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Infrared Point Target Detection based on Multi-label Generative MRF Model

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Abstract: Infrared point target detection based on markov random field (MRF) is mainly formulated as a binary classification problem, leading to a poor adaptability to complex background with high false alarm rate. This paper formulates the infrared point target detection as a multi-classification problem, and proposes a detection method based on multi-label generative MRF (MG-MRF) model. First, the MG-MRF model is proposed and the optimal label configuration of the infrared image is derived using iterated condition mode (ICM). Second, the pointwise adaptive filter is structured utilizing local labels to suppress the background clutter. Finally, an adaptive threshold is utilized to segment the target in the residual image. The experimental results on various backgrounds demonstrate that the detection method based on MG-MRF has a strong suppression of false alarm with superior performance in terms of accuracy and efficiency.

Keywords: infrared point target detection; markov random field; generative MRF model; background clutter suppression;

1. Introduction

Infrared target detection has attracted lots of research interests for its wide application in remote sensing, aviation, aerospace and other fields [1-4]. Due to the far imagery distance, target always appears as a small speckle in the infrared image and easily submerged in complex background, making the detection process more challenging. Relying on the infrared imagery characteristics, many detection methods have been carried out, including morphological method [5], statistical regression method [6], saliency based method [7] and other approaches [8-9]. Despite extensive researches carried out over the decades, infrared point target detection in complex backgrounds still remains a challenging task.

Markov random field is proposed in 1984 by S. Geman and D. GemaII [10], as a new description of image local information, has been widely used in image segmentation, image denoising and image reconstruction etc. [11-17], also provides a new idea for infrared target detection. [18] applied markov random field to infrared small target detection for the first time, proposed a regularized background suppression algorithm based on MRF model with a new potential function describing the roughness of local area. [19] proposed a new MRF potential function according to the difference of spatial distribution between background and target, but the performance decreased obviously due to the global fixed threshold in target segmentation when the background clutter undulates violently. [20] put forward an infrared small target detection based on generative MRF model and local statistics according to binary classification, improved the convergence speed utilizing priori SNR information while reducing the false alarm rate, but the performance is greatly affected by the accuracy of prior information, leading to a poor adaptability to varied background. Other MRF approaches of infrared target detection [21-22] were also implemented based on binary classification models.