Change detection in very high-resolution images using siamese residual u-net with squeezed high frequency attention block

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**ABSTRACT:** Recently, deep learning has been used for various tasks in the remote sensing field because of its robust feature extraction, strong generalization performance, and superior results compared to conventional threshold and machine learning methods. Although the advantages of deep learning in change detection have been demonstrated, deep learning-based change detection method has still some limitations.

One of the problems arises as input data passes through the deep learning model, which performs a process of compressing the features present within an image during the convolution process. This leads to a substantial loss of high frequency components, such as edge information in VHR (Very High-Resolution) satellite images. To address this issue, a High Frequency Attention Block (HFAB) that consists of an attention module containing high-frequency filters was proposed to preserve edge information in VHR satellite images. However, basic architecture of HFAB module has numerous parameters, leading to a feature vanishment problem in the deep architecture. Typically, the numerous parameters can cause model overfitting, negatively impacting the performance of deep learning model. In this study, we proposed a squeezed HFAB which is a modified attention module to optimize the parameters of deep learning change detection networks. We implemented the proposed method by removing some of the convolutional layers included in HFAB to prevent feature vanishment. The spatial attention module of the squeezed HFAB was composed of two layers to optimize the number of parameters of the deep learning model. Squeezed HFAB utilizes the Siamese Residual U-Net structure to detect change areas. The encoder of Residual U-Net uses a ResNet50 model as a backbone, and the decoder is implemented in the same structure as U-Net. The structure of ResNet50 applied in the encoder allows for more effective feature extraction at deeper layers and the ability to consider non-linearity, which can lead to better change detection performance even with the proposed method.

In order to verify the proposed change detection approaches, the cities of Sejong and Daejeon in South Korea, where large-scale changes have occurred, were selected as the study areas. Accordingly, each site consists of KOMPSAT-3A and QuickBird image pairs. In order to consider the seasonal changes caused by the time difference between two image pairs, we also used the near infrared band in addition to the red, green, blue bands generally used in change detection. Ground truth data was created by directly performing labeling work on the changed areas through visual inspection of two image pairs. A dataset consisting of 3,000 patches of 512 × 512 pixels size was constructed on the satellite images through random sampling. This was divided into a 7:2:1 (training: validation: test) ratio for performing the training and validation. The hyper-parameter settings used for model training were a learning rate of 1e-03, 20 epochs, and a batch size of 8. To enhance the reliability of the study, the hyperparameters of the two models were set identically. The quantitative assessment of model performance utilized metrics such as mean IoU (Intersection over Union), F1-Score, and Kappa coefficient. Both models were successful in detecting change areas, with the proposed method demonstrating higher accuracy. This trend was also apparent in the qualitative assessment of the results. The qualitative assessment was conducted through visual inspection, confirming that the proposed technique was superior in delineating the edges of change areas. Consequently, it is demonstrated that the proposed method can successfully detect the change area with preserve edge of object.

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