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Design and Implementation of a Novel Combined CFAR/SLB System

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***Abstract:** In this paper, a novel approach of combined Cell Averaging-Constant False Alarm Rate (CA-CFAR) detector and Sidelobe Blanking (SLB) system is proposed. CFAR based threshold estimation using a Generalized Automatic Sliding Window technique (GASW) is proposed to reduce the memory access and exploits pre-computed values for setting the new threshold for adjacent cell. The designed architecture is fully reconfigurable in terms of the number of reference and guard cells as well as the sampling frequency and the coherent processing interval (number of integrated pulses).*

***Keywords:** - CA-CFAR, SLB, GASW, architecture, reconfigurable, Generalized.*

I. INTRODUCTION

The purpose of CFAR detectors is to detect the threshold which should be adaptive to the variation of clutter or noise to maintain a constant false alarm rate. One such detectors is the well-known Cell Averaging *CFAR (CA-CFAR)* processor [1]. The interference pulses enter the radar receiver via the antenna sidelobes. To avoid sidelobe interferences of impulsive type, the radar usually employs a sidelobe blanking (*SLB*) system [2]. Advanced theoretical aspects of *CFAR* detection and *SLB* system are being well treated in the literature. The combined SLB/CA-CFAR system is not yet implemented. The intensive computational requirements, due to the high data rate in radar signal processing, cannot be accomplished only by the technology improvements but also by software architectures based on code optimisation models. In this paper, a novel approach [4] for real time implementation of a combined *CA-CFAR* detector and the classic *SLB* system is proposed. An optimisation of the *CA-CFAR* threshold computation is also proposed using a new technique called the Generalized Automatic Sliding Window (*GASW*).

II. PROPOSED ARCHITECTURE

The main and the auxiliary channels have their own antennas, receivers R_m and R_x, square law detectors and Analogue to Digital (A/D) converters. The corresponding value of the video signal is compared to the CA-CFAR threshold level to determine whether a target is present or not in the cell under test,. If this value is above the threshold, it is assumed that the target is detected in that cell, and the position is determined by the corresponding range.

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A blanking signal is generated between the video signals at the output of the square-law detectors in the two channels, when the ratio *U/V* is greater than a suitable blanking threshold *F*. This signal is used to control the decision output of the *CA-CFAR* detector through a gate.

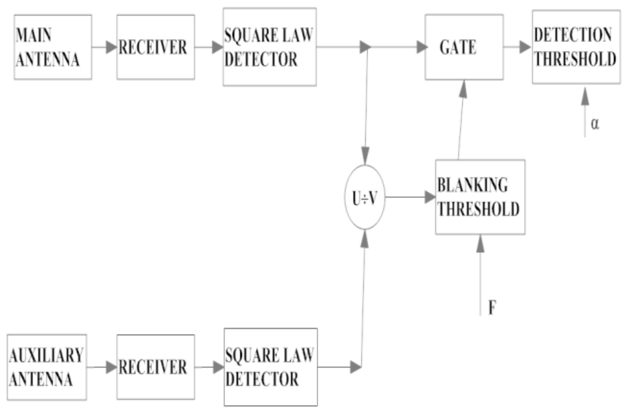

Figure 1. Proposed CA-CFAR/SLB Architecture

The SLB system in Figure.1 prevents the detection of strong targets and interference pulses entering the radar receiver via the antenna sidelobes. A target in the main beam produce a large signal in the main receiving channel and a small signal in the auxiliary receiving channel. A proper blanking logic allows this signal to pass. Targets and/or jammers *J* situated in the sidelobes give signal with small amplitude main but large auxiliary signals so that these targets are suppressed by the blanking logic. It is assumed that the gain G_A of the auxiliary antenna is higher than the maximum gain *Gsl* of the sidelobes of the radar antenna. The performance of the SLB may be analyzed by looking at the different outcomes obtained as a consequence of the pair *(u,* v) of the processed signals. Three hypotheses have to be tested: (1) the null hypothesis H_0 corresponding to the presence of noise in the two channels, (2) the H_1 hypothesis pertaining to the target in the main beam and (3) the H_2 hypothesis corresponding to target or interference signal in the sidelobe region. The null and H_1 hypotheses corresponds to the usual decisions of "no detection" and "target detection," respectively.

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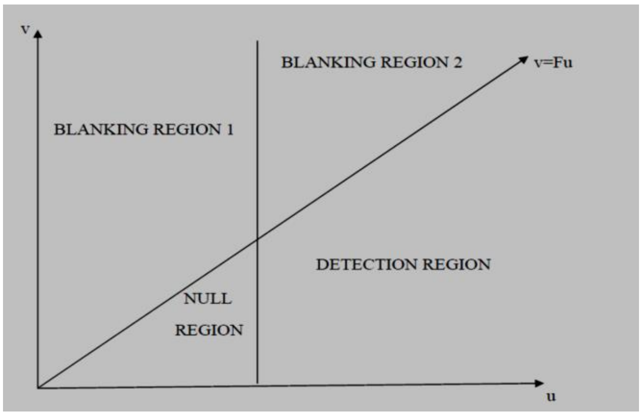

