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Article

Object-based Change Detection

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Summary: The iteratively reweighted multivariate alteration detection (IR-MAD) has shown to be a very useful tool for detecting changes in imagery acquired over the same area but at different times. However, applying the paradigm of object-based image analysis (OBIA) leads to the problem how to connect corresponding objects extracted from images recorded at two different times. Moreover, the huge number of object features available in OBIA results in numerical instabilities within the MAD method due to near-singular covariance matrices. The paper introduces recent developments for object-based change detection. First, a new approach to segmentation for object-based change detection will be presented: The algorithm segments the first image using the multiresolution segmentation. Assigned to the second image, all segmentation merges are checked for consistency and removed if the check fails. Second, the paper shows how to address the numerical problems in the MAD algorithm by regularisation as well as by dimensionality reduction using Principal Component Analysis (PCA). It will be demonstrated how to integrate the adapted segmentation andIR-MAD into the object-based change detection workflow.

Zusammenfassung: *Objekt-basierte Änderungsdetektion*. Die Methode der Iteratively Reweighted Multivariate Alteration Detection (IR-MAD) hat sich als sehr nützliches Instrument erwiesen, um Änderungen zwischen zwei Satellitenbildern unterschiedlicher Aufnahmezeiten eines Gebietes zu analysieren. Jedoch kann die Methode nicht direkt den Ansatz der objektbasierten Bildanalyse (OBIA) integrieren. Insbesondere ist es bisher nicht möglich Änderungen der Form zwischen den Bildern zu detektieren, da die Algorithmen zur Objektextraktion, der so genannten Segmentierung, nicht robust genug sind. Darüber hinaus führt die durch das OBIA-Konzept verfügbare große Anzahl untereinander korrelierter Objekteigenschaften dazu, dass die Methode der IR-MAD numerisch instabil wird. Diese Arbeit präsentiert zwei Neuentwicklungen im Bereich der objekt-basierten Änderungsdetektion. Einerseits wird ein Algorithmus zur Bildsegmentierung vorgestellt, der es ermöglicht, die IR-MAD-Methode direkt auf Basis der Objekte durchzuführen. Andererseits zeigt diese Arbeit auf, wie die numerischen Probleme der IR-MAD-Methode durch Regularisierung und Dimensionsreduktion mittels Hauptkomponentenanalyse gelöst werden können.

1 Introduction

Change detection has always been an important application for remote sensing data. It may be defined as the analysis of two or more images of the same area but acquired at different times in order to identify significant changes of or at the earth's surface. Change detection techniques are being used in a variety of fields, such as disaster management, forestry monitoring, water level monitoring, infrastructure planning, and many more.

According to the broad range of change detection applications using remote sensing data, also a huge number of data processing methods were proposed (Singh 1989, Lu et al. 2004, Radke at al. 2005, Canty 2009): Methods analysing difference images, classification-based approaches and kernel-based methods such as principal component analysis or multivariate alteration detection, to name just a few examples. All these approaches have in common that they compare corresponding image pixels of different acquisition times.

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