A DETECTION METHOD OF HIGH RESOLUTION RADAR TARGETS BASED ON POSITION CORRELATION

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Abstract This paper studies a detection method of targets of high resolution radar operating at the band of millimeter-wave (32~38GHz) under the background of the clutters, and proposes a new nonparametric detection method, which not only does less computation, but also is able to detect multiple extended targets radially distributed along distance "corridor", based on the position (range) correlation information of one-dimensional range images (or called range profiles) of high resolution radar targets. The experimental results, on the real echo data of tank illuminated by the millimeter-wave stepped frequency high resolution radar, have certified that such a method presented in this paper is a very effective detection method for multiple extended targets.

Key words High resolution radar; Millimeter-wave clutter; Range profile; Position correlation; Scattering centre; Nonparametric detection

I. Introduction

Under the millimeter-wave high resolution radar (MW-HRR), the radar returns of targets are the one-dimensional range images (also called range profiles) formed by multiple scattering centres of the targets. Moreover, the statistical distribution of amplitude of radar clutter deviates evidently from Rayleigh distribution. In particular, the amplitude distributions of those irregular clutter sources like hill, puddle, etc. are more complex. If they are modeled by a double-parameter distributed model, the corresponding parameters are also variables as time and space. So under the MW-HRR, those conventional target detection methods can not be used to detect those genuine target signals. However, how is such a problem solved? Some authors proposed applying the maximum likelihood method to first estimating the parameters of the double-parameter distributed model, after that, those parametric detection methods are employed to detect useful target signals. However, such an approach cannot meet the requirement of real-time processing, and those estimated parameters are biased for the situation of limited data. If such a problem is solved by means of the greatest of constant false alarm rate (GO-CFAR), the smallest of CFAR (SO-CFAR), the weighted cell averaging CFAR (WCA-CFAR) or the trimmed mean CFAR (TM-CFAR) detectors, due to the clutter edges generated by woods, hill and puddle, etc., there exists a large number of sharply peaked pulse disturbances, so even if infinite clutter cells are selected, the estimated clutter power is also biased, resulting in the detection performance being affected. Specifically, for the extended targets under the HRR, some protecting cells have often to be set up to improve the performance of the CFAR processing.
In addition, if the order statistics CFAR detector is employed, although better detection performance can be obtained in the case of clutter edges or multiple targets, the loss of the CFAR processing will increase\cite{5-8}.

It is well known that radar operators, although being of no adaptive ability like machines equipped with certain algorithms, could take advantage of visual redundancy to determine the tracks of targets, and find(detect) the genuine target within several sweep cycles. It was found\cite{9} that the mechanism of man’s brain detecting outside objects is associated with the oscillation of 40~60Hz in the man’s visual neural system. Such an oscillator could utilize correlation information from those sensed objects to perform some united detection and decision of the outside objects. This paper will utilize the redundant principle of brain visual information processing to propose an united detector based on the position correlation information of strong scattering centres in range profiles of targets.

II. The Recording of Position Information Based on the First Threshold

The returns of targets or clutter in certain direction look like a distance “corridor” relative to the HRR(Fig.1). The task for the HRR is to search and find any threatening targets on the distance “corridor”.

![Fig.1 The distance “corridor” under high resolution radar](image)

Because there exists always the loss of the CFAR processing in radar target detection, while the signal-to-clutter ratio\((S/C)\) is generally higher in the case of the HRR\cite{8}, so we will not consider the CFAR processing. In general, the anti-tank seekers operate at the worst environment. Moreover, for disguised targets like corner radiators, etc., there are probably fewer strong isolated scattering centres. Whereas the radar returns of artificial military targets like tanks(their radial sizes are of 5~10m) are formed by a string of continuing strong scattering centres. So, according to the features of the MW-HRR targets and clutter under such an environment, we might discriminate artificial targets and clutter like corner radiators based on difference between the numbers of their corresponding continuing strong scattering centres. In consequence, an united detection method based on position correlation is proposed.

1. The selection of the first threshold

The difference between the detector based on the first threshold and the detector based on the binary accumulation is that the former is conducted within one sweep cycle, the latter within multiple sweep cycles. Furthermore, the detector based on the first threshold is also needed to record the position information of strong scattering centres whose magnitudes exceed the first threshold, which will be convenient for in the sequel the united detector