Mechanics Transport Communications
ISSN 1312-3823 (print)
ISSN 2367-6620 (online)
volume 16, issue 3/2, 2018
Academic journal http://www.mtc-aj.com article № 1695

REMOTE SENSING SPECTRAL DATA IN ROAD IDENTIFICATION: CASE STUDY

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Key words: *Remote Sensing, Road Identification, Landsat, Sentinel, TOMS*
Abstract: *The idea of this paper is to exploit, view and develop to larger extent the possibilities which are offered by multispectral instruments having mid spatial resolution in this case instruments on board of Landsat and Sentinel satellites. The mid spatial resolution leads to obtaining of the mixed data related to mixing of land covers and to a lot of mistakes in the interpretation of the images. The correct identification of the mixed pixels is key element for the segmentation of the shape of the artificial feature from the land cover. This especially holds true for objects with relatively narrow structure for example two-lane roads for which the spatial resolution is larger that the object itself. For better road identification in the used Landsat/Sentinel images in the study we have combined spectrometry of asphalt, and in-situ measured spectral reflectance of pavers made from granite. In this innovative research the spectral and directional reflection properties of the asphalt surfaces compared to those of paving stone made from different rocks are measured. The in-situ measurements are obtained using the Thematically Oriented Multichannel Spectrometer /TOMS/ designed in Remote Sensing System Department at Space Research and Technology Institute – Bulgarian Academy of Sciences, Sofia.*

INTRODUCTION

In the present work statistical method for analyzing the spectral data in the segmentation of the roads with different surfaces was applied. This is usually done by using the multitemporal acquisitions offered by multispectral imaging sensors with different spatial resolution such as TM/ETM+ onboard Landsat 5/7 and MSI onboard Sentinel-2. The segmentation on images is a necessary step before start the process of classification (supervised/unsupervised) of distinct land covers. In the segmentation phase, relying on pixel by pixel calculations, the separating line between the homogenous areas should be drawn. For images with low and middle spatial resolution as rule this line is composed by mixed pixels. In order to decrease the uncertainty if the pixel is part of the segmentation line essential is to find out the correct proportions of pure classes (endmembers) in the single pixel. In this research for better segmentation of roads and interpretation of images we are measuring the reflectance spectra of the roads with asphalt surfaces and of pavers made from different rocks. The in-situ measurements are obtained using the Thematically Oriented Multichannel

Spectrometer /TOMS/ designed in Remote Sensing System Department at Space Research and Technology Institute – Bulgarian Academy of Sciences [1]. Several terrain campaigns for spectrometric measurements are performed in-situ by means of the field spectrometer TOMS. Petrologic studies are performed, too. The obtained spectral reflectance features of the studied objects could be compared with reference reflectance spectra from the collection of the reflectance spectra called spectral libraries [2].

MATERIALS AND METHODS

The approach accepted in this research includes the following steps: locate region of interest /RoI/ in the images taken by TM/ETM+ and MSI instruments; find all supporting data for the RoI (airborne multispectral data, in-situ collected multispectral data, geological and petrographic descriptions, etc.); implement segmentation procedure with the enhanced data. All the data are recalculated in a way to represent the reflectance of the objects.

RoI is situated in semi-mountain region in the west part of Bulgaria. It demonstrates a quite similar surrounding feature (forest, roads, etc.) which is main reason for their selection.

Figure 1. Image of RoI

Terrain spectrometric measurements are performed on the asphalt road and on the granite rocks (Figure 2a) revealed in the RoI. Precise laboratory spectrometric measurements are made on the samples of granites (Figure 2b) collected during the field surveys in the RoI and granite pavers. Their composition, texture, and structural characteristics are described using [3]. Field spectrometric measurements are prepared in the period 2008-2018. Preprocessing for the adjustment of the data is conducted with the software of the field spectrometer. It has been standard statistical processing of data received. Post-processing of the field and laboratory reflectance data included removal of defective data, averaging of the ten spectra per target, and if necessary smoothing of the resulting spectra.

a b

Figure 2. Granite (a) in and granite sample (b) from Sredna Gora Mountain, Bulgaria

About 10 km south of the town Zlatitsa on the road to Panagyurishte outcrop of the South Bulgarian granitoids are embedded in metamorphic rocks of Prarodopska group. To the South Bulgarian granitoids intrusive bodies concerned with Palaeozoic ages, different sizes and composition, divided into three intrusive complexes.

