WAVEFORM DESIGN FOR SAR USING CRAMER-RAO THEORY

Robert Linnehan[1], John Schindler[2], Leonid Perlovsky[1]
, David Brady[3], Murlidhar Rangaswamy[1]
[1]Air Force Research Lab
[2]Anteon Corporation
[3]Northeastern University

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Abstract: linnehan19165

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The Cramér-Rao Bound (CRB) establishes a lower bound on the error variance of an unbiased parameter estimate. In this paper CRBs are derived for target parameter estimates using synthetic aperture radar (SAR). The design of efficient radar waveforms must account for the phenomenology of targets and clutter. Since radar waveforms are usually designed for specific algorithms, the designer faces a problem when the method of processing is not specified. The CRB offers an approach for resolving the difficulty. The CRB can be used to establish optimal waveform-dependent performance bounds independently from signal processing algorithms.

In a simple case of a flat, horizontal area, a SAR image can be regarded as the estimation of complex scattering coefficients at fixed, equally spaced points on the ground. We first consider the CRB for target reflectivity with the assumption that the sensor position is exactly known with respect to all scatterers on the ground, the only source of random error being measurement noise. Two methods in this case are presented. The first method assumes simultaneous estimation of all scatterers in the SAR field of view. The second method assumes estimation of only the scatterer of interest (the target) and treats all other scatterers as noise with known moments. By allowing random positioning of the scatterers in azimuth, range and height we explore the consequences of diversity in the radar aperture with respect to the CRB.

The CRB development is extended to a parameter of greater interest: target height. In this case scatterer positions are considered known only in the azimuth dimension, and height is assumed to be estimated jointly with ground range for a limited field of scatterers. Here we show that height can in fact be estimated by including vertical excursion in the aperture.

Motivation for this theoretical study is to aid the SAR research and development community. Solving lower error bounds on SAR parameters provides a measure to ensure efficient and effective algorithms or systems, prior to their development. Furthermore, Cramér-Rao theory can be used as a reference to analyze the performance of algorithms and systems already in existence.

1. (a)
Robert Linnehan
Air Force Research Laboratory
Hansom, AFN, MA
01731 USA
robert.linnehan2@hanscom.af.
(b) 781-377-9842
(c) 781-377-8984

2. F - Wave Propagation and Remote Sensing

3. (a)

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