

A Fusion Method of Interesting Targets Detection

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Abstract. A fusion method of shelter targets detection is proposed in this paper based on the D-S theory. Firstly, combining the features of position and the strong echo character of shelters on the SAR (Synthetic Aperture Radar) image, the shelter targets can be recognized. Then, using the character of shape, this paper can recognize the shelters targets on the optical image after registration with the SAR image. In the end, this paper uses the D-S theory fusing the detection results of the SAR image and the optical image. The results show that this method can recognize the shelters accurately combining the advantages of the SAR image and the optical image.

Introduction

In recent years, the development of image fusion technology has provided condition for the fusion detection of two sensors. Combining the advantages of the two sensors can recognize the shelters accurately. Due to the shelters are very small in general, it is very difficult to extract the target from the large airport area only relying on the way of data driven. Therefore, it is necessary to summarize a set of effective detection method^[1]. Each component in the airport is interrelated and interdependent. In this paper, based on the priori knowledge, the potential position of shelter targets is identified through the end breaking road of shelter targets, which can indicate the position well. Then, the ROI is Determined, this paper makes use of the peak characteristics on SAR images and the shape features on optical images to detect the shelter targets respectively. In the end, it uses the detection results to determine the position of the shelter targets accurately.

A Fusion Method Based on D—S theory

D—S theory was first used in expert system, which is an uncertain reasoning method, using confidence interval instead of a single probability value. D—S theory, which can express uncertain event, adapt to a wider range than the Bayesian theory.

D—S theory plays an important role in the field of target recognition, taking into account the views of many experts and information from multiple sensors and other issues^[9].

Elements in space Θ and space S linked through multivalued mapping: $\Gamma: S \rightarrow 2^\Theta$, Where, element s is mapped to $G(s)$. The relationship between S and Θ can be represented by C:

$$G(s) = \{\theta \mid \theta \in \Theta, sC\theta\} \quad (1)$$

The confidence is also a factor must be consider in D—S theory. Firstly, the basic probability assignment function, expressed by mass, can be defined by:

$$m: 2^\Theta \rightarrow [0,1] \quad (2)$$

$$m(A) = \frac{\sum_{G(x_i)} P(s_i)}{1 - \sum_{G(x_i)} P(s_i)} \quad (3)$$

Where, $\Theta = \{\theta_i | i = 1, 2, \dots, n\}$ identification space, 2^Θ represents the sets consisted by the subset of Θ . $\theta_i \cap \theta_j = \varphi$, when $i \neq j$, where θ_i and θ_j represent different conclusions and A is one of the subset of identification space Θ .

Through the literature^[10] can we know the new basic probability distribution function based on information fusion?

$$m(A) = m_1 \oplus m_2(A) = \frac{\sum_{B_i \cap C_j} m_1(B_i)m_2(C_j)}{1 - \sum_{B_i \cap C_j} m_1(B_i)m_2(C_j)} \quad (4)$$

Because of the false alarm and omission in the possession of detection, the results may not be accurate. Thus the literature^[10] proposed using the discount factor to adjust confidence interval:

$$m'_i(H_1) = (1 - \varepsilon_i)m_i(H_1) \quad (5)$$

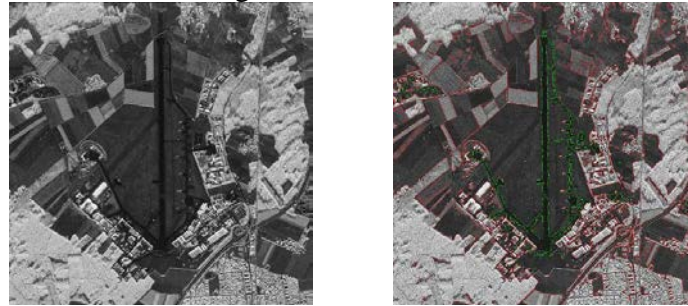
$$m'_i(H_0) = (1 - \varepsilon_i)m_i(H_0) \quad (6)$$

$$m'_i(\Theta) = \varepsilon_i \quad (7)$$

Results and Discussion

This paper selects Oberpfaffenhofen area of Germany as the experimental data, the spatial resolution of Single-look SAR is $1m \times 1m$, with 4680×4624 pixels. Due to the subsequent integration requires, the optical image should be cut into pieces with the size of SAR image, which are 4336×4336 pixels.

