EFFICIENT NON HOMOGENEOUS CFAR PROCESSING

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***Abstract*— In this work a new radar detection method is proposed, the Cell Average Neural Network Constant false Alarm Rate (CANN CFAR), which can be used with Weibull distributed non homogeneous radar returns. This processor combines Maximum Likelihood estimation method with Neural Networks for the clutter parameter estimation, resolving homogeneity and determining clutter bank transition points and size. To characterize its performance, probability of detection is evaluated using Monte Carlo simulations and compared to other efficient CFAR schemes. As a result, CANN CFAR detection has better performance than conventional CFAR processors, especially when detecting targets located near clutter heterogeneities. An additional advantage of the proposed technique is its efficiency when determining clutter transition points, bank size and threshold setting. This efficiency translates in lower computation time than other CFAR algorithms, mostly considering real time processing.**

***Keywords*— Neural Networks, threshold, CFAR, clutter, detection, statistics.**

I. INTRODUCTION

In the case of naval medium range radars operating at S, C and X bands with pulse repetition frequencies (PRF) between 750 and 5000 Hz, available time between each radar return goes from 1 to 0.2 mseg. respectively. When working in real time, this is the available interval to carry out several processes such as signal capturing, filtering, detection, tracking, etc. It is well known that modern technologies like FPGA and digital signal processors (DSP) execute algorithms at very high speed. However, several radar processing tasks, as for example CFAR detection, require iterative algorithms that have slow convergence. Then, it is essential that these processing tasks be as efficient and fast as possible.

We are especially interested on the detection process carried out using constant false alarm rate (CFAR) in heterogeneous clutter. In a CFAR processor, the detection threshold is computed so that the radar receiver maintains a constant pre-determined probability of false alarm (P_{fa}) (Mahafza, 2000). In general, the radar return is completely unknown, and must be modeled in order to study its behavior and to find an appropriate CFAR detector. The herogeneous clutter is usually modeled as a sharp transition from one region to another, with a different distribution. In this work, the Weibull distribution is chosen to model heterogeneous radar returns. This distribution has been widely used to model both land and sea clutter and can generally be matched to experimental data over a wide range of conditions (Minkler and Minkler, 1990). Its probability density function (PDF) is known to represent sea and ground clutter at low grazing angles or at high resolution situations (Ravid and Levanon, 1992). It is characterized by two parameters: scale and shape.

Several detection schemes that are available take into account this two- parameter heterogeneous clutter model. The most notable is the Log-T (LT) detector proposed by Goldstein (Gandhi *et al.*, 1995; Goldstein, 1972; Weber and Haykin, 1985). For the two-parameter Weibull estimation problem, some authors assumed one parameter known and estimate the other. That is the case when this kind of distribution is used with the well known CFAR detection, as for example with cell average (CA) and order statistics (OS) CFAR processors (Gandhi and Kassam, 1988; Rohling, 1983).

A CFAR algorithm in which the parameters are estimated using Maximum Likelihood (ML CFAR), was developed by Ravid and Levanon (1992). The main objective was to reduce extensive CFAR loss exhibited by some conventional CFAR processors. However, this algorithm is more computational intensive than the other approaches.

Other specially interesting scheme is the *Range Heterogeneous* (RH) CFAR proposed by Doyuran and Tanik (2007). RH CFAR is suitable for non Rayleigh and range heterogeneous clutter. This algorithm esti-