra molecular unit cell and a chrysoberyl type structure [6].

One of the major problems in a study of this type is the accumulation of a sufficient number of samples to be representative of a mineral series. Separation from the rock of the individual mineral species and the determination of their chemical composition is sometimes difficult. Fortunately, some of the samples obtained were individual minerals which had been chemically analyze. In figure, the 1-µm absorption band is due to crystal field absorption of Fe^{+2}[7].

The concept of removing the unnecessary water bands is described in the Figure 4. The amount of light scattered by the illuminator (if it is natural illumination) due to the solar irradiance the absorption of water generates noise inside the spectra. Thus, the removal of peaks will lead us to understand the other absorption caused by the crystal lattice of the mineral. Moreover, the water bands causes the overlap effect if we have several number of spectra. The ASCII formatted data of the reflectance spectra is imported into MATLAB are shown below:

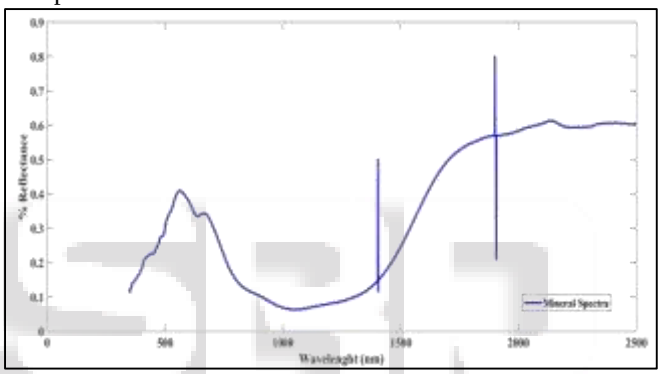

Fig. 5: Noisy mineral spectra with unnecessary peaks

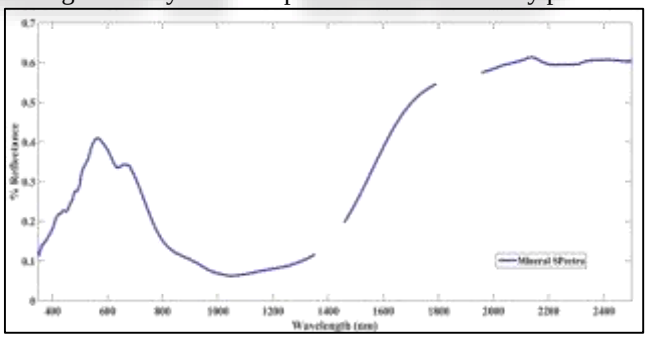

Fig. 6: Mineral spectra with water band removal process

By comparing the Figure 5 and Figure 6, we can assure the removal of the unwanted peaks into the mineral spectra. Thus, the identification of such mineral would be easy by their spectral features.

Moreover, the command given to remove the waterbands is remove certain spectral data of particular wavelength region where the water absorption is particularly high. The bands are of 1350-1460nm and 1790-1960nm are removed by the algorithm described [3].

Such spectroscopic data will useful to identify the mineral abundance on the planetary surface by their spectral features. The abundance estimation is done by measuring the band depth of the mineral spectra. The data from the arrays are should not have any manipulation while subset of the spectra. The region described into the method is certainly includes the highly precise spectral data [2].

V. CONCLUSION

The method described here is necessary while measuring and comparing the several reflectance spectra for the planetary mineralogy application. The spectral features are noisy due to solar irradiance and more absorption of the water. That causes the error in measurement of mineralogy application. Thus, this type of signal processing required for the removing the unnecessary absorption due to the water bands. The objective of the removing water band with necessary algorithm is described in the method. But, for the compositional study and abundance measurement of the mineral, accurate signal processing technique should be developed in future.

ACKNOWLEDGEMENT

For this fundamental research on mineralogy of the planetary analogue, I would like to thank the Head of Instrumentation and Control Department, Dr. Komal R. Borisagar, for her invaluable support throughout the research.

REFERENCES

[1] Colthup, Norman. Introduction to infrared and Raman spectroscopy.Elsevier, 2012.
[2] Kortüm, Gustav. Reflectance spectroscopy: principles, methods, applications. Springer Science & Business Media, 2012.
[3] Robinson, I., and A. Mac Arthur. "Post processing field spectra in MATLAB."W.-K. Chen, Linear Networks and Systems. Belmont, CA: Wadsworth, 1993, pp. 123–135.
[4] Bharti, Rishikesh, et al. "Relevance of mineral texture on bidirectional reflectance and emission spectroscopy: Implications for geological remote sensing." Geoscience and Remote Sensing Symposium (IGARSS), 2012 IEEE International. IEEE, 2012.
[5] Wendlandt, Wesley William, and Harry G. Hecht. Reflectance spectroscopy. Vol. 80. New York: Interscience, 1966.
[6] Chang, Cheng-Wen, et al. "Near-infrared reflectance spectroscopy–principal components regression analyses of soil properties." Soil Science Society of America Journal 65.2 (2001): 480-490.
[7] Clark, Roger N., et al. "High spectral resolution reflectance spectroscopy of minerals." Journal of Geophysical Research: Solid Earth 95.B8 (1990): 12653-12680.

