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ScienceDirect

Advances in Space Research 66 (2020) 1829–1845

ADVANCES IN SPACE RESEARCH (a COSPAR publication)

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Extraction of urban built-up surfaces and its subclasses using existing built-up indices with separability analysis of spectrally mixed classes in AVIRIS-NG imagery

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Received 6 March 2020; received in revised form 21 June 2020; accepted 28 June 2020
Available online 16 July 2020

Abstract

Understanding the urban environments and their spatio-temporal behavior is necessary for local and regional planning along with environmental management. For monitoring and analyzing the urban environment, remote sensing imagery has been widely used due to its ability for repetitive coverage over large geographical areas. Compared with conventional per-pixel and sub-pixel analysis of remote sensing imagery, spectral indices have noticeable advantages because of their easy implementation and fast execution. However, most of the spectral indices are designed for multispectral imagery to extract only one land cover class, and confusion between other land cover classes still persists. This research explores the most significant spectral bands in AVIRIS-NG hyperspectral imagery for detection of built-up surfaces and its subclasses i.e. roads and roofs. Further, this study utilizes existing built-up indices for detection of urban built-up surfaces in the first level followed by its subcategories in the second level. Finally, a separability analysis between spectrally mixed urban land cover classes using various measures is also addressed. Results of the analysis indicate that BSI, NBI, and BAEI can prove to be effective for extraction of built-up surfaces with an overall accuracy (OA) of 93.89%, 90.11%, and 85.15%, respectively. Further, REI with OA of 94.40% appears to be suitable for extraction of road surfaces while NBAI with 95% OA can prove its efficacy for extraction of rooftops in AVIRIS-NG imagery. It also concludes that, for aforesaid indices, built-up surfaces (Level-1 and 2) can be effectively separated from the bare soil in hyperspectral imagery with slight confusion between road and roof surfaces.

Keywords: Hyperspectral remote sensing; Urban built-up surfaces; Spectral indices; Road extraction; Roof extraction; Separability analysis

1. Introduction

Over the past few decades, urbanization has been taking place at a rapid pace around the world. The increasing built-up areas and urban density have transformed natural land cover surfaces into built-up surfaces (Schneider et al., 2009; Lu et al., 2011). Urbanization leads to several environmental problems such as air pollution, water quality degradation, urban heat island effect and loss of biodiversity etc. (Weng, 2001; Conway, 2007; Xu, 2008). Due to these major environmental impacts, understanding of the urban environment and their spatio-temporal effects is necessary for local and regional planning along with sustainable development. The need of the hour is to develop cost-effective approaches to achieve urban sprawl information temporally. As a result of this, built-up surface mapping as an indicator of urbanization has attracted active research and different methodologies for urban mapping have been developed in recent years.

Remote sensing can prove to be an effective tool for understanding the urban environment (Manolakis and

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https://doi.org/10.1016/j.asr.2020.06.038
0273-1177/