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A spectral gradient difference based approach for land cover change detection

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Change detection with remotely sensed imagery plays an important role in land cover mapping, process analysis and dynamic information services. Euclidean distance, correlation and other mathematic metrics between spectral curves have been used to calculate change magnitude in most change detection methods. However, many pseudo changes would also be detected because of inter-class spectral variance, which remains a significant challenge for operational remote sensing applications. In general, different land cover types have their own spectral curves characterized by typical spectral values and shapes. These spectral values are widely used for designing change detection algorithms. However, the shape of spectral curves has not yet been fully considered. This paper proposes to use spectral gradient difference (SGD) to quantitatively describe the spectral shapes and the differences in shape between two spectra. Change magnitude calculated in the new spectral gradient space is used to detect the change/no-change areas. Then, a chain model is employed to represent the SGD pattern both qualitatively and quantitatively. Finally, the land cover change types are determined by pattern matching with the knowledgebase of reference SGD patterns. The effectiveness of this SGD-based change detection approach was verified by a simulation experiment and a case study of Landsat data. The results indicated that the SGD-based approach was superior to the traditional methods.

1. Introduction

Change detection with remote sensed imagery is the process of identifying the changed areas and changed types of land cover/land use using the remotely sensed imagery acquired at different times (Singh, 1989; Coppin et al., 2004; Chen et al., 2003). As timely and accurate change information of land cover/land use provides a strong support for natural resource management and dynamic information services (Xian et al., 2009; Bartholomé and Belward, 2005; Lambina et al., 2001; Li, 2010), a number of change detection methods have been developed in recent decades (Lu et al., 2004; Coppin et al., 2004; Castellana et al., 2007; Liu et al., 2006; Nielsen et al., 1998). These techniques could be categorized into post-classification methods (Liu et al., 2008; Chen et al., 2011; Bruzzone et al., 2004) and direct radiometric comparison methods (Singh, 1989; Bruzzone, 2000; Chen et al., 2003). Methods such as change vector analysis (CVA), image difference, spectral angle difference (SAD) and image correlation are optionally unsupervised, more straightforward and operational (Lu et al., 2004); therefore they are more commonly used than the former. However, it must be noted that radiometric comparison methods are affected by interference factors, such as the differences in atmospheric conditions, sun angle and inter-class variance (Radke et al., 2005). As a result, many pseudo changes may appear. For example, the spectral variation induced by changes in soil moisture, water turbidity and building depreciation at different collection times could lead to many detection errors (Chen et al., 2003, 2011). Therefore, the main challenge in change detection is to determine how to preserve the real changes while eliminating the pseudo ones.

Even with the number of change detection methods, it appears that none of them is sufficiently universal to eliminate various pseudo changes (Hégarat-Mascle and Seltz, 2004). In general, each land cover type has a typical spectral curve characterized by its own spectral values and shape (Tso and Mather, 2001). Previous change detection methods, including CVA and image difference, detect the changes based on the variations of spectral values, which could lead to many pseudo changes, such as differences in soil moisture, building depreciation, and so on. Fig. 1(a) shows

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