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DEVELOPMENT OF AN ALGORITHM FOR AUTOMATED CONTROL OF SIMULATOR TRAINING OF ATC CONTROLLERS

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ABSTRACT	KEYWORDS
The article discusses the main algorithms of automated control of simulator training of ATC controllers. A methodology for organizing joint simulator training of flight crews and ATC specialists has been developed, based on mastering a set of competencies allocated for a set of exercises for the development of individual knowledge suitable for instrumental assessment and automation. Basic algorithms for the tasks of an automated modular simulator based on a semantic network have been developed with readjustment of the learning rate by changing the level of trainees' load on the automated simulator system for the training of flight crews and ATC specialists. It is shown that the use of automated modular simulators makes it possible to improve flight safety, as well as to increase the speed and efficiency of training military pilots and ATC specialists.	Air traffic control, air traffic controller, control post, simulator, guidance theory and methodology, combat control of aviation, ATC specialists.

Introduction

Promising scientific research is being carried out in the world to make a transition to a new level of training of aviation personnel, in the context of the transformation of the air navigation system, since flight safety remains an imminent priority of its activities. Aviation accidents show that the cause of many air accidents is the human factor, that is, errors made by pilots and air traffic control specialists in situations aggravated by severe weather conditions or some combination of adverse factors due to the fact that pilots and air traffic control specialists are not sufficiently trained to operate aircraft in emergency situations. It is possible to reduce the impact of the human factor by improving the training of pilots and air traffic control specialists, including air navigation services for aircraft flights. The use of modern simulators serves to reduce these risks through the formation and development of high-quality qualifications and skills among future pilots and air traffic control specialists. In general, simulators are increasingly used to solve such problems in the training of military personnel in the developed countries of the world. Modern simulation simulators require training of pilots and air traffic control specialists simultaneously in real time, synchronously with all specialists. In this regard, special attention is paid to the development of new methods and algorithms for controlling modern simulation simulators. In particular, one of the main tasks of military universities is the training of pilots and specialists in air traffic control - the widespread use of various aviation simulators in the education system is of great practical importance. One of the most important issues in this direction is the development of an integrated method of simulator training in the training of pilots and air traffic control specialists, which increases their efficiency.

New methods and algorithms for the creation of simulators, the use of information and communication technologies are being developed in the world, and scientific foundations for improving existing ones are being created. In this direction, the creation of three-dimensional models of objects, the qualitative reflection of the virtual environment and the image of three-dimensional objects in the vestibular apparatus of the trainee, the virtual environment of the aircraft.

The algorithm for displaying three-dimensional objects and the results of real accounting devices synchronously with the simulator and the development of a mathematical model is one of the important tasks. A comprehensive solution to these problems is an urgent scientific problem and a pilot in the market of simulation simulators. From this point of view, this work is one of the urgent problems of our time.

Research Methodology

At present, the development of an automated model of air traffic control and a graphical representation of tasks in various situations in the field of air traffic control responsibility in a standard form on various dispatching devices remains an urgent issue. For a specific airspace of the aerodrome territory, such a program allows real-time display of incoming and outgoing air traffic flows corresponding to the structure of the airspace.

In the simplest circuit of the air traffic control system, the air traffic controller is a link that has a set of tasks when interacting with aircraft crews and neighboring control towers. He forms in his mind a general view of the dynamic state of the air and an information model of its control. It should be noted that the information model is the only system that directly controls air traffic management in combination with the dynamic state of the air.

In the process of direct control of aircraft, the main part of typical tasks should be distinguished: analysis of the dynamic state of the air; assessment and forecasting of the development of the dynamic state of the air; decision-making on air traffic management; resolution of direct conflict situations; Multiple tasks at the same time determination of the procedure for take-off and landing of aircraft.

Each task can be represented as a set of individual operations, which, in turn, are broken down into simple actions. To solve the issues of air traffic management, air traffic control specialists perform a number of step-by-step activities in the process of preparing the simulator.

Results of the Study

In order to automate the preparation of the simulator, the following typical operations should be performed: determination of the parameters of the location and movement of aircraft; determination of deviations from the specified parameters of aircraft movement; calculation of safe intervals between aircraft and timely command of their crews for safe separation; determination of aircraft landing and take-off intervals; conducting radio communication in accordance with the established phraseology, including communication in English, etc.

