Ship Target Detection Method Based on Local Saliency Enhancement

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Abstract

Due to the non-uniformity of ship target scattering, speckle noises and side lobes, synthetic aperture radar (SAR) ship target detection is facing great challenges. Therefore, to improve the detection performance in this scenario, the ship detection method based on the local saliency enhancement is proposed in this paper. Firstly, the proposed method improves the target-to-clutter ratio (TCR) by combining the relative differences of multi-features between ship target and the clutter background, and the threshold segmentation is performed based on the final local enhancement results. The experimental results show that the proposed method can suppress clutter background and speckle noises, improve the TCR and the algorithm has a high detection rate and a low false alarm rate in the complex background and multi-target marine environment.

Method

Because of the obvious speckle noises and the side lobes reflected from strong scattering targets in SAR images, the detection performance of ship target is greatly affected. Therefore, the ship detection algorithm based on local saliency enhancement is proposed. Fig. 1 gives the specific algorithm flow chart.

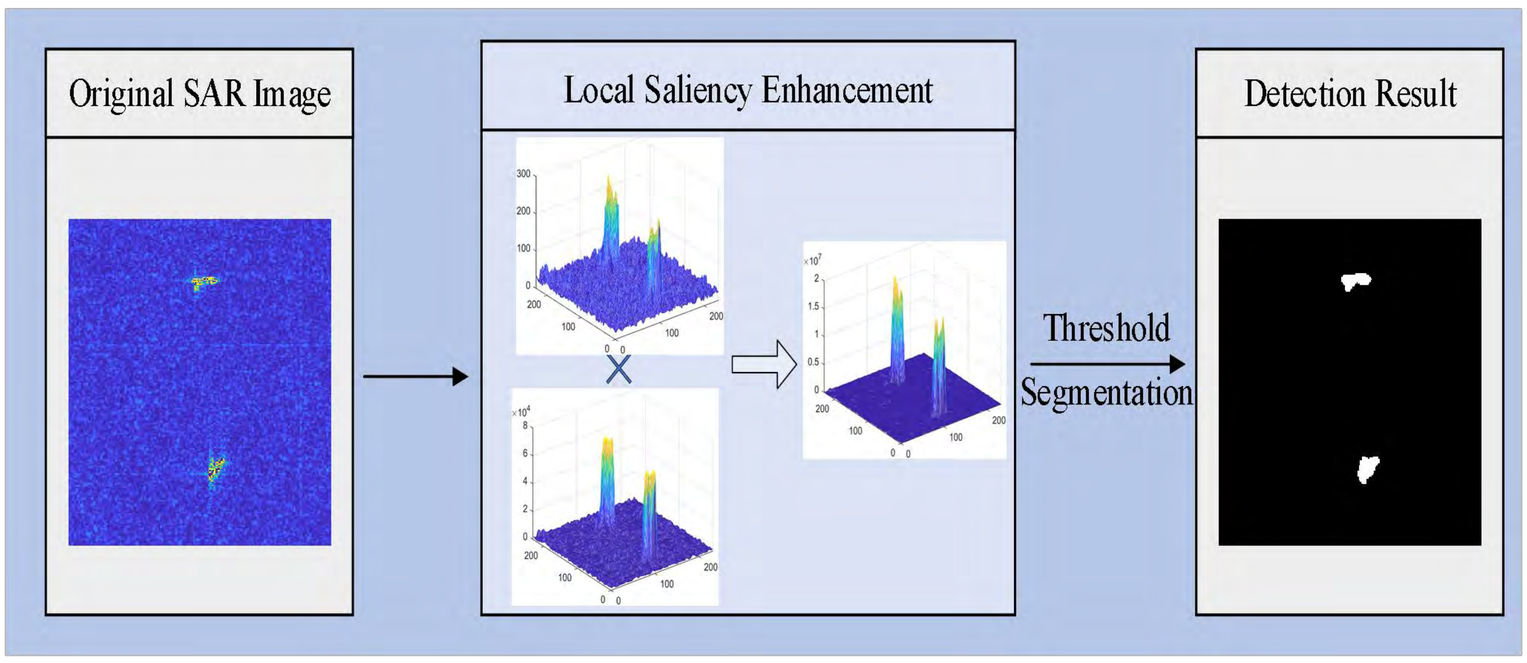


Fig. 1

Method

Considering the background pixels around the target and the side lobes, the sliding window shown in Fig. 2 is selected to reduce the impact on the detection performance.

