ROAD CLASSIFICATION AND CONDITION DETERMINATION USING HYPERSPECTRAL IMAGERY

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ABSTRACT:

Hyperspectral data has remarkable capabilities for automatic identification and mapping of urban surface materials because of its high spectral resolution. It includes a wealth of information which facilitates an understanding of the ground material properties. For identification of road surface materials, information about their relation to hyperspectral sensor measurements is needed. In this study an approach for classification of road surface materials using hyperspectral data is developed. The condition of the road surface materials, in particular asphalt is also investigated. Hyperspectral data with 4m spatial resolution of the city of Ludwigsburg, Germany consisting of 125 bands (wavelength range of 0.4542µm to 2.4846 µm) is used. Different supervised classification methods such as spectral angle mapper are applied based on a spectral library established from field measurements and in-situ inspection. It is observed that using the spectral angle mapper approach with regions of interest is helpful for road surface material identification. Additionally, spectral features are tested using their spectral functions in order to achieve better classification results. Spectral functions such as mean and standard deviation are suitable for discriminating asphalt, concrete and gravel. Different asphalt conditions (good, intermediate and bad) are distinguished using the spectral functions such as mean and image ratio. The mean function gives reliable results. Automatisierte Liegenschaftskarte (ALK) vector data for roads is integrated in order to confine the analysis to roads. Reliable reference spectra are useful in evaluation of classification results for spectrally similar road surface materials. The classification results are assessed using orthophotos and field visits information.

1. INTRODUCTION AND RELATED RESEARCH

Comprehensive information about road networks as one of the transportation features is helpful for assessment and planning of transportation (routing). Retrieval of road information such as road surface material and pavement type condition is one of the essential issues in urban areas. This is done with either traditional surveying or remote sensing (RS) (Zhang and Couloigner, 2004).The former needs more labour and is more time consuming in comparison to the latter. Hyperspectral imagery, also known as imaging spectrometry, is the acquisition of data in many narrow, contiguous spectral bands (Goetz et al., 1985). It provides more detailed information in comparison to other remote sensing techniques. Different chemical materials such as asphalt and gravel by their corresponding physical (absorption, albedo, reflectivity etc) properties can be derived on a very detailed level from the hyperspectral imagery. This characteristic is helpful in discrimination and extraction of urban area objects especially those with similar spectral properties. Road surface materials can be identified with hyperspectral imagery with less cost compared to field surveying. Most of the available methods for mapping roads are either manual or semi-automatic. However, these approaches are time consuming and expensive. In particular, that they may involve a lot of field work and interpretation of aerial imagery from which only limited information can be acquired. Hyperspectral data has significant potential in terms of automatic identification of road surface materials. However, no standard approach for mapping road surfaces and identifying the condition of road surface materials exists up to date. Most of the methods that exist were originally developed for mineral detection. Thus it is a challenge to use these methods in identifying road surface materials due to the variation of these materials in relatively small regions in the case of roads.

In recent times there has been an increase in the demand to find economical automated methods to extract information from hyperspectral data due to the fast developments in urban areas. Noronha et al., (2002) focus on extraction of road centerlines, detecting pavement condition and developing a spectral library. The analysis of hyperspectral data is done using MultiSpec software and maximum likelihood classification is applied. Bhattacharyya distance is used for separability analysis between road materials and roof types. For better discrimination of roofs and roads, an object-oriented image classification technique is used. This technique tries to analyse the homogenous image object rather than independent pixels. A multispectral sensor (IKONOS) is used as an ancillary sensor. Comparison of configuration for urban target separation in spectrometry and multispectral remote sensing shows that some of the features are not determined in the latter. This is due to the broadness and location of the bands. Moreover, its broad band channels do not resolve small-scale spectral absorption features which are unique for several built up areas. According to the separability analysis results, concrete and