These tasks are not clearly formalized (multi-criteria), so only instructors who are experts in this area can characterize a variety of alternative ways of performing air traffic management tasks, for example, to assess the usefulness of the alternative way of solving a direct conflict situation chosen by the trainee. Knowledge of expert instructors, which allows you to choose the types of air traffic management tasks and develop optimal solutions, are heuristic and individual, they are difficult to define and formalize [2].

Numerous scientific studies of real air traffic management processes have shown that the activity of an air traffic control specialist in real air traffic control can be presented in the form of an algorithm of his activity in analyzing and perceiving the air condition, making decisions and performing the necessary procedures.

It should be noted that, recognizing the air traffic control specialist as a system operator, in contrast to machine adaptive systems, optimization is achieved by minimizing the operator's incorrect movements [3-5].

The algorithm of the process of automating the simulator training of the air traffic controller in the form of a self-tuning system is presented in Fig.1.

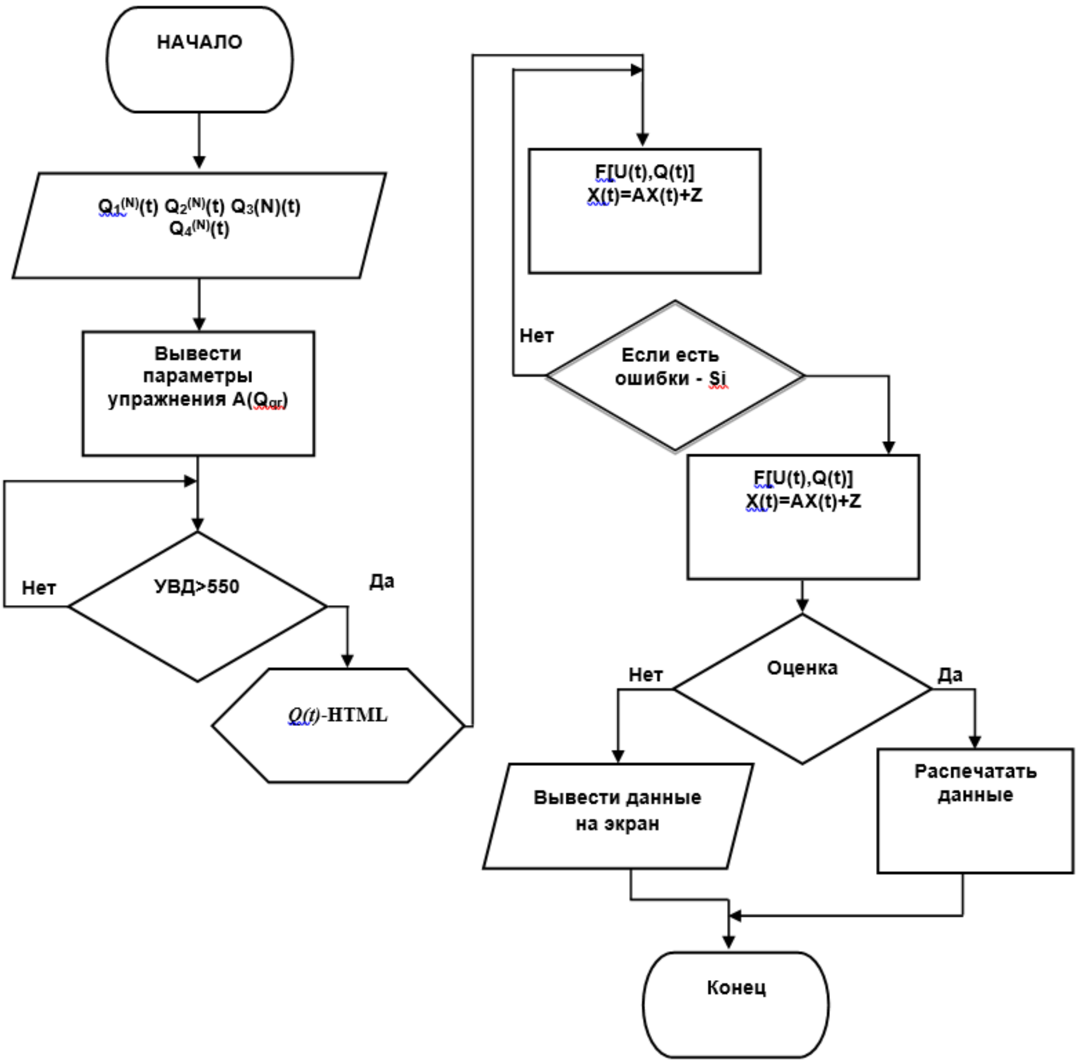

Fig.1 Algorithm for automating the simulator preparation process

At the same time, *Ui* is the influence of the learning system by changing the dynamic state of the air; Q1 - parameter of the content of the exercise; Q2 is the parameter of the exercise repetition in one lesson; Q3 is a parameter that characterizes the duration of breaks between exercises; Q4 is a parameter for changing the initial conditions for the algorithm execution.

In the process of performing his duties, the air traffic control specialist must make a decision on the favorable result of the flight of the aircraft, taking into account the achievement of fuel efficiency in compliance with all standards and requirements of flight safety. Many decisions are made in the face of severe time constraints and insufficient weather information.