SAR image segmentation. According to the complexity of the image, it is divided into three kinds of targets by the multiphase segmentation. Parameters are as follows: the time step is 0.1s, the weight value needed by multiphase segmentation is $\lambda_1 = 1$, $\lambda_2 = 3$, and $\lambda_3 = 6$, the standard deviation after regularization is. The results shown in Figure 1:



(a)Original SAR image (b) Multiphase segmentation result

Fig.1. Multiphase segmentation experiment

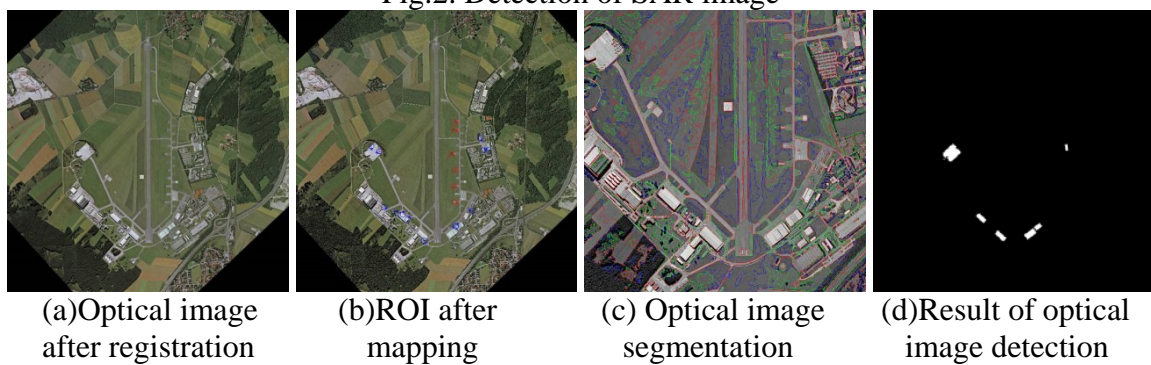
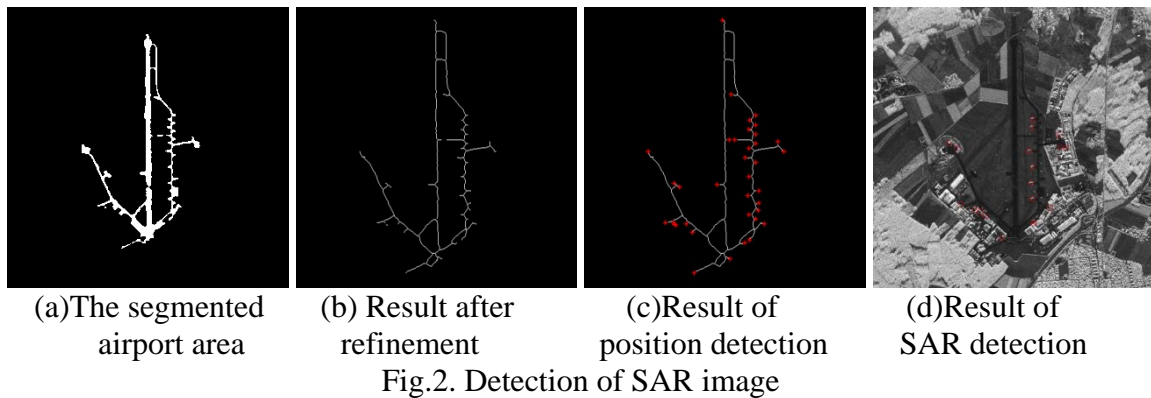
Experimental results show that: The method of multiphase segmentation can effectively solve the situation of gray-aliasing and complicated background in the airport area, and can segment the runways and the taxiways well, which are connected with the runways.

Shelter targets detection on SAR image. Firstly, the extracted airport area must be refined with the results shown in Figure 2 (b). Then, we can get the potential position of shelters by the method of position characteristics detection with the results shown in Figure2(c).According to the prior knowledge, can we detect the strong echo character within the neighborhood of the endpoint with the results shown in Figure2 (d).

Experimental results show that: Combining the features of position and the strong echo character, the shelter targets can be recognized accurately. Among the total 13 real targets, 12 targets were detected accurately, with the detection rate by 92.3% and the false alarm rate by 36.8%. Further removal of false alarms must be done to improve the reliability of detection.

