Classification of collapsed buildings during earthquakes from stereo aerial photographs using multiple features

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Abstract

An effective disaster response planning covers three activities: 1) development of a realistic damage simulation model, 2) methods to rapidly assess actual damage, and 3) models to allocate limited rescue resources to damaged areas in an optimal way. Remote sensing techniques both by space-borne or air-borne sensors could make a very effective contribution especially to the first and second activities. The basis for these approaches is a multi-tiered procedure that allows broad regional damage assessments to be conducted using moderate-resolution data (Landsat, SPOT) and more detailed assessments using high-resolution information (Quickbird, Ikonos, aerial images). This concept can be considerably assisted with an automated system, using image analysis and photogrammetry technologies.

We present a method based on two kind of image-extracted features comparing stereo pairs of aerial images before and after earthquake. The study area is a part of the city of Bam, Iran which was hit strongly by an earthquake on December 26, 2003. In order to classify damages caused by earthquakes, we have explored the use of two kind of extracted features: volumes (defined in object space) and edges (defined in image space). For this purpose, DTMs were created automatically from pre- and post-earthquake aerial images. Then the volumes of the buildings were calculated. In addition, a criterion for edge existence - in accordance with pre-event building polygon lines – from post-event images is proposed. A simple clustering algorithm, based on the nearest neighbor rule was implemented using these two features simultaneously. Based on visual inspection of the stereo images, three-level of damage scales (total collapse, partial collapse, no damage) were considered. By comparing pre- and post-earthquake data the results have been evaluated. The overall success rate – total number of correctly classified divided by the total number of samples – was found to be 71.4%. With respect to the totally collapsed buildings we obtained a success rate of 86.5% and 90.4% respectively, which is quite encouraging. The results of the analysis show that using multiple features can be useful to classify damages automatically and with high success rate. This can give first very valuable hints to rescue teams.

Keywords: Remote Sensing, Earthquakes, Detection, Segmentation, Aerial, Edge, Urban, Building.

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