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AVIATION SIMULATOR SOFTWARE, TYPICAL FUNCTIONS AND ITS DEVELOPMENT PROSPECTS

Flight simulators have been used for more than eighty years. The development of aircraft simulators that simulate the pilot's work in the cockpit, the conditions of take-off, flight, landing, as well as the work of the dispatcher to train and maintain the professional level of aviation specialists is being addressed worldwide[1]. Training complexes can be divided into several parts, one of which is software.

The instructor's workstation software allows him to set various parameters of take-off, flight and landing conditions, as well as monitor and control the simulator subsystems. The article discusses typical functions of simulator software and prospects for the training development on flight simulators.

Keywords: *flight simulators, software, visualization, instructor's workplace, training in piloting.*

According to ARINC 610 revision C "Guidelines For Design and Integration of Aircraft Avionics Equipment in Simulators," the prime object in creating simulators software is to ensure that the aerobatic simulators use the relevant aircraft equipment to provide spare parts, and the software must ensure that the reaction of the equipment on the aircraft and on the aerobatic simulator is the same. In addition, an important feature of the software should be the ability to "save" or "freeze" the current training activity on the simulator, in order to be able to analyze a specific situation during the training process.

Flight simulator includes instructor's workstation with control panel. It is from this console that complex, emergency and non-standard situations are entered and canceled, meteorological conditions are set, etc. There is a headset, monitors and other equipment necessary to conduct training or maintain the professional level of pilots.

On civil flight simulators, the instructor's workplace is located into the simulator cockpit (or outside), in military aircraft it is located outside the simulator, which does not affect the standard set of software functions.

Complexity and modularity are general principles of instructor's workplace software development.

Complexity is realized by creating a system that is flexibly configurable to work with various combinations of software and hardware, and modularity is implemented by sequentially dividing the structure of the entire program into software modules, which should ensure an increase in the functionality of the program. However, the modular approach, easing some of the difficulties, imposes additional restrictions on the system as a whole, associated with bringing the data into a compatible form.

The instructor's workplace software can be subdivided into the following modules:

- a module of general functionality, including the processing of control elements application graphical user interface;
- interface module for data exchange of the instructor's workplace with the simulator subsystems.

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In turn, the software module of the general functionality includes the following components:

- software module of the graphical user interface;
- a general application settings module that interacts with elements of the application's graphical user interface;
- model of interaction with the interface level of the application for changing and displaying parametric information through a graphical user interface [2].

Figure 1 – Instructor's workstation software

At the interface level, the software module of the instructor's workplace interacts with mathematical models that simulate the operation of the aircraft on-board systems.

Typical software allows you to set the following parameters: aircraft position, flight altitude, speed, amount of fuel, meteorological conditions, temperature, pressure, wind speed and direction at the surface of the earth and at heights. Databases of flight simulators can consist of more than 20,000 airports in the world and contain a relief grid of the entire earth's surface. For greater realism, the screen displays both large objects - seas, cities, forests, and small - cars, trees, animals and airfield objects. At airfields, dynamic objects are also visible - an approaching tanker, a baggage loader, as well as other aircraft - in the process of taxiing, taking off, or flying along a given route[3,4].

There are acoustic noise simulators, which allows you to hear the sound situation during all procedures and modes - starting and testing the engine, take-off, flight, landing. The sounds of emergency situations are also imitated. IATA recommends to use seventeen basic simulator functions, which are reflected in the instructor's workstation software. This are:

- “saving data” or “freezing” flight data (latitude, longitude, airspeed, course, altitude);
- “saving data” or “freezing” only the location (latitude and longitude), all other flight parameters remain dynamic;
- “saving data” or “freezing” altitude;

- “saving data” or “freezing” the amount of fuel;
- location setting;
- change in latitude and / or longitude;
- change in height;
- course change;
- “take a picture” function (the state of the simulator system);
- recall of a (saved) snapshot (of the simulator system state);
- acceleration in N times of position, height, amount of fuel;
- zero fuel value on the ground or in the air;
- setting the fuel weight;
- setting temperature / pressure (sea level, earth or air temperature overboard and pressure);
- instant movement of the aircraft;
- wind setting.

At the end of the training flight, it may be necessary to “freeze” the flight simulation before transferring the simulator to another pilot to continue the flight under the conditions that have been established.

During a training maneuver, the instructor can stop the process in order to explain the function of the system or a state that is transient and disappears at the end of the maneuver.

