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Infrared Small Target Detection in Heavy Sky Scene Clutter Based on Sparse Representation

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Abstract

A novel infrared small target detection method based on sky clutter and target sparse representation is proposed in this paper to cope with the representing uncertainty of clutter and target. The sky scene background clutter is described by fractal random field, and it is perceived and eliminated via the sparse representation on fractal background over-complete dictionary (FBOD). The infrared small target signal is simulated by generalized Gaussian intensity model, and it is expressed by the generalized Gaussian target over-complete dictionary (GGTOD), which could describe small target more efficiently than traditional structured dictionaries. Infrared image is decomposed on the union of FBOD and GGTOD, and the sparse representation energy that target signal and background clutter decomposed on GGTOD differ so distinctly that it is adopted to distinguish target from clutter. Some experiments are induced and the experimental results show that the proposed approach could improve the small target detection performance especially under heavy clutter for background clutter could be efficiently perceived and suppressed by FBOD and the changing target could also be represented accurately by GGTOD.

Keywords: Infrared imaging, Small target detection, Sparse representation, Fractal surface, Irregular targets.

Nomenclature

a_{GGIM}	The amplitude parameter of generalized Gaussian intensity model
$\boldsymbol{C}$	Fractal surface array
$\boldsymbol{D}$	Over-complete dictionary
$\boldsymbol{D_c}$	Background clutter over-complete dictionary
$\boldsymbol{D_t}$	Target over-complete dictionary
$\boldsymbol{d_i}$	The ith atom in the over-complete dictionary
$\boldsymbol{d_i^b}$	The ith atom in the background over-complete dictionary
$\boldsymbol{d_i^t}$	The ith atom in the target over-complete dictionary
$\boldsymbol{f}$	The original infrared image
$\boldsymbol{f_b}$	The background image
$\boldsymbol{f_n}$	The noise image
$\boldsymbol{f_s}$	Synthesized test image
$\boldsymbol{f_t}$	The target image
$\boldsymbol{I_c}$	The simulated fractal clutter image
$\boldsymbol{I'_{GGIM}}$	The image of generalized Gaussian intensity model before amplitude adjustment
$\boldsymbol{I_{GGIM}}$	The image of generalized Gaussian intensity model after amplitude adjustment

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