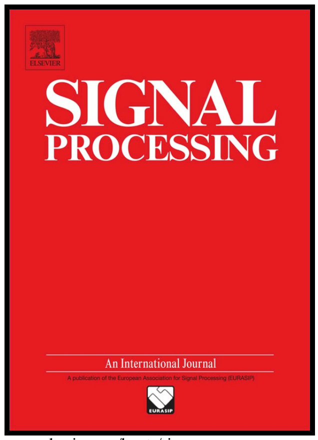
Three GLRT detectors for range distributed target in grouped partially homogeneous radar environment

Yanling Shi



www.elsevier.com/locate/sigpro

PII: S0165-1684(16)30383-8
DOI: http://dx.doi.org/10.1016/j.sigpro.2016.12.030
Reference: SIGPRO6358

To appear in: *Signal Processing*

Received date: 19 July 2016
Revised date: 2 December 2016
Accepted date: 31 December 2016

Cite this article as: Yanling Shi, Three GLRT detectors for range distributec target in grouped partially homogeneous radar environment, *Signal Processing* http://dx.doi.org/10.1016/j.sigpro.2016.12.030

Three GLRT detectors for range distributed target in grouped partially homogeneous radar environment

Yanling Shi
College of Telecommunications & Information Engineering, Nanjing University of Posts and Telecommunications, Nanjing, 210003, China
ylshi@njupt.edu.cn

Abstract

In this paper, we consider the range distributed target detection in partially homogeneous (PH) clutter which displays different statistical properties in adjacent range cells. We propose a group method that adjacent cells with slightly varying statistics are divided into a group. Given the cells group effects on deducing the generalized likelihood ratio test (GLRT), three detectors: one-step group GLRT (1S-G-GLRT), maximum a posteriori estimation group GLRT (MAP-G-GLRT) and two-step group GLRT (2S-G-GLRT) are developed. It is verified that the 1S-G-GLRT and 2S-G-GLRT are constant false alarm rate (CFAR) with respect to the scale parameter of texture and the estimated speckle covariance matrix. The experiments show that, in the simulated clutter, the three proposed detectors behave approximately similarly, all of them outperforming three existing detectors remarkably despite the effects of target models and group strategies. In the real clutter, the 1S-G-GLRT and MAP-G-GLRT have advantages over the detectors without grouping in PH real clutter.

Keywords

Group GLRT, Target detection, Partially homogeneous sea clutter, Radar

Notation

Throughout the paper, unless otherwise stated, lightface lowercase letters denote scalars, boldface lowercase letters stand for vectors, and boldface uppercase letters represent matrices. For a complex matrix $\mathbf{A}$, $\mathbf{A}^{\mathrm{T}}$ and $\mathbf{A}^{\mathrm{H}}$ denote the transpose and conjugate transpose, respectively. For a positive definite matrix $\mathbf{M}$, $\mathbf{M}^{1/2}$ and $\mathbf{M}^{-1/2}$ are the square-root matrix and the inverse of square-root matrix, respectively. For a scalar λ, $E\{\lambda\}$ is the statistical expectation of λ, and $\ln\lambda$ is the natural logarithm of λ. $\hat{\tau}_{MAP|\mathrm{H}_i}$ denotes the maximum a posteriori estimation (MAP) of τ under hypothesis H_i, $i=1,2$. $\hat{\alpha}_k$ denotes the maximum likelihood estimate of α_k. $\Gamma(\bullet)$ denotes the Gamma function. $CN(\mathbf{0},\mathbf{M})$ stands for the complex Gaussian distribution with zero mean and covariance matrix $\mathbf{M}$; $\chi^2(N)$ is the chi-square distribution with N degrees of freedom; and $CW_N(\mathbf{\Sigma},L)$ represents the complex Wishart distribution with parameters L, N and identity covariance matrix $\mathbf{\Sigma}$. Moreover, $\mathbf{I}_N$ is the identity matrix of order N. In addition, we summarize the main symbols and acronyms used in this paper in Table I and Table II, respectively, for ease of reference.

Table I The main symbols used in the paper

Symbol	Definition	Symbol	Definition
$\mathbf{z}_k$	Return vector at the k –th range cell	$\mathbf{p}$	Nominal steering vector
$\mathbf{c}_k$	Sea clutter	α_k	A scalar on target effects.
$\mathbf{g}_k$	Speckle	τ_k	Texture
G	Number of groups, $g=1,2,\cdots,G$	H_g	Total cell number of the 1~ $g-1$ -th groups.
h_g	Cell number of each group, $\mathbf{h}=[h_1,h_2,\cdots,h_G]$	β_g	Scale parameter of texture in the g -th group $\boldsymbol{\beta}=[\beta_1,\beta_2,\cdots,\beta_G]$
η_g	Shape parameter of	ρ	One-lag correlation