The first set includes intrusive granites, granodiorites and small bodies of diorite and quartz-diorites. In this complex Smilovenski, Hisarski and Poibrenski plutons are included. The composition of the second intrusive complex includes amphibole-biotite, biotite and light granites. To this complex belong Koprivshtenski, Klisurski and Matenishki plutons. Third intrusive complex is represented by granular biotite, biotite-muscovite and pegmatite granitoids. In this complex Strelchenski, Karavelovski, Lesichovski and Varshilski plutons are presented. [4,5] In the point of field measurement biotite granites of the Northwest Koprivshtenski pluton are revealed. They are light gray, sometimes rusty colored by iron hydroxides, medium-to coarse-grained, with a clear lineal porphyroid parallelism. They are formed by K-feldspar, plagioclase, quartz, biotite, apatite and zircon [3].

Description of granite samples: A pinkish medium-grained sample consisting of feldspar and quartz with minor biotite. Petrographic description of granite samples: They consist of average 50% orthoclase, 35% quartz, 15% plagioclase, 1% biotite and 1% magnetite. The plagioclase often shows sericitic alteration while the biotite may be altered to chlorite. The thin section did not show any carbonate, but the spectrum and chemical analysis both indicate a trace is present.

The accuracy of the spectra comprising these data sets is verified comparing them with in-situ and ex-situ reference reflectance spectra of the similar types of land cover acquired in a field campaign. These measurements support segmentation of mixed pixels which is the case for pixels from the borders of the areas.

Segmentation plays a key role in many image processing applications, including grayscale image analysis. A generally accepted meaning of the word “segmentation” in the image processing community is the decomposition of the image under study into its different and consistent areas of interest. The presented measurements contain significant spectral information and are using for supporting the segmentation process in image analysis.

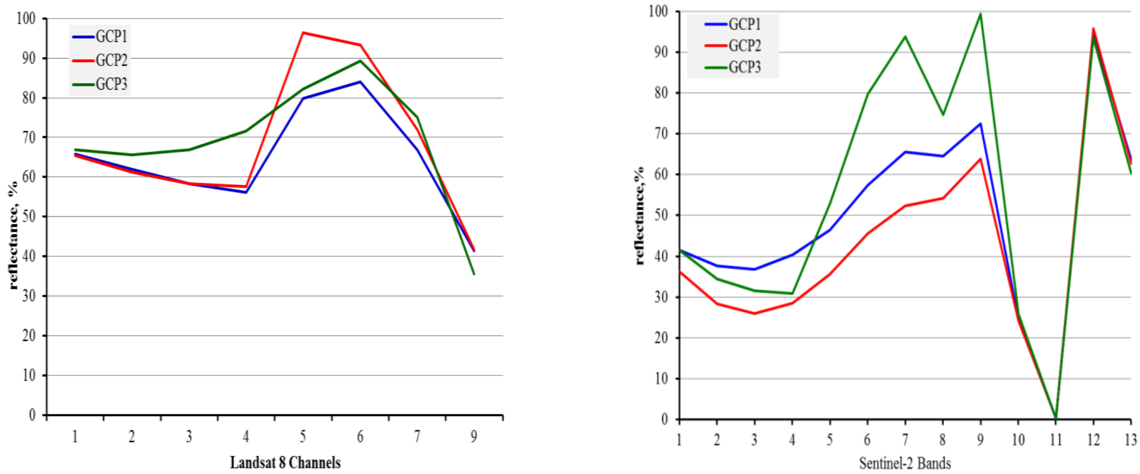
RESULTS AND DISCUSSION

Figure 3a demonstrates the spectral reflectance characteristics in three ground control points /GCP/ in RoI obtained from Landsat 8 (November 2015). For better interpretation and classification of rocks in mountain regions the described measurements complete the methodologies [6]. Figure 3b demonstrates the spectral reflectance characteristics for each GCP obtained from Sentinel-2 MSI (August 2015). GCP1 and GCP2 include mainly soil and rocks. In GCP3 the three main land cover types – rocks, soils and vegetation – are consisted.