Figure 2. Different Regions of Operations in SLB

The blanking command is delivered when H_2 is detected. SLB performance can be expressed in terms of the following probabilities: (1) The probability P_B of blanking a jammer in the radar sidelobes, which is the probability of the associated the received signals (u, v) with H_2 when the same hypothesis is true; P_B is a function of the jammer-to-noise ratio (JNR) value, the blanking threshold F and the gain margin p = G_A/G_{sl} of the auxiliary antenna with respect to the radar antenna sidelobes. (2) The probability P_{FA} of false alarm, which is the probability of associating the received signals (w, v) with the hypothesis H_1 when the true hypothesis is H_0.P_{FA} is a function of the detection threshold a normalized to the noise power level and of the blanking threshold F. (3) The probability P_0 of detecting a target in the main beam, which is the probability of associating the received signal (u, v) with H_1 when the same hypothesis is true; P_0 depends, among other things, on the signal-to-noise power ratio SNR, P_{FA}, and the blanking threshold F. (4) The probability P_{FT} of detecting a false target produced by a jammer entering through the radar sidelobes. P_{FT} is the probability of associating (w, v) with H_1 when H_2 is true; it is a function JNR1 the thresholds a and F, and the gain margin p. (5) The probability P_{TB} of blanking a target received in the main beam. This is the probability of associating (M, v) with H_2 when H_1 is the true hypothesis. P_{TB} is related to SNR, F, and the auxiliary gain
w = G_A/G_t normalized to the gain G, of the main beam.

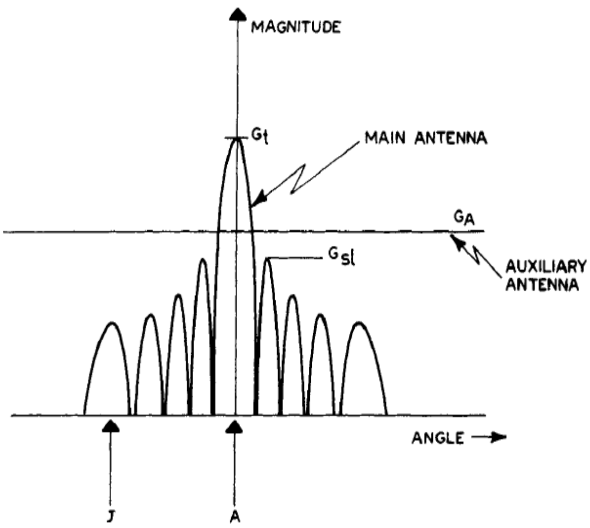

Figure 3. Main and Auxiliary Antenna Patterns of SLB (IEEE 1968)

III. RESULTS AND DISCUSSIONS

The numerical results of the proposed implementation of the CACFAR/SLB scheme configuration is shown in Figure.4. In real time all samples are considered.primary consideration is given to the achievement of a minimum processing time for the CA-CFAR threshold estimation using the GASW technique's. Declared samples as being targets by the CA-CFAR detector will undergo a SLB processing time depends on the number of targets. The CA-CFAR detection and SLB system are carried out for eight hundred samples,32 reference cells,2 guard cells are taken,whenever target is above the threshold,CA-CFAR will detect the target and false targets are eliminated shown in Figure.5.When the target is surrounded by noise it cannot be detected hence target cannot be detected shown in Figure.6.

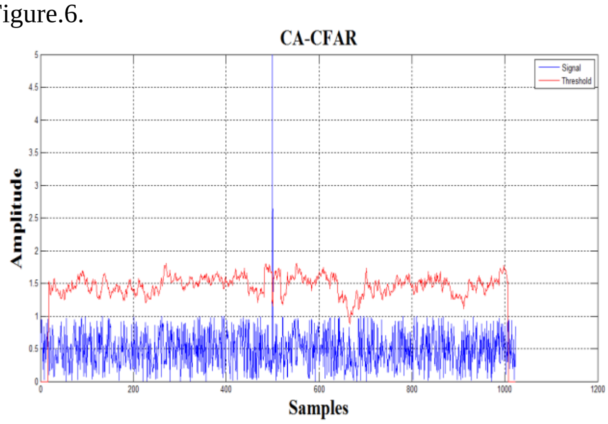

Figure 4. CA-CFAR Output

Figure 5. CFAR Output in the Presence of False Alarms

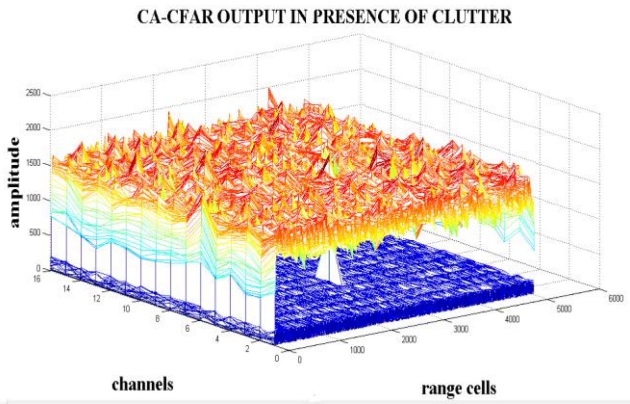

Figure 6 Target Suppressed by Noisy Environment.

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IV. CONCLUSION

An efficient implementation of a combined *CA-CFAR /SLB* system with non coherent integration for adaptive target detection using computing time saving method for real time implementation. The high performance of the proposed system was feasible thanks to the employment of the GASW technique which efficiently uses data to diminish the memory accesses and reutilize pre-computed values to compute the new thresholds for adjacent cells. The proposed system allows the interference elimination and increases the effectiveness of the CA-CFAR detector. A new adaptive sidelobe blanking combined with a CFAR is proposed to prevent acquisition of strong target in antenna sidelobes and also to reject pulsed interference originating in the sidelobes with maintaining constant false alarm rate.

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