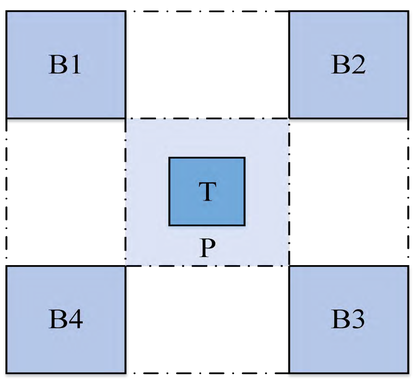
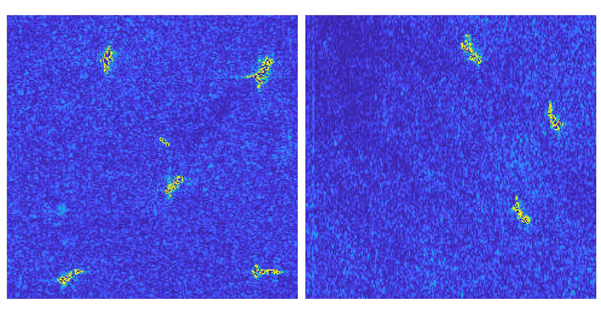


Fig. 2

Results

First of all, in order to verify the effectiveness of target enhancement of our method, we select two SAR images with 256×256 pixels and obvious speckle noises to show the target enhancement effect, as shown in Fig. 3(a)(b).