In addition to these functions, maintenance settings can also be used (resetting the error memory, setting the parameters for registering errors, saving the error memory, loading the error memory) and specific functions for military use (fixing ammunition, task execution time, suspending the task, changing consumables, changing load / carrying capacity, etc.).

For each aircraft model, a set of subsystem failures is implemented. It is possible to specify failures of aircraft subsystems [5].

Modern simulators are very expensive, the release of a new aircraft requires the presence of an appropriate simulator, virtual technologies can change this situation.

Virtual technologies have entered everyday life, quite quickly they penetrate the field of professional training.

The VR training device consists of:

- VR headset;
- VR on-board computer;
- software for VR flight;
- steering wheel pedals;
- joystick or other aircraft control device.

As a visualization system, virtual reality glasses synchronized with the behind-the-table image generation system are used. The system allows you to load a location from anywhere in the world. The capabilities of virtual technologies are such that they allow trainees to “fly” in a single surrounding space, take-off, landing, etc. The simulator makes it possible to use virtual cockpit fittings, since the visualization system allows displaying the pilot’s hands. The trainee is able to perform all actions with the cockpit fittings with his hands.

At the intersection of simulator technologies and virtual reality technologies, new advanced solutions may arise in the field of training and maintaining the professional level of aviation personnel.

The software implements a highly detailed image of the virtual cabin and dashboard, which make the simulation as close as possible to the real process of aircraft control, the latest 3D graphics provide a high level of realism. VR devices allow you to undergo flight training in a less stressful and more controlled environment.

In April 2021, the Swiss company VRM Switzerland, which provides pilot training, was the first in history to receive approval from the EU Aviation Safety Agency for the use of the VRM H125 VR flight simulator for training pilots [6].

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АВИАЦИЯЛЫҚ СИМУЛЯТОРДЫҢ БАҒДАРЛАМАЛЫҚ ҚҰРАМЫ, ТИПТІ ФУНКЦИЯЛАРЫ ЖӘНЕ ОНЫҢ ДАМУ БОЛАШАҒЫ

Ұшу тренажерлары сексен жылдан астам қолданылып келеді. Әуе кемесінің кабинасындағы ұшқыштың жұмысын, ұшу, ұшу, қону жағдайларын, сондай-ақ авиация мамандарын даярлау және кәсіби деңгейін қолдау бойынша диспетчер жұмысын имитациялайтын авиациялық тренажерларды әзірлеу әлемнің барлық жерінде қамтылған. Оқу кешендерін бірнеше бөліктерге бөлуге болады, олардың бірі – бағдарламалық қамтамасыз ету.

Нұсқаушының жұмыс орнының бағдарламалық қамтамасыз ету оған ұшу, ұшу және қону жағдайларының әртүрлі параметрлерін орнатуға, сондай-ақ тренажердің ішкі жүйелерін басқаруға және басқаруға мүмкіндік береді. Мақалада авиациялық тренажерларға арналған бағдарламалық қамтамасыз етудің типтік функциялары және авиациялық тренажерлар бойынша оқытуды дамыту перспективалары қарастырылады.

Түйін сөздер: *авиациялық тренажерлар, бағдарламалық қамтамасыз ету, визуализация, нұсқаушының жұмыс орны, ұшқыштарды оқыту.*

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ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ АВИАЦИОННЫХ ТРЕНАЖЕРОВ, ТИПОВЫЕ ФУНКЦИИ И ПЕРСПЕКТИВЫ ЕГО РАЗВИТИЯ

Авиационные тренажеры используют уже на протяжении более чем восьмидесяти лет. Разработкой авиационных тренажеров, имитирующих работу пилота в кабине воздушного судна, условия взлета, полета, посадки, а также работу диспетчера для обучения и поддержания профессионального уровня авиационных специалистов занимаются во всем мире. Тренажерные комплексы можно разделить на несколько частей, одной из которых является программное обеспечение.

Программное обеспечение рабочего места инструктора позволяет ему задавать различные параметры условий взлета, полета и посадки, а также контролировать и управлять подсистемами тренажера. В статье рассматриваются типовые функции программного обеспечения авиационных тренажеров и перспективы развития обучения на авиационных тренажерах.

Ключевые слова: авиационные тренажеры, программное обеспечение, визуализация, рабочее место инструктора, обучение пилотированию.