URBAN BUILDING DAMAGE DETECTION FROM VERY HIGH RESOLUTION IMAGERY USING ONE-CLASS SVM AND SPATIAL RELATIONS

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1. INTRODUCTION

The availability of commercial very high resolution (VHR) satellite imagery makes it possible to detect and assess building damage in the aftermath of earthquake disasters using these data. Although the conventional change detection methods may be used to assess the building damage, the analysis is directed on all classes, both damaged and undamaged classes, but is not focused on the class of interest. Another problem with building damage detection is that the accuracy obtained using spectral features alone is comparatively low, since urban land cover types are spectrally similar. Thus, spatial features are needed to be exploited to improve the detection accuracy. In this paper, we proposed to detect the building damage from multitemporal VHR images using One-Class Support Vector Machines (OCSVM) at object level, which combines the spectral and spatial features and only focuses on the building damage class.

2. METHODS

2.1 OCSVM

The OCSVM is a recently developed one-class classifier. Rather than training on every class as required by conventional classifiers, the OCSVM only requires training data from one class (the class of interest or target class) and can focus on the class only. It has been used for mapping of a specific land cover types [1, 2].

The OCSVM may be viewed as a regular two-class SVM where all the training data lies in the first class, and the origin is taken as the only member of the second class [3]. The OCSVM algorithm in [3] first maps input data into a high-dimensional feature space via a kernel function and then iteratively finds the maximal margin hyperplane, which best separates the training data from the origin.

2.2 Multilevel image segmentation

Image segmentation is a prerequisite step for object based analysis. Since land cover types appeared on VHR imagery are multiscale, multilevel image segmentation results are more appropriate. Here, we adopted an improved watershed transformation which combines multispectral gradient [4] and dynamics of watershed contours [5], to produce multilevel segmentations. The obtained multilevel objects were used in the subsequent step for building damage detection.

2.3 Spatial relations

Since many urban land cover types are spectrally similar, building damage detection using spectral features alone could not produce satisfactory results. We assume that the shape features of an image object and its spatial relations with the neighboring objects change before and after the earthquake. Thus, shape features and spatial relations were combined with spectral features for improved building damage detection. The invariant moments and LISA (local indicator of spatial association) index [6] were used in the study.

2.4 Building damage detection

Building damage detection was conducted by object based multitemporal classification using OCSVM. The use of different feature sets in OCSVM was tested: spectral and spatial features, separately and combined.

3. STUDY AREA AND DATA

The study area is the urban area of Dujiangyan, Sichuan province, China. The area is located 80 km away from the epicenter of Wenchuan Earthquake of May 12, 2008, and is the closest city to the epicenter. The area was heavily hit by the Earthquake and suffered severe damage. A lot of buildings in urban area were collapsed and destroyed.

The datasets used in this study include Quickbird images acquired in July, 2005, before the earthquake and September, 2008, after the earthquake, respectively. Pan-sharpening multispectral images and panchromatic images with 0.61m resolution were used. A portion of image of 2250 × 1550 pixels was finally used in the study.

4 RESULTS AND DISCUSSION

Building damage detection was conducted on object level by OCSVM using different feature sets. It was found that although the use of spectral features in OCSVM obtained relatively accurate detection result, the combination of spectral and spatial features in OCSVM led to a significant improvement in the detection accuracy, in term of kappa coefficient as well as producer's and user's accuracies of building damage class. The related issues, such as parameter selection for image segmentation and OCSVM, will be discussed in the full text.

5. CONCLUSION

Object based OCSVM was evaluated in building damage detection using VHR multitemporal images. The results showed that the combination of spectral features and spatial relations on object level produced accurate results. The results also showed that object based OCSVM is a promising and effective method for rapid building damage detection and assessment.

6. REFERENCES

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