Landslides Detection by Convolutional Neural Network using Multi-temporal and Single-polarized SAR Images

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Abstract

In recent years, disasters frequently occurred in Japan. Rapid disaster detection techniques are required to the assessment of damage for rescue, rehabilitation and reconstruction just after disaster. Synthetic Aperture Radar (SAR) images obtained by a land observing satellite (ALOS-2 operated by JAXA) have a potential for the rapid assessment of damage over a wide area regardless of time and weather. Change detection is a simple way for disaster detection in the differences between multi-polarimetric SAR images before and after disaster. Change detection for disaster detection requires a SAR image just before disaster to reduce non-disaster changes such as vegetation changes (seasonal changes) and urban changes. However, SAR images just before disaster are not always available under the current operation of satellite. Especially, the imaging frequency of multi-polarimetric SAR image is low compared with single-polarimetric SAR images. In this study, we focused on the advantage of single-polarimetric SAR images on the frequency of imaging and proposed a landslide detection method using the multi-temporal and single-polarimetric SAR images. First, a patch-based composite was created from SAR images before disaster. Next, a differential image was calculated from a pair of a patch-based composite and SAR image after disaster. These processes reduced non-disaster changes as compared with a differential image calculated only from a pair of SAR images before and after disaster. After that, changes caused only by landslide were detected from the differential image by using the convolutional neural network (CNN). We applied this method to the detection of landslide caused by heavy rain in Northern Kyushu on July 2017. We divided the differential images, which are in the devastated area, into training area and test area. Training and test areas were further divided into patches as training and test data for CNN, respectively. The CNN was trained to classify whether a patch includes landslides within its central small region in 6-hold cross validation. The performance of the method was evaluated by the accuracy and F-measure for test data. As a result, the accuracy was 0.78 and F-measure was 0.76. These results suggest that multi-temporal and single-polarimetric SAR images have a potential to detect landslides even though a single-polarimetric SAR image provides poor information on land surface as compared with a multi-polarimetric SAR image.