Such processes cannot always be described by solving the optimization problem, since in practice, in real conditions, there is always an uncertainty factor due to the rapid development of the situation, the occurrence of emergencies, changes in meteorological conditions, etc. At the same time, the decision-making process of an air traffic control specialist is often probabilistic, and decisions are made heuristically [6].

On the one hand, the activity of the air traffic control dispatcher is algorithmic in nature, since the air traffic control technology is confirmed by international rules and local documents and procedures of aviation organizations regulating flights [7]. On the other hand, the choice of an algorithm of actions necessary in a given situation from various permissible ones has a heuristic character. A subjective assessment of a decision made in hazardous conditions expresses a positive result in the form of mathematical expectation, that is, the decisions made are evaluated in terms of the subjective probability of the outcome. The activity of an air traffic control specialist in real air traffic control can be presented in the form of an algorithm of his activity in analyzing and perceiving the air condition, making decisions and performing the necessary procedures (see Fig. 2).

As noted above, the training rate of each air traffic control specialist may vary and have maximum thresholds, so the process of acquiring skills during the training phases may have minimal values.

Thus, in this model, the task of optimizing the simulator preparation time is reduced to finding a rational value of α, while the actions of the trained air traffic controller are expressed in the form of several subtasks simulating real events, and a certain task performed at a given time.

In the process of simulator training of an air traffic controller, not only the speed of training is important, but also the quality of training. The process of direct air traffic management can be divided into three stages: information processing, decision-making and evaluation of the correctness of the actions performed in accordance with the algorithm presented in Figure 2.

