ERROR VARIANCE ESTIMATION IN BAYESIAN REFRACTIVITY FROM CLUTTER INVERSION

Caglar Yardim[1], Peter Gerstoft[2], William S. Hodgkiss[1 2], Ted Rogers[3]

[1]Electrical and Computer Engineering Department, University of California, San Diego
[2]Marine Physical Laboratory, Scripps Institution of Oceanography, University of California, San Diego
[3]Atmospheric Propagation Branch, SPAWAR Systems Center, San Diego, CA

Abstract Submission Form

2006 National Radio Science Meeting

Abstract: yardim14595

Date Received: September 21, 2005

1. (a) caglar yardim
   MPL-SIO-UCSD 0238
   9500 Gilman Drive
   La Jolla, CA
   92093 USA
   cyardim@ucsd.edu
   (b) 858 534 0574
   (c) 858 534 7641

2. C - Signals and Systems
3. (a)
4. C - Contributed Paper
5. No special instructions

Error Variance Estimation in Bayesian Refractivity from Clutter Inversion

A common occurrence in low altitude sea-borne radar applications is ducting. Its effects can be calculated using the modified index of refraction (M-profile). An approach for estimating M-profiles is Refractivity From Clutter (RFC). In a heavily ducted environment, there is strong interaction with the sea surface and sea clutter is much higher than it would be in a standard atmosphere. Therefore, radar clutter returns can be a rich source of information about the environment the radar is operating in. RFC uses this clutter return to estimate the modified refractivity profile.

The inversion problem is formulated in a Bayesian framework. A likelihood formula is defined using the radar clutter return and a non-informative prior and a range-independent M-profile is used for simplicity. Maximum a posteriori solutions are calculated by use of a genetic algorithm (GA) while Bayesian minimum mean square error estimates and other necessary multi-dimensional Bayesian integrals are calculated using a hybrid genetic algorithm Markov chain Monte Carlo (GA-MCMC) sampler. An electromagnetic split-step fast Fourier transform parabolic equation propagation model is used as a forward model. The posterior probability distributions of the unknown duct parameters are estimated. Then they are used to calculate propagation factors and coverage diagrams, which can be incorporated into radar performance predictions.

The likelihood depends on the probability distribution of the errors. The errors are assumed to be Gaussian distributed with zero mean and a full covariance matrix. Often, the errors are assumed to be independent, identically distributed with constant variance. However, this actually is not an accurate model in RFC. The error variance changes with range and errors can also be correlated depending on the propagation conditions. Based on the observed statistics of the errors, various methods of obtaining the covariance matrix will be presented. Their effects on the overall inversion results will also be discussed.