

## METHODOLOGY FOR ASSESSING THE EFFECTIVENESS OF MODELING THE AIR SITUATION

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### I. INTRODUCTION

When developing the technology of analytical-simulation modeling of the air situation, an important stage is the assessment of the values of the indicators of the effectiveness of its modeling, which will make it possible to make a well-founded conclusion about the degree of correspondence of the simulated air situation to the real situation.

It is quite obvious that to assess the effectiveness of modeling requires an appropriate methodology that takes into account the specifics and features of the subject area under consideration. The purpose of the work is to develop a methodology for assessing the effectiveness of modeling the air situation.

### II. THE SOLUTION OF THE PROBLEM

The results of the studies carried out aimed at developing a method for modeling the air situation, its conceptual model and substantiating the indicators for assessing the effectiveness of modeling the air situation showed that it is advisable to implement the methodology for assessing the effectiveness of modeling the air situation in three stages:

- the stage of assessing the effectiveness of modeling the air situation at the level of primary processing of radar information;
- the stage of assessing the effectiveness of modeling the air situation at the levels of secondary and tertiary processing of radar information;
- the stage of assessing the effectiveness of modeling the air situation, in general, according to the generalized indicator.

The stage of evaluating the effectiveness of modeling the air situation at the level of primary processing of radar information. At this stage, the parameters of the accuracy and reliability of modeling are calculated, characterizing the correspondence of the parameters (range, azimuth, elevation, radial speed) of the radar marks of the simulated air targets to the parameters of the radar marks of real air targets, and this compliance is checked.

The stage is based on the application of methods for testing hypotheses about the parameters of the probability distribution law and statistical estimation of the parameters of the probability distribution laws of random variables [1].

To implement the calculations, it is necessary to carry out a number of tests when simulating several variants of the air situation either in the form of field experiments or using a simulation model of the operation of the radar station.

At this stage of assessing the effectiveness of modeling the air situation, quantitative values of the indicators of accuracy and reliability of modeling are determined, characterizing the correspondence of the parameters of the radar marks of the simulated air targets to the parameters of the radar marks of real air targets, namely:

- estimates of the parameters of the empirical law of probability distribution of the parameter of the radar mark of the simulated air target;
- evaluating the accuracy of estimates of the parameters of the empirical law of probability distribution of the parameter of the radar mark of the simulated air target;
- assessing the reliability of estimates of the parameters of the empirical law of probability distribution of the parameter of the radar mark of the simulated air target.

These assessments make it possible to make a well-founded conclusion about the degree of correspondence of the simulated air situation to the real air situation at the level of primary processing of radar information.

The stage of evaluating the effectiveness of modeling the air situation at the levels of secondary and tertiary processing of radar information. At this stage, it is planned to carry out a number of statistical tests of the operation of the radar station when it is exposed to environment simulation tools for several variants of the virtual environment.

Evaluation of the effectiveness of modeling the air situation at the levels of secondary and tertiary processing of radar information is based on a comparison of reference information about the air situation and trajectory information issued by the radar station.

The input data for this stage of the proposed methodology are data on the reference air situation and data on the results of the operation of the radar station.

At this stage, assessing the effectiveness of modeling the air situation:

- by the method of simulation or semi-natural modeling, tests are performed several times for the same reference air situation;
- after each test, the identification of the trajectory information issued by the radar station and the reference trajectory information is performed;
- based on the results of identifying information about the trajectories of air targets, numerical values of indicators of trajectory information characteristics and information capabilities of a radar station are determined, which, in fact, are indicators of the effectiveness of modeling the air situation at the levels of secondary and tertiary processing of radar information;
- after the entire test cycle, the obtained values of the indicators are averaged;
- on the basis of the averaged values of the efficiency indicators for modeling the air situation, a substantiated conclusion is made about the degree of correspondence of the simulated air situation to the real air situation at the levels of secondary and tertiary processing of radar information.

The stage of assessing the effectiveness of modeling the air situation, in general, according to the generalized indicator. In the presence of random factors, the area of required values of efficiency indicators for modeling the air situation at the levels of primary, secondary and tertiary processing of radar information can be specified in the form of a fuzzy set. Then the probability of achieving the required level of efficiency of modeling the air situation is determined as the mathematical expectation of the membership function.

When calculating the generalized indicator by the method of statistical tests, a given membership function of a fuzzy set of values of modeling efficiency indicators at the levels of primary, secondary and tertiary processing of radar information is assumed.

The calculated value of the generalized indicator of the effectiveness of the simulation of the air situation allows us to make a well-founded conclusion about the degree of correspondence of the simulated air situation to the real air situation, in general.

### III. CONCLUSIONS

As a result of the research carried out, a three-stage technique for assessing the effectiveness of modeling the air situation has been developed, which allows:

- at the first stage – to determine the quantitative values of the parameters of the accuracy and reliability of modeling, characterizing the correspondence of the parameters of the radar marks of the simulated air targets to the parameters of the radar marks of real air targets, and, on their basis, make a well-founded conclusion about the degree of correspondence of the simulated air situation to the real air situation at the level of primary processing of the radar information;
- at the second stage – to determine the quantitative values of the parameters of the accuracy and reliability of modeling, characterizing the correspondence of the motion parameters and trajectories of the simulated air targets to the motion parameters and trajectories of real air targets, and, on their basis, make a substantiated conclusion about the degree of correspondence of the simulated air situation to the real air situation at the levels of secondary and tertiary processing of radar information;
- at the third stage – to determine the quantitative value of the generalized indicator of the effectiveness of modeling the air situation, and, on its basis, make a well-founded conclusion about the degree of correspondence of the simulated air situation to the real air situation, in general.

### REFERENCES

- [1] Tikhonov V.I., Kharisov V.N. Statistical analysis and synthesis of radio engineering systems and devices. M.: Radio and communication, 1991. 608 p.