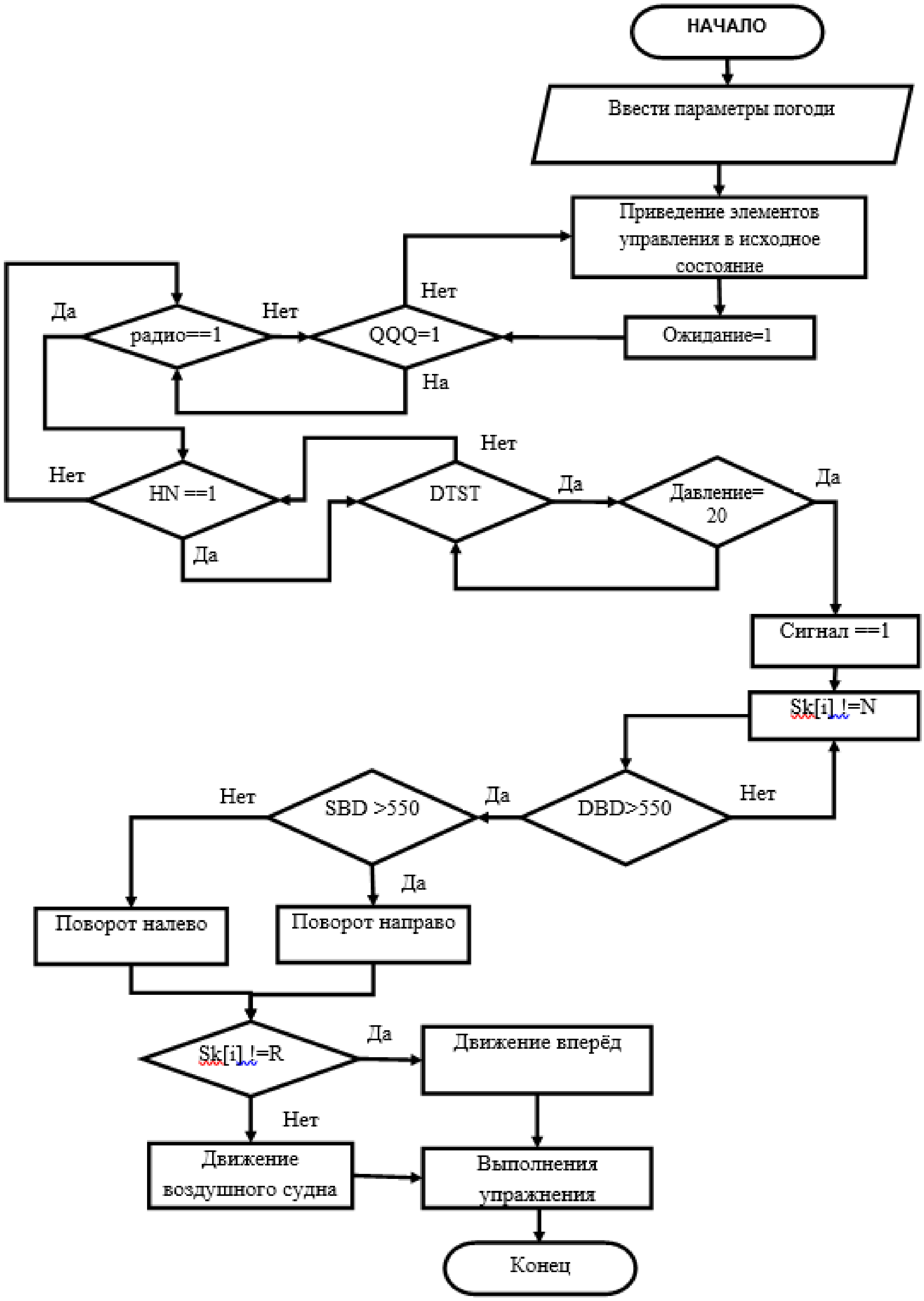

Fig.2. Air traffic control specialist's algorithm of work

At the first stage - the stage of information processing, the air traffic control specialist can make a mistake and perform any action, so it is necessary to take into account both the probability of chaotic actions of the air traffic control specialist.
At the second stage, the disorder of the ATC specialist characterizes a variety of his alternative actions. The problem of the GP process is to make the optimal decision in a particular situation from the point of view of the established flight safety criteria.
At the third stage, the assessment of the usefulness of the decision can be carried out by determining the results in the form of a mathematical expectation [8]. As more data become available, the subjective probability of the results changes. To calculate probabilities, Bayes' iterative algorithm is used.
At the same time, the main goal is to minimize the number of errors associated with the actions of the ATC specialist and the conditions of simulator training [9]. If the future ATC specialist has performed the correct action that does not lead to the development of the correct conflict situation, then it is necessary to increase the probability of choosing this action and, accordingly, reduce the probability of choosing other actions, since the normalization condition must be met [10-13].

Conclusion

As a result of the disclosure of the aspects of improvement of the research complex intended for joint training of flight crews and ATC specialists, the following can be cited:
For the first time, a methodology for organizing joint simulator training of flight crews and ATC specialists has been developed, based on mastering a set of competencies allocated for a set of exercises for the development of individual knowledge suitable for instrumental assessment and automation.
A method for automating simulator training has been developed, which is different from the existing one: the quantitative assessment of the knowledge gained is determined by automatic measurement of assessment parameters (particular indicators, such as errors that determine the level of training, and the time to determine the specified parameters); support for the method of automatic influence on the level of loads adopted for students, in order to accelerate the assimilation of knowledge by future ATC specialists, etc.
Basic algorithms for the tasks of an automated modular simulator based on a semantic network have been developed with readjustment of the learning rate by changing the level of trainees' load on the automated simulator system for the training of flight crews and ATC specialists.
Requirements for joint training of flight crews and ATC specialists, as well as requirements for the ATC structure, have been developed. It is shown that the use of automated modular simulators makes it possible to improve flight safety, as well as to increase the speed and efficiency of training military pilots and ATC specialists.

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