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Change mapping in the Rocky Flats area as test bed for damage detection algorithms

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Remote sensing techniques have revealed a suitable monitoring tool to provide data useful for disaster studies. They allow the quick detection of damages and building collapses due to earthquakes, especially in remote areas or where the infrastructures are not well developed to ensure the necessary communication exchanges. In particular, the advent of very high spatial resolution optical satellite imagery has greatly increased our ability to monitor damages in urban area. Satellite observations, which are carried out regularly and continuously, provide a great deal of insight into the temporal changes of surface. This enhanced spatial resolution provides more precise information of changes and is increasingly used to carry out detailed characterization of the damages in urban areas. In fact, the detection of fine-scale physical changes in individual objects, such as single buildings, houses or roads, is greatly enabled by these systems.

Fortunately earthquakes do not happen frequently, so sometimes it is necessary to use test sites that can be representative of surfaces changes caused by seismic event. For this reason, in this study, Rocky Flats has been considered as test area. Rocky Flats was a site for the production of nuclear arms located immediately to the North West of the city of Denver, Colorado, USA. From 1952 to 1989, the primary mission of Rocky Flats was to build plutonium triggers for nuclear bombs. In 1993, the U.S. Secretary of Energy announced that the site's nuclear weapons production was officially over and the site started being cleaned up and dismantled in 1998. About 800 buildings, some of them very large, have been taken down to bare soil. This demolition was completed in mid-2005. This situation can be representative of a destructive earthquake where

damages are heavy and buildings are completely destroyed.

In this paper, we present two different change detection techniques to monitor surface changes caused by earthquakes. The first one is a Change Detection (CD) method based on a Maximum Likelihood (ML) classifier, where temporal changes of reflectance and different response of multispectral data for distinct objects are simultaneously taken into account in the same classifier to identify the different classes of changes on the scene. The other one is an approach based on a Neural Network (NN) architecture called NAHIRI (Neural Architecture for High-Resolution Imagery) to produce change detection maps from very high-resolution satellite imagery. NAHIRI contemporarily exploits spectral and temporal information by adding a filtering effect, directly stemming from the multi-temporal information, to the classification changes yielded by the multi-spectral data. In fact, the distinctive feature of this method is that the NNs simultaneously exploit both the multi-spectral and the multi-temporal information associated with the changed values of the pixel spectral reflectances.

Two multi-spectral QuickBird (QB) images acquired on October 23, 2003 and on October 15, 2005 have been used for mapping temporal changes over the Rocky Flats site by adopting both techniques. The two methodologies have been able to identify automatically the changes occurred between 2002 and 2005 as the demolition of the buildings, the conversion of asphalt parking to soil, the creation of drainage channels and the change of water bodies. The quantitative results are analyzed in order to single out advantages and criticisms of the two different approaches for supporting the activity of the civil protection and rescue teams during crisis phases.