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Necessity and Possibility of Taking Into Account of Space and Time Domain Parameters of Interfering Reflections from the Underlying Surface in the Design of Anti-Interference Airborne Radar Stations for Air Surveillance

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Abstract—The development of anti-interference radar stations is impossible without the knowledge of interference parameters. The main difficulty of designing of anti-interference airborne radar stations for air surveillance is associated with the suppression of reflections from the underlying surface. In order to estimate the azimuthal-velocity parameters of reflections from the underlying surface in airborne surveillance stations with unambiguous distance measurement we implemented the simulation model of digital output signals of a coherent radar receiver. During the model development we used digital maps and an antenna with low side lobe level. With the help of simulations we have justified the necessity and possibility of development of anti-interference airborne radar stations with low-channel design and simultaneous application of direct inter-period and inter-channel correlation connections.

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INTRODUCTION

The problem of all-sector detection of low-speed low-altitude small-size air targets using active airborne surveillance radar stations has not been sufficiently investigated theoretically and experimentally. Difficulties associated with the solution of this problem are connected with the combined influence of clutter reflections from the underlying surface and of various external electromagnetic radiations on the radar station. The utilization of airborne radar stations with high and medium frequencies of sounding signals repetition complicates the solution of this problem in the radar sense. A detailed survey of various airborne radar systems of long-range detection of air targets is given in [1]. None of these systems has solved the problem of all-sector radar detection of air targets.

Potential solutions for this problem are available in the "Hawkeye" system, which is performed within the framework of its modernization. However, the detection capabilities of this system in the case of flight over densely populated and industrial areas are far from the potential ones.

In this paper by means of simulations using digital maps we have demonstrated the possible direction of solution to this problem in relation to the airborne radar stations with unambiguous range measurement. One should note a special role of the utilized carrier wave band of the sounding signal in solution to the problem.

The interference immunity challenges are well-known and they are associated with the fact that in the airplane radars for air surveillance the parameters of interfering reflections from objects and targets are not separated on the spatial and time-domain (frequency) ones except for the narrow front and backward sectors in the direction of the carrier flight. This effect appears most sufficiently in the case of receiving of the reflection from orthogonal directions with respect to the velocity vector of the carrier.

For example, for the carrier wavelength $\lambda = 23$ cm, carrier velocity $V_c = 200$ m/s and antenna main beam width in the azimuthal plane $\Delta\beta = \lambda/L_h$, where $L_h = 7.5$ m is the horizontal effective size of the antenna aperture, the far-field reflections from the underlying surface vary in the Doppler frequency by the value $2V_c/L_h > 53$ Hz, instead of the expected 19 Hz (the packet spectrum for the surveillance rate of 10 s). In this case the angle of boresight elevation is close to zero and the signals are received from the directions, which differ by the beam width at the half-power level.