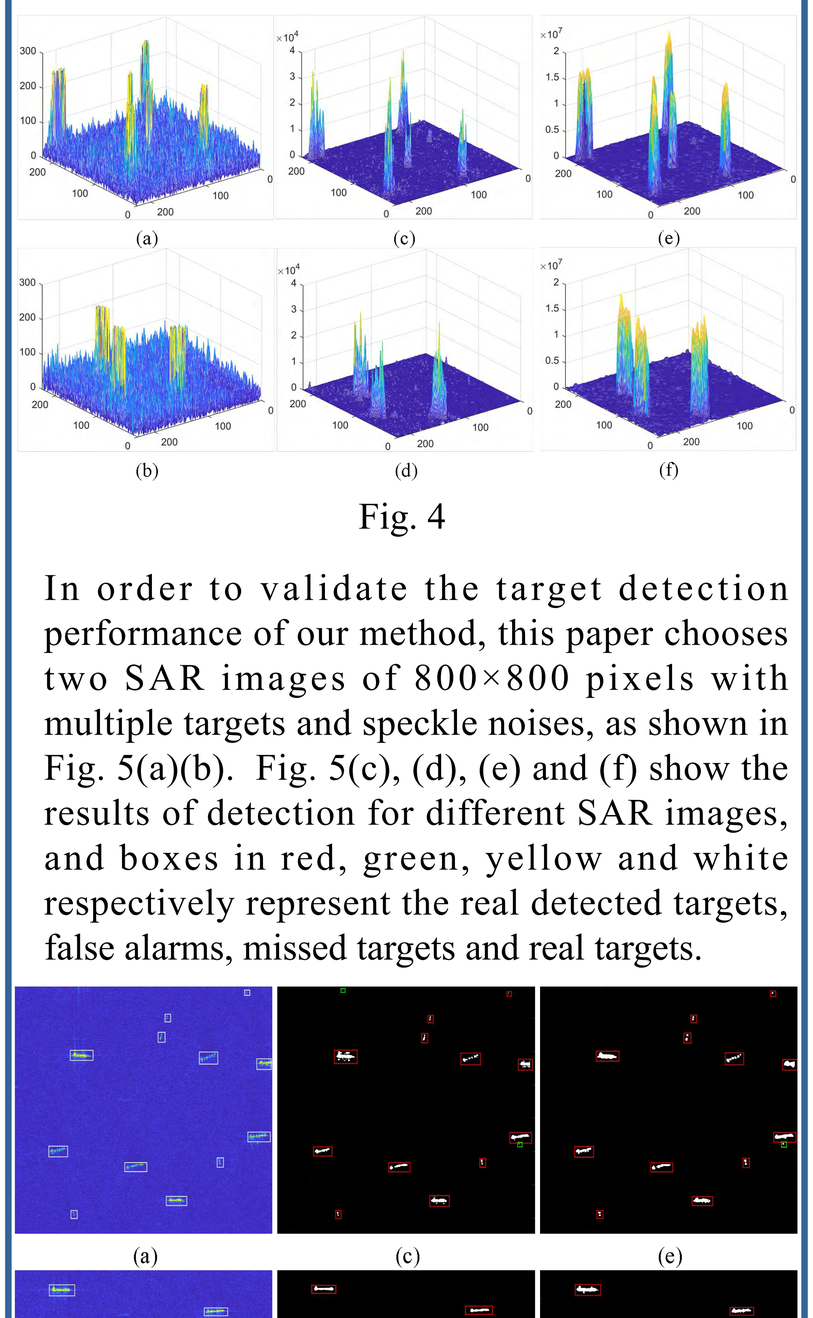


(a) (b)

Fig. 3

Fig. 4(a)(b) show the original target clutter comparison results of two scene images. Fig. 4(c)(d) show the target enhancement results of the FMPCM method, and Fig. 4(e)(f) give the target enhancement results of our method. The contrast between target and clutter is not obvious in the raw SAR scenes. After the target enhancement processing by the FMPCM method and proposed method, the TCR is significantly improved.

The FMPCM method can enhance the TCR by 5~9dB, and our method can enhance the TCR by 13~16dB. Therefore, the enhancement effect of our method is better than the FMPCM method.



(a) (c) (e)

(b) (d) (f)

Fig. 4

In order to validate the target detection performance of our method, this paper chooses two SAR images of 800×800 pixels with multiple targets and speckle noises, as shown in Fig. 5(a)(b). Fig. 5(c), (d), (e) and (f) show the results of detection for different SAR images, and boxes in red, green, yellow and white respectively represent the real detected targets, false alarms, missed targets and real targets.

(a) (c) (e)

(b) (d) (f)

Fig. 5

As shown in Fig. 5, due to the better suppression effect of the proposed method, the false targets can be reduced, and the detection rate for small targets can raise.

Figure of merit (FoM) is used to qualitatively evaluate the detection performance and was denoted as

$$FoM = \frac{N_{detect}}{N_{false} + N_{ship}}$$

Table I

Images	Target	FMPCM	Proposed
Fig.5(a)	12	0.8571	0.9231
Fig.5(b)	13	0.9231	1

Table I lists the FoM values for both methods. As shown in Fig. 5 and Table I, FMPCM may miss small ship targets and produce false alarm. The proposed method greatly improves the detection performance.

Conclusion

The ship target detection method of local saliency enhancement based on multiple features is proposed in the paper, which mainly uses the texture and intensity dissimilarity between ships and sea clutter background in SAR image. The algorithm effectiveness is proved by extensive different SAR images, and under conditions of strong side lobes and speckle noise, the proposed algorithm can realize target enhancement and clutter suppression effectively. The detection results show that the proposed algorithm can extract ship targets from the clutter background and maintain the contour of the ship target.ckground and multi-target marine environment.