SPECTRAL RATIO LIDAR FOR OBJECTS DETECTION

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ABSTRACT:

Laser remote sensing has been widely applied during the last decade, it has great advantages in objects observation remote sensing. The different applications of lidar provide unique data on 3 dimensional topography survey, canopy geometry and etc. However, most of the lidar applications are concentrated on the detection of vertical spatial information, but can not supply the essential chemical composition of objects. This is a pretty big limitation of lidar applications. If lidar could supply the spatial information as well as the property information, it would include vertically-resolved discrimination of the types of surface measured.

According to the principles that each object has its own spectrum, we propose a new technique of lidar system which could enable the analyst to identify the features of an object by comparison the spectral ratio of lidar backscatters with library spectra. This lidar system uses low power laser diodes to make horizontal-path lidar measurements of objects. It has three distinct advantages. Firstly, as the precise pointing capability, narrow laser divergence and multiple probe wavelengths, it could yield much more accurate spatial and spectral data; secondly, by keeping the two or more probe wavelengths close, the lidar system could eliminate the influence from atmosphere; thirdly, as a positive form of remote sensing, lidar could transmits laser and receive the backscatters both in the daytime and night. Therefore, any differences in measured spectral backscatters at the multiple probe wavelengths of lidar are due to differences of the objects features but not other impacts. The emphasis is on the method's ability to identify spectral features used to separate the wavelengths of interest. Then set the diode wavelengths near to the sensitive wavelengths exhibited by the characteristics of each object. The detection results are used to calculate the ratios of backscatter signals of different transmitting wavelengths, and then to analyze the characteristics of objects. So how to select the laser transmitting wavelengths and how to establish the spectral ratio model are the key problems of spectral ratio lidar detection.

The laser transmitting wavelengths selection is based on the spectral analysis of hyperspectral data. This hinges on the notion that different objects have a characteristic response as a function of wavelength. Reflections and absorptions are two complementary concepts of light behavior, when laser is incident on the surface of an object, some of it is reflected, some is absorbed, and in certain cases, some is transmitted. The problem with laser is that they are less straightforward to recover compared to reflection or reflectance, which can be directly measured by image sensors. Nevertheless, transmitting lasers set at the absorption wavelengths are closely related to the characteristics of the objects, and therefore, the presence of an absorption wavelength at a certain spectral range is often a "signature" for characteristics and their concentrations. Thus, compared to the dominant statistical approaches, the use of absorption and reflectance features of laser transmitters for object identification has a clear physical

meaning. Especially for vegetation detection, the dominant pigment in healthy green leaves, Chl a, strongly absorbs visible light in the region from 600-700nm for use in photosynthesis; but with high diffuse reflectance of the near-infrared region because of the plants have adapted so they do not use this massive amount of near-infrared energy. This transition around 700 nm is referred to as the '*red edge'*. In general, these absorption and reflectance features around the '*red edge'* are very sensitive to the vegetation growth status, if there is much less reflected radiation in red wavelengths than in near-infrared wavelengths, then the vegetation is likely healthy and dense whereas if there is little difference in the intensity of the reflected red and near-infrared wavelengths then plant leaves are likely sparse, absent, or dead. So when we set the laser transmitting wavelengths close to the '*red edge*', we can use it to discriminate living vegetation from non-living sources of land surface.

In this paper, the principle and the pilot study of novel spectral ratio lidar system are introduced. The lidar system that actively measures spectral response in two narrow wavelengths at the absorption valley and reflectance peak of chlorophyll containing is designed. We do the hyperspectral experiments both in field and laboratory to measure the spectral reflectance of vegetation samples, make spectral analysis to discover the exact absorption and reflectance position of '*Red-edg*e', and then set the lidar transmitting wavelengths near to this 'red-edge' position. We would establish a spectral ratio lidar system to detect vegetations and other objects, with the advantages of lidar, the high precision NDVI which reflects the vegetation characteristics could be calculated by the laser backscatter ratio. As a new technical of objects observation, the application value of this lidar is analyzed and issues to approach the final goal are discussed, the future development plans are presented.

KEY WORD: lidar, hyperspectral data, objects detection