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ИЗВЕСТИЯ

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DESIGN FEATURES OF MODERN FLIGHT SIMULATION DEVICES, MOBILITY SYSTEMS AND VISUALIZATION SYSTEMS

Abstract. The aviation system is a complex and dynamic structure, the parts of which interact with each other, affect each other, and their interaction should be as safe as possible. The safe functioning of this system ultimately depends on the lives of people, both in the air and on the ground. Training and retraining of pilots, as you know, goes in several stages, and simulator training takes a significant and unconditional place in the ground training of future pilots. During the simulator training, the pilot acquires, maintains and improves practical skills and abilities with the help of devices that simulate the cockpit and flight of the aircraft.

Keywords: aviation technology, simulator, flight simulation, mobility systems, visualization systems, safety.

Introduction. The use of so-called simulation dynamic stands-simulators or dynamic simulators for training pilots, dispatchers and other specialists associated with the safe operation of aircraft in real conditions makes it possible to be at the helm of the aircraft. To feel in real time, without threat to life, its virtuality and its probable abilities, and the admissibility of sensations in piloting and control. The simulators are capable of simulating certain situations, various meteorological conditions and special cases when moving on the ground, in flight, as well as simulating the operation of aircraft systems using special models implemented in the software of the simulator's computer complex. They are economical, reliable, and most importantly, safe, since a real flight is always associated with a certain risk, and especially when the pilot who controls it is not experienced. With the help of simulators, you can work out many emergency situations, even those that are not provided for by legislative acts and flight manuals. In accordance with the Order of the Minister for Investments and Development of the Republic of Kazakhstan dated June 5, 2018 No. 431 "On Amending the Order of the Minister of Transport and Communications of the Republic of Kazakhstan dated September 28, 2013 No. 764" flight safety ”simulator training on an integrated flight simulator is performed at least once every 6 months, in the amount of 12 hours and at least once every 3 months in the amount of 6 hours [1].

Today, simulators are used to train and maintain a professional level, both in civil and military aviation, and the demand for simulator training is increasingly important, since the human factor still continues to be the main cause of aviation accidents and incidents. It should also be noted that the development of aviation technology and software made it possible to bring the technical capabilities of simulators to such a level of perfection that training on simulators becomes more effective than training on a real aircraft. Of great importance in the modern process of training and retraining of pilots and maintaining their professional skills is the fact that an aviation simulator allows you to save significant financial resources in view of the fact that the cost of operating a real aircraft significantly exceeds the cost of operating a simulator (despite the high cost of modern simulators, approaching the cost of the aircraft themselves).

In addition to training purposes, modern simulators can also be used for scientific purposes, for example, to determine the procedure algorithm in case of violation of the flight parameters specified in the aircraft flight manual. In military aviation, simulators are capable of simulating a combat situation, the use of any aircraft weapons of destruction of the enemy, which are difficult to implement in the course of military exercises.

There are three types of simulators: tactical simulators called Full Mission Simulator, complex simulators - Full flight simulator, and procedural simulators - Flight Procedures Training Device. Most often, complex and procedural simulators are used in civil aviation. On procedural simulators, pilots acquire the skills to perform procedures for preparing and performing a flight, procedural simulators do not provide an opportunity to acquire piloting skills, while integrated simulators are able to provide training for a student in functional duties in aircraft control.

Methods. Complex simulators are very complex systems. They are able to simulate the movement of an aircraft, both along the take-off field and in flight. They have mobility systems or so-called acceleration simulators that set the cab in motion, which allows

and angular accelerations along all three axes, in addition, it is possible to simulate movement.

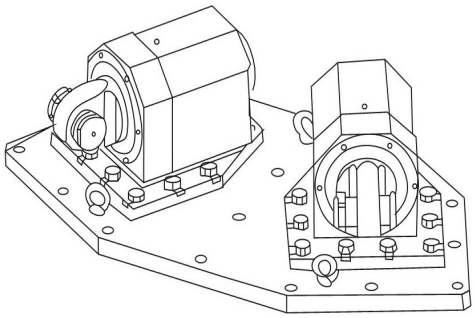

Figure 1. Paired gimbal of the mobility system.

