A Deep Learning Approach for Earthquake Damage Extraction in Buildings by Integrating Spatial and Frequency Domain Texture Features

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The collapse of buildings is the main cause for casualties after earthquakes. Real-time and accurate positioning of the building areas are crucial to make an effective implementation of emergency rescue after an earthquake. Synthetic Aperture Radar (SAR) possesses advantages such as all-weather and all-day capabilities, as well as resilience to lighting and weather conditions. Therefore, the use of SAR imagery has garnered significant attention in various fields, including post-earthquake rescue, damage estimation, and urbanization studies, and so on. The single-polarimetric spaceborne SAR data are very difficult to decipher, because their information is simple and abstract, and the spatial resolution of radar satellite data is limited. In this case, the accuracy of recognizing building earthquake damage information using only one post-earthquake single-phase SAR data is low. In order to ensure the accuracy of building damage information extraction as much as possible, the project utilizes deep learning network to fuse multiple feature parameters to identify building damage from post-earthquake SAR images. By comparing the classification accuracies of deep learning networks with different data and feature parameters, we found that the deep learning method combining spatial domain and frequency domain texture features can more accurately recognize collapsed buildings and non-collapsed buildings. The method demonstrates a robust capability to identify collapsed and intact buildings. Taking the area of Kahramanmaras, Turkey hit by the 6 February, 2023 Turkey-Syria earthquake as the case study, the region severely affected by the earthquake, this project incorporates both spatial and frequency domain features into the deep learning network for classification. Experimental results show that the proposed method achieves a classification accuracy of 80.98%, significantly surpassing the classification accuracy of 47.84% for the original SAR image. Moreover, the accuracy of 80.98% is higher than using only spatial domain features (73.30%) or only frequency domain features (73.42%). The proposed method in this study can provide fundamental support for post-earthquake disaster assessment and situational awareness.