Optical image target detection. Before detection, the optical and SAR image must be registered. The optical image after registration is shown in figure 3 (a). Then, the ROI on SAR image was mapped onto the optical image. As shown in figure 3 (b), the shelter targets in the red ROI has been recognized accurately on SAR image. Therefore, only the area with more false alarms should be

detected, which was shown in the blue ROI. The segmentation result of the optical image after registration was shown in the figure 3(c). The result of objection extraction by the method of Fourier descriptor combined with template matching was shown in figure 3(d).



Experimental results show that: through the registration of optical and SAR image, the ROI on SAR image can be mapped onto the optical image to segment the optical image directly, which can eliminate the procession of image thinning and position feature detection. What's more, the area with more false alarms was detected to remove the false alarm effectively and improve the detection efficiency.

4. Fusion detection.

According to the above detection method, the optical image detection is based on the results of SAR image detection, and thus the detection results of the optical image detection should be given a higher degree of confidence. However, the detection results on SAR images of the same area are also correct. Therefore, this paper uses the D-S theory fusing the detection results of the SAR image and the optical image. For $m(X)$ and $m'(X)$ does not have to be relational, the detection result of optical image was given 1, and the detection result of SAR image was given 0. The detection result was shown in figure

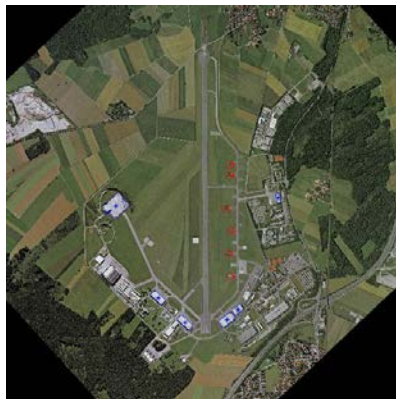


Fig.4 Integration test results

Experimental results show that: combining the advantages of the SAR image and the optical image, this method can recognize the shelters accurately, reduce the false alarm rate and improve the reliability of target detection.

Conclusion

Based on the D-S theory, a fusion method of shelter targets detection is proposed in this paper. SAR image show strong echo characteristics to artificial targets and can expose camouflage. What's more, Optical image has clear boundary. Therefore, this paper uses the D-S theory fusing the strong echo detection results of the SAR image and shape detection results of the optical image. Experimental results show that: this method can recognize the shelters accurately, reduce the false alarm rate and improve the reliability of target detection.

References

- [1] Jun-ling, CHEN Tian-ze, SU Yi. A Method of Airport Shelter Detection Based on Feature Fusion in Remote Sensing Images [J]. Remote Sensing Technology and Application, 2009, 37(12):379-384.
- [2] Chan T F, Vese L A. Active contours without edges [J]. Image Processing, IEEE Transactions on, 2001, 10(2): 266-277.
- [3] Vese L A, Chan T F. A multiphase level set framework for image segmentation using the Mumford and Shah mode l [J]. International journal of computer vision, 2002, 50(3): 271-293.
- [4] Ayed I B, Mitiche A, Belhadj Z. Multiregion level-set partitioning of synthetic aperture radar images [J]. Pattern Analysis and Machine Intelligence, IEEE Transactions on, 2005, 27(5): 793-800.
- [5] LI Chuan, PENG Fu-rong, LU Jian-feng. Skeleton Extraction Algorithm Based on Distance Field Thinning [J]. Microelectronics & Computer. 2011, 28(10), 114-117.
- [6] HUANG Jia-xin, LU Jun, ZHAO Ling-jun. New SAR Target Classification Method Based on Simulation Image Template [J]. Journal of System Simulation, 2013, 6: 036.
- [7] XU Qiang, MA Deng-wu. Shape Matching Combining Corner with Fourier Descriptor [J]. Opto-Electronic Engineering, 2013, 40(6): 123-128.
- [8] Meng Fan, FANG Sheng-hui. Quasi-automatic Extraction of Zonal Roads from Remote Sensing Images Using Template Matching and BSsnake Model [J]. Geomatics and Information Science of Wuhan University, 2012, 37(1): 39-42.
- [9] LIU Fu-xian, XING Qing-hua. New decision making method based on D-S fusion evidence [J]. Systems Engineering-, 2009 (007): 125-131.
- [10] LEI Lin, ZHOU Shi-lin, ZHAO Zhu-xin. Target Fusion Detection Algorithm Based on ROI and Evidence Theory [J]. Signal processing, 2010, 26(2): 225-229.