Results. The control of the mobility system comes from the control stand, which includes: a control computer with drive links of the mobility system for settings and adjustments; drive link control crate; uninterruptible power supply; software.

Since the simulator platform is limited in its stroke, the overload can only be reproduced for a limited amount of time, but even this time is sufficient for the pilot to be informed of the change in overload caused by a control error.

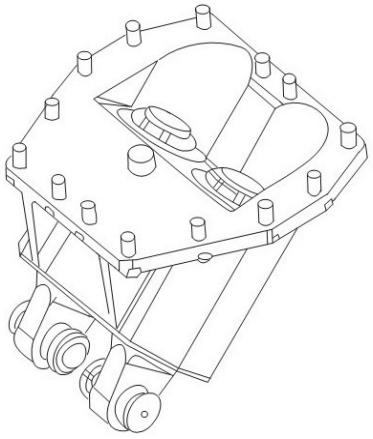

Figure 2. Lower gimbal.

	Name of characteristic	Units of measurement	Value of characteristic	Note
1	Maximum consumed electric power	kw	90	
2	Carrying capacity	Kg	9000	
3	Maximum linear displacements of PDS (operational)	m		The characteristic value must be at least as specified in the table.
	longitudinal X			
	vertical Y		+1,38..1,07	
	transverse Z		+0,88...-1,01±1,12	
4	Maximum angular displacements of PDS (operational)	degree		
	longitudinal X		±24,9	
	vertical Y		±27,9	
	transverse Z		+25…-29	
5	Maximum travel speeds along each of the three axes of rotation of the PDS	m/s	0,6	The maximum movement speed of the PDS is created by a harmonic signal with an amplitude of 0.2 m and a frequency at which the PDS movement speed of 0.6 m / s will be achieved
6	Maximum rotational speeds for each of the three axes of rotation	°/c	20,0	The maximum rotation speed of the PDS is created by a harmonic signal with an amplitude of 5 grams and a frequency at which a rotation speed of 20°/s will be reached.
	Name of characteristic	Units of measurement	Value of characteristic	Note

7	Maximum acceleration of movement along each of the three axes of rotation	m/s^2	6,0	The maximum acceleration of the displacement of the PDS is created by a harmonic signal with an amplitude of 0.03 m and the frequency at which the acceleration of displacement of the PDS is 6 m / s²
8	Maximum acceleration of rotation on each of the three axes of rotation	°/s	60,0	The maximum acceleration of the PDS rotation is created by a harmonic signal with an amplitude of 0.03 m and a frequency at which an acceleration of rotation of 60 deg / s² will be achieved
9	The characteristic of the quality (smoothness) of movement when controlling movement along the yaw axis Y			Ускорение перемещения ПДС создается гармоническим сигналом с амплитудой 0,3 м и частотой при которой будет достигнуто ускорение перемещения ПДС 0,6 м/с²
	Deviation of the acceleration of movement along the yaw axis (Y) from the specified, no more	m/s^2	0,04	
	Parasitic acceleration of rotation about the roll axis (X), no more	$°/s^2$	1,0	
	Parasitic acceleration of rotation relative to the pitch axis (Z), no more	$°/s^2$	1,0	
	Frequency response for each of the 6 degrees of freedom			The amplitude of displacement at the initial frequency of 0Hz is 0.25 m, and the amplitude of rotation is 6 degrees, the final frequency is 10 Hz.
	Attenuation of the amplitude of displacement at the following frequencies <0,5 0,5…1,0 1,0…2,5 2,5…10	dB	0…-1,0 -1,0…-2,5 -2,5…-4,0 No increase in amplitude	

