Research on the Method of extracting mining subsidence by combining improved U-Net model and DInSAR Technology

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Abstract

Ground subsidence caused by the exploitation of mineral resources is not only an important factor to be considered in the development and utilization of land space, but also an obvious indication for the area of underground illegal mining.The difference interferometric phase diagram of subsidence mining area is obtained by using synthetic aperture radar differential interferometry (DInSAR) technology, FCN-8s, PSPNet Deeplabv3 and U-Net models are used to train the network. The results show that the U-Net model has high detection accuracy and takes short time. In order to improve the semantic segmentation and extraction accuracy of mining subsidence, the efficient channel attention (ECA) module is introduced into the traditional U-Net model for training. The ECA-UNet results show that compared with the traditional model, the intersection union ratio (IOU) corresponding to mining subsidence is increased by 2.54%.

Study area

- We select images from 11 October, 2019 to 22 December, 2019 for deformation monitoring.
- The study area and SAR image coverages are shown in Figure 1.

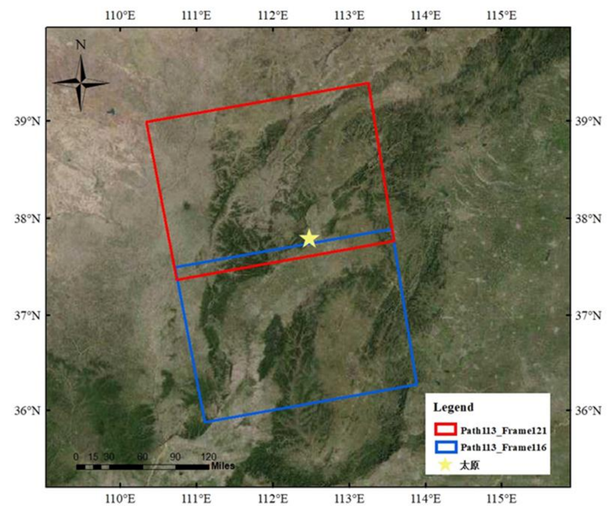

Figure 1 Location of the study area and coverage of SAR data for subsidence monitoring in Shanxi Province.

Image preprocessing

- Preprocess the data includes image coregistration, multi look, filtering and so on.

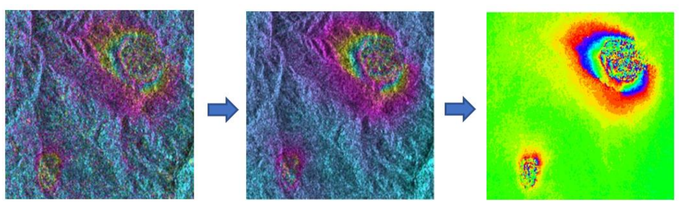

Figure 2 Differential interferogram and conversion processing effect

Method

- We use deep learning model includes FCN, PSPNet,Deeplabv3 and U-Net model.
- In order to improve the detect performance,we add four ECA modules to the coding part of U-Net model.
- ECA module can make the network pay attention to the target information effectively and ignore the irrelevant information at the same time.

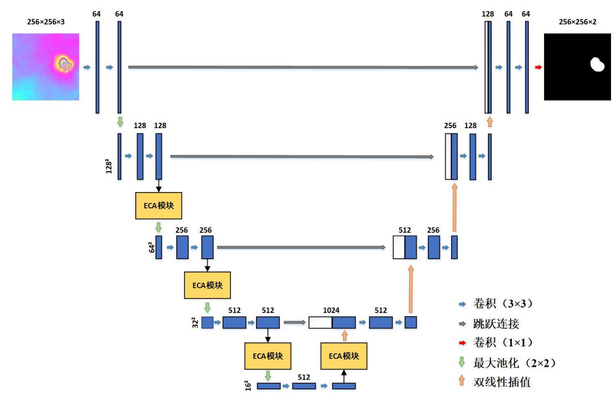

Figure 3 ECA-Unet model structure

Accuracy

Table 1 Accuracy evaluation of different models on test dataset

	PA	MIoU	IoU（background）	IoU（mining subsidence）	Training time/h
FCN32s	97.71%	73.68%	98.21%	49.15%	1.84
FCN16s	98.32%	78.35%	98.50%	58.20%	1.88
FCN8s	98.53%	79.32%	98.58%	60.05%	2.11
PSPNet	98.16%	79.21%	98.65%	59.77%	6.50
Deeplabv3	98.20%	79.71%	98.57%	60.85%	7.50
U-Net	98.31%	79.24%	98.27%	60.20%	5.08
ECA-UNet	98.55%	80.58%	98.41%	62.74%	6.36

Result analysis and Conclusion

- Randomly select an image from the test dataset, as shown in Figure 4. Compared with the result of traditional U-Net model, the edge contour of the result of ECA-UNet is smoother, which is closest to the visual interpretation of the mining subsidence label.

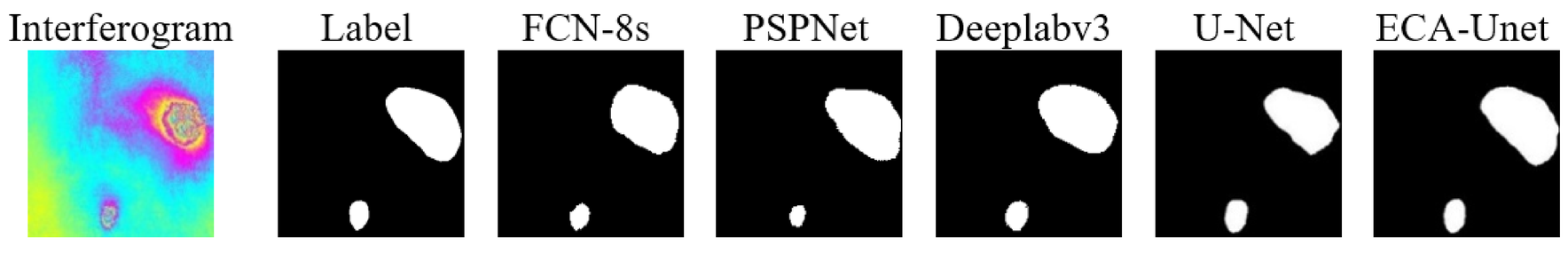

Figure 4 Results of different models

- We use ECA-UNet to obtain the mining subsidence area from the large-scale differential interferogram. The differential interferogram phase diagram is shown in Fig.5 and the extraction result diagram is shown in Fig.6.(elliptical marks 1 and 2 are wrongly divided)

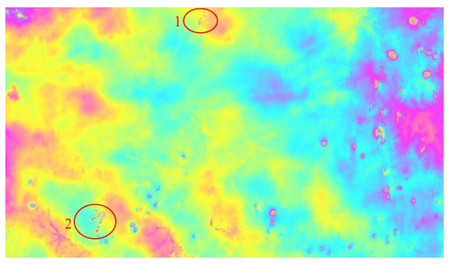

Figure 5 Mining subsidence phase diagram

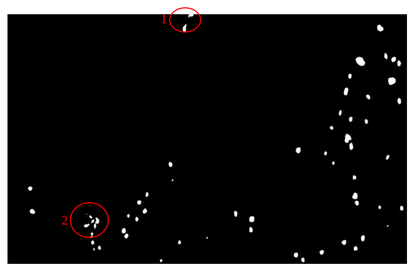

Figure 6 Segmentation results

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