In Figure 4a and 4b the reflectance spectra of granites and asphalt on the road in the RoI acquired in the terrain measurements with TOMS for the period 2008-2018 is presented as average value of the spectral reflectance in percentage. The higher value of spectral reflectance in the wavelength range (400-900) nm of granites depends on their lighter colour compared to black asphalt.

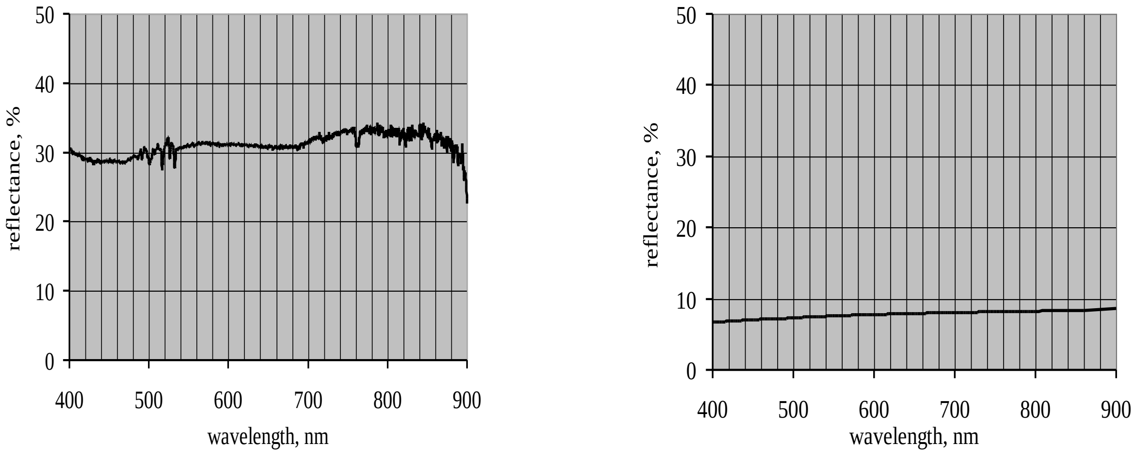
CONCLUSIONS

These type of investigations are significant because of misinterpretation in images with mid spatial resolution especially with relatively narrow structure for example two-lane roads for which the spatial resolution is larger that the object itself. The steps mentioned in the paragraphs above a simple but reliable methodology for supporting and better segmentation of the roads is introduced.



a b

Figure 3. Spectral reflectance characteristics of GCP in the RoI acquired from Landsat 8 (a) and Sentinel-2 MSI (b)



a b

Figure 4. TOMS reflectance spectra of the granite (a) and asphalt (b) in RoI

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СПЕКТРАЛНИ ДАННИ ОТ ДИСТАНЦИОННИ ИЗСЛЕДВАНИЯ ПРИ РАЗПОЗНАВАНЕ НА ПЪТИЩА: ПРИМЕР ОТ ПРАКТИКАТА

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БЪЛГАРИЯ

Ключови думи: *Дистанционно изследване, разпознаване на пътища, Landsat, Sentinel, TOMS*

Резюме: *Идеята на тази статия е да се използват, разгледат и развият в по-голяма степен възможностите, предлагани от многоканалните спектрални инструменти, които имат средна пространствена разделителна способност - в този случай инструментите на спътниците Landsat и на Sentinel. Средната пространствена разделителна способност предопределя получаването на смесени данни, свързани с получаването на сигнал от смесени земни покрития, което води до много грешки при интерпретацията на изображения. Правилната идентификация на смесените пиксели е ключов елемент при сегментирането на формата на "изкуственият" елемент от земната повърхност. Това се отнася особено за обекти със сравнително тясна структура, например двулентови пътища, за които пространствената разделителна способност е по-голяма от самия обект. За по-добра идентификация на пътища в изображенията от Landsat / Sentinel в изследването сме комбинирали теренно спектрометриране на асфалт и на гранитни павета. В това изследване се измерват спектралните отражателни характеристики на асфалт и павета от гранит. Теренните измервания са проведени с тематично ориентиран многоканален спектрометър (TOMS), проектиран в секция "Системи за дистанционни изследвания" в Института за космически изследвания и технологии - Българска академия на науките, София.*