URBAN BUILDING DAMAGE DETECTION FROM VERY HIGH RESOLUTION IMAGERY BY ONE-CLASS SVM AND SHADOW CHANGES

Peijun Li, Benqin Song and Haiqing Xu
Institute of Remote Sensing and GIS, Peking University, Beijing 100871, P R China
Emails: pjli@pku.edu.cn, sbq43031@126.com, xuhaiqing@pku.edu.cn

1. INTRODUCTION

The prompt and accurate detection and monitoring of urban building damage caused by earthquake disaster is one of the important aspects for disaster assessment and management. The availability of commercial very high resolution (VHR) satellite imagery makes it possible to detect and assess building damage using these data. A common 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 [1]. Thus, other information, such as spatial information, is required to improve the detection accuracy. In this paper, we proposed a new method to detect the building damage from multitemporal VHR images, which combines the spectral and spatial information.

2. METHODS

Shadow is very common in VHR images of urban areas, mainly caused by high buildings and trees. Buildings and corresponding shadow areas are commonly adjacent in the VHR imagery of urban area. Generally, when the buildings collapse (or completely destroyed) due to earthquake or other disasters, the corresponding shadow areas will also disappear. Thus, shadow changes observed in VHR images of different dates can be used to refine the results obtained by using spectral information. In this study, building collapse (i.e. from building to non-building) and shadow change (i.e. from shadow to non-shadow) are separately detected using object-based direct multitemporal classification by One-Class Support Vector Machine (OCSVM) [1, 2]. Then the changes in shadows adjacent to buildings were used to refine the preliminary result of building damage in previous step.

2.1 Multilevel image segmentation

Building damage detection was conducted on object level. Thus, image segmentation is a prerequisite step. 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 [3] and dynamics of watershed contours [4], to produce multilevel segmentations. The obtained multilevel objects were used in the subsequent multitemporal classification by OCSVM.

2.2 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 successfully used for mapping of a specific land cover types [5, 6] and change detection [1].

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 [7]. The OCSVM 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 [7].

In this study, OCSVM was used to classify multitemporal images to extract building collapse and shadow changes, respectively.

2.3 Building damage detection

After building collapse and shadow change were detected using object based multitemporal classification in previous step, simple conditional statements were implemented to refine the result. For each building collapse area detected, if it is adjacent to an area with shadow change, then it will be remained. Otherwise, it will be considered as non building damage area and will be removed (or excluded) from final result. Finally, the detected patches less than the size of the average buildings in the scene were removed by thresholding.

3. RESULTS AND CONCLUSION

The urban area of Dujiangyan, Sichuan province, China was selected as the study area. The area was heavily hit by Wenchuan Earthquake of May 12, 2008 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.

In order to fully evaluate the performance of the proposed method, building damage detection was also conducted on object level by OCSVM using spectral information alone and used as a benchmark. The experimental results showed that although the use of spectral features in OCSVM obtained relatively accurate detection result, the method proposed in this study produced 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. In particular, false alarms (or commission errors for class damaged building) are considerably reduced, compared to those obtained using spectral information alone. The related issues, such as parameter selection for image segmentation and OCSVM, and further refinement of the results will be discussed in the full text.

4. REFERENCES

[1] P. Li and H. Xu, "Land cover change detection using one-class support vector machine", *Photogrammetric Engineering & Remote Sensing*, vol. 76, no. 1, 2010 (in press).

[2] P. Li, H. Xu, and J. Guo, "Urban building damage detection from very high resolution imagery using One-Class SVM and spatial features", *International Journal of Remote Sensing*, 2009 (in press).

[3] P. Li, X. Xiao, "Multispectral image segmentation by a multichannel watershed-based approach", *International Journal of Remote Sensing*, vol. 28, no. 19, pp. 4429-4452, 2007.

[4] L. Najman, M. Schmitt, "Geodesic saliency of watershed contours and hierarchical segmentation", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 18, no. 12, pp. 1163-1173, 1996.

[5]C. Sanchez-Hernandez, D S Boyd, and G. M. Foody, "One-class classification for mapping a specific land-cover class: SVDD classification of Fenland", *IEEE Transactions On Geoscience and Remote Sensing,* vol. 45, no. 4, pp.1061-1073, 2007.

[6] J. Muñoz-Marí, L. Bruzzone, and G. Camps-Valls, "A Support Vector Domain Description Approach to Supervised Classification of Remote Sensing Images", *IEEE Transactions On Geoscience and Remote Sensing*, vol. 45, no. 8 , pp. 2683-2792, 2007.

[7] B. Scholkopf, J.C. Platt, J. Shawe-Taylor, A.J. Smola, and R.C. Williamson, "Estimating the support of a high dimensional distribution", *Technique report*, Microsoft Research, MSR-TR-99-87, 1999.