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Peculiarities of Airway Processing when Tracking Air Targets Observed at Small Eleveation over Underlying Surface

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Abstract—The paper considers peculiarities of airway processing of air targets flying rapidly at small elevation angles, with regard for radio wave propagation over the underlying surface, and with high requirements to accuracy and reliability of the route data. The work includes results of simulation permitting to assess effectiveness of the approaches suggested.

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Effectiveness of route processing of air targets, detected in the near zone at small elevation angles above the underlying surface, can be determined via several most important criteria, such as route initiation time instant, the time of acquisition of airway data with a required accuracy, and reliability of tracking without reset. These criteria are especially important for radar systems with mechanical scanning in azimuth, where the minimum period of target's sounding is dictated by antenna rotation conditions.

The traditional approach to route processing [1] includes two steps: (a) detection of trajectory and transfer of the target to the tracking mode of operation; and (b) refinement of coordinates and motion parameters in the process of route tracking.

Using this approach, the route acquisition stage begins with shaping the strobe of capture around the newly detected blip. Dimensions of the strobe are dictated by a priori data about the target's maximal speed. All this leads to indeterminacy in pick-up of the true blip in the strobe because of its large dimension and, as a consequence, to possibility of initiating false routes. The presence of false marks (blips) in the strobe may be explained by residual passive interference arising from the underlying surface. A typical countermeasure for diminishing the number of new false routes is elaboration of the capture logic rules and introduction of the procedure of trajectory confirmation [1, 2]. In turn, it results to an increase (up to 3–4 sounding cycles) in the decision-making time necessary for detection of the new route and for establishment of initial estimated of trajectory parameters.

In the case of tracking of targets flying at small elevation angles above the underlying surface, the accuracy of determination of coordinates and motion parameters, and the reliability of the airway routing depend much on the effect of multibeam propagation of radio waves. Because of coherent summation of the direct field from the target, and of the backward one from the underlying surface, some additional components of measurement errors may arise, especially in the elevation coordinate, and also missing measurements, when the target enters the area of interference gaps.

Judging by the data in concern with attainable accuracy of measurement of elevation coordinate by different methods [3], none of the methods gives truly reliable information about target's altitude.

Improvement of accuracy of coordinate estimates with the aid of optimal algorithms of the extended Kalman filter type is hardly possible because of non-Gaussian nature of measurement errors of the elevation coordinate [4, 5].

The most commonly encountered decision to this problem, as applied to a radar with all-around rotation, is tracking in two measurable coordinates—range and azimuth. Then the beam axis position serves as an estimate of the elevation coordinate. However, the problem of estimation of target's altitude still persists.

The purpose of the present work is selection of the structure of the algorithm for filtration of coordinates and motion parameters of targets, observed at small elevation, under conditions of multibeam propagation of radio waves. Another purpose consists in considering a multivariant optimized algorithm for trajectory detection based on many hypotheses.