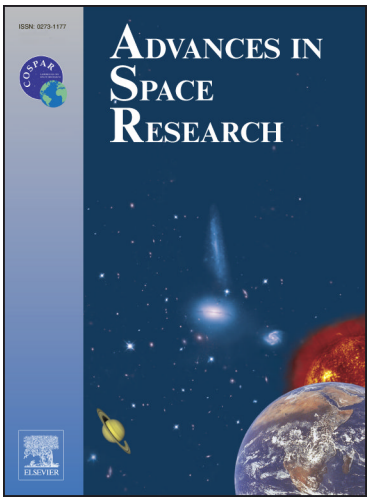

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A Robust Object-Based Shadow Detection Method for Cloud-Free High Resolution Satellite Images Over Urban Areas and Water Bodies

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Abstract: Unwanted contrast in high resolution satellite images such as shadow areas directly affects the result of further processing in urban remote sensing images. Detecting and finding the precise position of shadows is critical in different remote sensing processing chains such as change detection, image classification and digital elevation model generation from stereo images. The spectral similarity between shadow areas, water bodies, and some dark asphalt roads makes the development of robust shadow detection algorithms challenging. In addition, most of the existing methods work on pixel-level and neglect the contextual information contained in neighboring pixels. In this paper, a new object-based shadow detection framework is introduced. In the proposed method a pixel-level shadow mask is built by extending established thresholding methods with a new C_4 index which enables to solve the ambiguity of shadow and water bodies. Then the pixel-based results are further processed in an object-based majority analysis to detect the final shadow objects. Four different high resolution satellite images are used to validate this new approach. The result shows the superiority of the proposed method over some state-of-the-art shadow detection method with an average of 96% in F-measure.

Keywords: shadow detection; object-based; high resolution satellite images; C_4 index; Water bodies.

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1 Introduction

Since 1999 with the launch of the IKONOS imaging sensor, different applications are revolutionized with respect to possibilities of high resolution image data. In addition to classic applications of remote sensing images, e.g. digital elevation model generation, land cover mapping and change detection, high resolution images provide a possibility to precisely detect and analyze small urban features such as buildings, trees, and even cars (Lorenzi et al. , 2012). However, to fully exploit their application potential several challenges in processing these types of data need to be addressed. One important issue is caused by the elevation differences of terrestrial objects, especially in urban areas. Geometrical distortions and shadows are the main effects created in the image scene due to these elevation changes (Zhan et al. , 2005). Compared to sunlit areas, shadow areas appear with different intensity, brightness, and with lower contrast (Shahtahmassebi et al. , 2013). Also in the borders of shadow overcast areas, unwanted contrast appears. These effects are hampering image classification, change detection, stereo image matching and other processes (Benarchid et al. , 2013, Chaudhuri et al. , 2016,