Small target detection based on difference accumulation and Gaussian curvature under complex conditions

He Zhang, Yanxiong Niu, Hao Zhang

PII: S1350-4495(17)30047-6
DOI: http://dx.doi.org/10.1016/j.infrared.2017.08.016
Reference: INFPHY 2363

To appear in: *Infrared Physics & Technology*

Received Date: 23 January 2017
Revised Date: 16 August 2017
Accepted Date: 22 August 2017

Please cite this article as: H. Zhang, Y. Niu, H. Zhang, Small target detection based on difference accumulation and Gaussian curvature under complex conditions, *Infrared Physics & Technology* (2017), doi: http://dx.doi.org/10.1016/j.infrared.2017.08.016

Small target detection based on difference accumulation and Gaussian curvature under complex conditions

HE ZHANG, YANXIONG NIU*, HAO ZHANG

School of Instrumentation Science and Optoelectronics Engineering, Beihang University, Beijing 100191, China
**Corresponding author: niuyx@buaa.edu.cn*

HIGHLIGHT

- We propose a new method for small target detection under complex conditions
- Multi-scale neighborhood clustering is applied to remove heterogeneous region.
- Small target can be separated from homogeneous region by Gaussian curvature.

ARTICLE INFO

Article history:

Received XX Month, XXXX

Available online XX Month, XXXX

Keywords:
Small target detection
Different accumulation
Clustering
Gaussian curvature

ABSTRACT

Small target detection is a significant subject in infrared search and track and other photoelectric imaging systems. The small target is imaged under complex conditions, which contains clouds, horizon and bright part. In this paper, a novel small target detection method is proposed based on difference accumulation, clustering and Gaussian curvature. Difference accumulation varies from regions. Therefore, after obtaining difference accumulations, clustering is applied to determine whether the pixel belongs to heterogeneous region, and eliminate the heterogeneous region. Then Gaussian curvature is used to separate target from homogeneous region. Experiments are conducted for verification, along with comparisons to several other methods. The experimental results demonstrate that our method have an advantage of 1-2 orders of magnitude on SCRG and BSF than others. The detection probability can be approximately 90% when the false alarm probability is 100%.

1. Introduction

Small target detection under complex conditions is a significant subject for defense, guidance, navigation, infrared search and track (IRST) and other photoelectric imaging systems [1-5]. With effects of weather, illumination, clouds and field selection, the small target is imaged in complex background, leading to the decreased detection probability and reduced system performance. Therefore, small target detection under complex conditions has always been an important and difficult task.

Small target detection has been widely studied in the past few decades and several classical spectrum filtering methods have been proposed. High-pass filter, Butterworth high-pass filter and Gaussian high-pass filter can separate high-frequency information from low-frequency information. These methods perform well under the situation of high signal to noise ratio (SNR) , but is ineffective under complex conditions. This is mainly because that these methods can't distinguish high-frequency background and targets absolutely. Boccignone et al. introduced wavelet transform to the small target detection to enhance the targets, suppress noise and improve signal to noise ratio [6]. But wavelet transform retains more noise points in the low signal to noise ratio conditions.

For background estimation, many other methods, such as max-mean filter and max-median filter, have been proposed [7]. These methods have simple principle and are easy to accomplish, but they are less effective in