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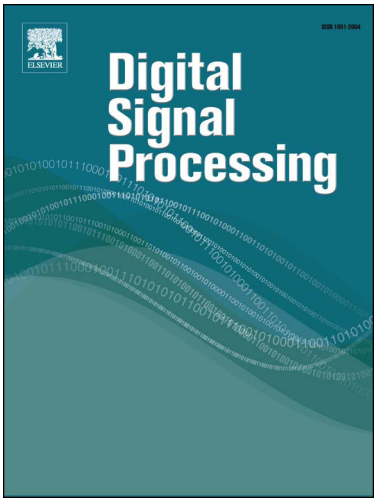

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Sea Clutter Modeling using an Autoregressive Generalized Nonlinear-Asymmetric GARCH Model

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Abstract

The sea clutter modeling is critical to the radar design and assessment of relevant detection algorithms. In this paper, we investigate a family of generalized autoregressive conditional heteroscedastic (GARCH) processes to model the sea clutter as a time series, in which the current variance is dependent on historical information. The most general model (so-called the ALLGARCH model) provides more flexible variance structures to model non-Gaussian, asymmetry, and nonlinear properties of the clutter. However, after going through the usage of the ALLGARCH model, we find that it is not very suitable because the coefficients of the model, which are numerous, would be difficult to estimate in a real-time operating environment. Meanwhile, we find that some of the coefficients are negligible under almost all kinds of sea environments and weather conditions. Motivated by these observations, we propose a novel GARCH model for sea clutter modeling, which is a generalization of the nonlinear-asymmetric GARCH (NA-GARCH) model. Considering the correlation between adjacent clutter returns, autoregressive terms are also introduced. By systematically analyzing practical sea clutter data under different sea environments, we demonstrate that the proposed model achieves comparable fitting effect to some commonly used statistical models. Also, we develop the corresponding generalized likelihood ratio test (GLRT) algorithm for the new model. Numerical simulations exhibit that the proposed detector achieves higher probability of detection, comparing with the AR-GARCH detector.

Keywords: Radar, sea clutter, GARCH, nonlinearity, asymmetry.

1. Introduction

Sea clutter is the electromagnetic wave backscattering from ocean surface, when illuminated by radar. Both airborne and surface radars usually op-

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