IMPROVED NEURAL NETWORK BASED CFAR DETECTION FOR NON HOMOGENEOUS BACKGROUND AND MULTIPLE TARGET SITUATIONS.

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Abstract— The Neural Network Cell Average - Order Statistics Constant False Alarm Rate (NNCAOS CFAR) detector is presented in this work. NNCAOS CFAR is a combined detection methodology which uses the effectiveness of neural networks to search for non homogeneities like clutter banks and multiple targets within the radar return. In addition, the methodology proposed applies a convenient cell average (CA) or order statistics (OS) CFAR detector according to the context situation. Exhaustive analysis and comparisons show that NNCAOS CFAR has better performance than CA CFAR, OS CFAR and even CANN CFAR detectors (the latter, a previously proposed neural network based detector). Furthermore, it is verified that the new proposal presents a robust operation when maintaining a constant probability of false alarm under different radar return situations.

Keywords— Neural Networks, threshold, CFAR, clutter, multiple targets, detection.

I. INTRODUCTION

In a previous work, the CANN CFAR was presented; it performs an homogeneity analysis of the radar return clutter by means of a neural network (NN). It was demonstrated that the NN homogeneity test has better performance when determining non homogeneities within a radar return than classical methods (Gálvez et al., 2011).

Some characteristics of classical CFAR algorithms are the following:

- The CA CFAR processor is the optimum CFAR processor (maximizes detection probability) in a homogeneous background for certain well defined conditions.\(^1\)
- The OS CFAR processor exhibits some loss of detection power in homogeneous noise background compared with the CA but its performance in a multiple target environment is clearly superior (Gandhi and Kassam, 1988).
- Multiple target situations, lead to almost negligible losses in OS CFAR processing compared with conventional CFAR processing (Rohling, 1983).
- The OS CFAR processor is unable to prevent excessive false alarm rate at clutter edges, unless the threshold estimate incorporates the ordered sample \(k\) near the maximum, that is unless \(k\) is very close to \(M\); but in this case the processor suffers greater loss of detection performance (Gandhi and Kassam, 1988).

Gandhi and Kassam (1988) suggest that it may be interesting to consider adaptive versions of the OS schemes. For example, in the OS CFAR scheme, we may set the value of the \(k\)th sample adaptively based on some procedure that infers the background situation. This procedure will simply test whether the background is homogeneous or contains regions of clutter transitions (Gandhi and Kassam, 1988). The difficulty in finding one processing algorithm that accommodates the variety of environments encountered in practice has led to the development of composite processors (Smith and Varshney, 2000).

Taking advantage of the above classical CFAR characteristics, the NNCAOS CFAR offers the possibility of making an on line classification to each radar return by means of NN, with the purpose of applying the appropriate CFAR process over each range cell. This processor includes the same efficient NN block as the CANN CFAR (Gálvez et al., 2011) to estimate homogeneity in the case of clutter banks (CB), and incorporates an additional NN block to find out whether the radar return contains multiple targets (MT). These two NN blocks search for non homogeneities CB and MT within the radar return that allow to define suitable contexts for CFAR detection.

This work is organized as follows. In section II, some related basic detection models and notation are presented. The novel NNCAOS CFAR method is explained in Section III. A complete performance analysis, including simulation and comparisons, is presented in Section IV. Finally, the conclusions are expressed in Section V.

II. SOME BASIC CONCEPTS

In this section homogeneous and non homogeneous radar returns containing CB and MT are studied. A brief description of the model used, the Weibull radar return, is made. In addition, two classic CFAR detection