Infrared maritime target detection using the high order statistic filtering in fractional Fourier domain

Anran Zhou, Weixin Xie, Jihong Pei

PII: S1350-4495(18)30011-2
DOI: https://doi.org/10.1016/j.infrared.2018.04.006
Reference: INFPHY 2538

To appear in: *Infrared Physics & Technology*

Received Date: 7 January 2018
Revised Date: 11 April 2018
Accepted Date: 12 April 2018

Please cite this article as: A. Zhou, W. Xie, J. Pei, Infrared maritime target detection using the high order statistic filtering in fractional Fourier domain, *Infrared Physics & Technology* (2018), doi: https://doi.org/10.1016/j.infrared.2018.04.006

Infrared maritime target detection using the high order statistic filtering in fractional Fourier domain

Anran Zhou[a], Weixin Xie[a], Jihong Pei[a,*]

[a] *College of Information Engineering, Shenzhen University, Shenzhen, 518060, China*

Abstract

Accurate detection of maritime targets in infrared imagery under various sea clutter conditions is always a challenging task. The fractional Fourier transform (FRFT) is the extension of the Fourier transform in the fractional order, and has richer spatial-frequency information. By combining it with the high order statistic filtering, a new ship detection method is proposed. First, the proper range of angle parameter is determined to make it easier for the ship components and background to be separated. Second, a new high order statistic curve (HOSC) at each fractional frequency point is designed. It is proved that maximal peak interval in HOSC reflects the target information, while the points outside the interval reflect the background. And the value of HOSC relative to the ship is much bigger than that to the sea clutter. Then, search the curve's maximal target peak interval and extract the interval by bandpass filtering in fractional Fourier domain. The value outside the peak interval of HOSC decreases rapidly to 0, so the background is effectively suppressed. Finally, the detection result is obtained by the double threshold segmenting and the target region selection method. The results show the proposed method is excellent for maritime targets detection with high clutters.

Keywords: high order statistic filtering; fractional Fourier domain; maximal peak interval; maritime targets detection.

1. Introduction

In recent years, illegal marine pollution discharge has caused serious ecological damages. Piracy, smuggling, illegal immigration and other phenomena are common. Maritime salvage, defense against illegal ship invasion, and the sea route management become hot spots. Therefore, infrared maritime ship target detection is of great significance to maritime management. However, there are some difficulties in ship target detection. First, the contrast between background and ships is low and the ships' outline is often vague. Second, the distribution of ships' intensities is usually uneven. Third, the sea clutters are moving, complicated and changeable. Last, ships of different materials, such as metal boats and wooden boats, have different characteristics of thermal infrared radiation. To solve the above problems, many algorithms have been proposed in recent years.

Threshold segmentation is a classical method based on pixels, for example, the Otsu method [1], the one-dimension maximum entropy [2], and the two-dimensional maximum entropy [3], their segmentation results all have limitations, because the gray distribution of maritime infrared images is diverse, a single threshold cannot accurately segment the target. For the CFAR method [4], as the gray level of some sea clutters is close to that of ships, the adjustment of windows size still cannot get an ideal segmentation.

Due to the complexity of infrared maritime images, multi-features can more fully represent the target and the multi-feature method draws extensive attention. The gray value, significant mapping value and gradient

*corresponding author
Email address: jhpei@email.szu.edu.cn (Jihong Pei)