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Sequential Detection of Target Trajectory Using the Decision Statistics of Pips

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Abstract—Algorithms of target trajectory detection using the likelihood functions of the pip with maximum decision statistic and all the pips in the tracking strobe have been synthesized on the basis of the Wald sequential criterion. These algorithms were analyzed using the statistic simulation for the case of detecting the target trajectory from data of surveillance radar measuring the range and radial velocity of target.

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INTRODUCTION

One of the main objectives of the secondary processing of radar data is the detection of target trajectory. It consists in making a more reliable decision on the presence of target in the coverage area of radar prior to passing the target for tracking that allows the computational costs to be substantially cut in creating the secondary processing systems of radar data.

The algorithms of target trajectory detection using the heuristic "l/n" criteria [1] and finding wide practical application are referred to the category of simplest algorithms. The processing of obtained measurements in such algorithms is performed within the limits of selected window.

The optimal decision-making at the fixed number of scans implies the use of the Neumann–Pearson criterion [2]. In this case the last scan is used to determine the likelihood ratio that is compared with the threshold, the computation of which often represents a sufficiently complex task.

The Wald's criterion taking into account the sequential nature of data arrival has found a widespread use for optimal detection of target trajectory [1, 3]. In this case, the likelihood ratios are calculated at each step and compared with two thresholds determined from the specified probabilities of the true and false detection of target trajectory. The sequential method enables us to cut the average time of target trajectory detection as compared with the optimal decision-making techniques at the fixed number of scans that makes it possible to reduce the total quantity of tested hypotheses about the presence of undetected targets in the scanned area.

The solving of the problem of target tracking in clutter involves the wide use of the "strongest neighbor" method [4] and the method of probabilistic integration of data [5], which utilize the decision statistics of pips obtained in the optimal receiver of the primary processing of signals. That is why, it is a topical task to design algorithms for sequential detection of target trajectory using the decision statistics of pips obtained during the primary processing of radar data.

This paper presents the algorithms designed for sequential detection of target trajectory using the likelihood functions of the pip with the maximum decision statistic and all pips in the tracking strobe. These algorithms were analyzed using the statistical simulation for the case of detecting the target trajectory from data of surveillance radar measuring the range and radial velocity of target.

STATEMENT OF THE PROBLEM

Each scan in the optimal receiver of the primary processing of signals involves the target detection by comparing the decision statistics in each resolution cell with input threshold H_{in}, the selection of which is performed in accordance with the required probability of false alarm F_{in}; in addition each scan also involves the measurement of target coordinates. In case of target detection, a pip is generated and also the value of obtained decision statistic is stored.