Visualization systems are of great importance in flight simulators. They reproduce images that reflect reality as much as possible. These systems change the off-cockpit environment depending on the pilot's procedures. The images have to be perceived correctly by the pilot and this is a very big problem. There are two systems for visualizing the outside of the cockpit environment, projection and collimation. Each of them has its own advantages and disadvantages. A projection system for visualizing the outside of the cockpit environment. A screen is located at a distance of about 3-5 meters from the trained pilot. The projector projected onto the screen an image corresponding to the manipulations made by the pilot, generated by the software. The advantage of such a system is its simplicity and low cost. The projection system does not require the pilot to "get used" to the image and, consequently, the pilot's visual organs are not fatigued. Among the new training technologies, promising projection laser technologies are currently leading [3].

Conclusions. The disadvantages of such a system include the underestimated realism of the image. Collimation system for visualization of the out-of-cab environment. This system uses mirrors, beamsplitter and spherical concave, and also uses a projector. The beam of light rays from the projector propagates radially and refracts in such a way that the specified light rays in the beam become parallel to each other. The best performance is possessed by an imaging system based on optical collimation devices (spherical mirror + beam-splitting plate) and several projection monitors (from 3 to 5). A rational optical design, a special power structure and an almost ideal

sphericity of a glass mirror make it possible to easily assemble multi-window visualization systems from such OCDs, which ensure the fusion and continuity of a panoramic image [4].

The disadvantages of this system are its complexity, high cost, as well as a negative effect on the organs of vision, which is expressed in the rapid fatigue of the pilot's eyes.

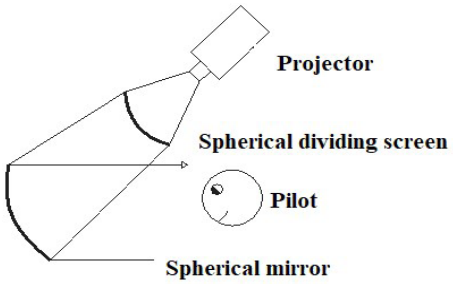

Figure 3- Layout of the functional parts of the visualization system

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ҰШУ ҮШІН ҚҰРЫЛҒЫЛАРДЫҢ ЖАСАУ ЕРЕКШЕЛІКТЕРІ, ҰТЫМДЫҚ ЖҮЙЕЛЕРІ ЖӘНЕ ВИЗУАЛИЗАЦИЯ ЖҮЙЕЛЕРІ

Аннотация. Авиациялық жүйе – бұл күрделі және динамикалық құрылым, оның бөліктері бір-бірімен әсерлеседі, бір-біріне әсер етеді және олардың өзара әрекеттесуі мүмкіндігінше қауіпсіз болуы керек. Бұл жүйенің қауіпсіз жұмыс істеуі, сайып келгенде, адамдардың әуеде де, жерде де өміріне байланысты. Ұшқыштарды даярлау және қайта даярлау, өздеріңіз білетіндей, бірнеше кезеңнен өтеді және дайындық жаттығулары болашақ ұшқыштардың жер үстінде даярлауында маңызды және сөзсіз орын алады. Дайындық оқудан өткен кезде тыңдаушы кабинаның және әуе кемесінің ұшуын имитациялайтын құрылғылардың көмегімен практикалық дағдылар мен іскерліктерді алады, ұстайды және жетілдіреді.

Түйін сөздер: авияциялық техника, тренажер, ұшуды имитациялау, ұтқырлық жүйелері, қауіпсіздік.

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КОНСТРУКТИВНЫЕ ОСОБЕННОСТИ СОВРЕМЕННЫХ УСТРОЙСТВ ИМИТАЦИИ ПОЛЕТА, СИСТЕМЫ ПОДВИЖНОСТИ И СИСТЕМЫ ВИЗУАЛИЗАЦИИ

Аннотация. Авиационная система представляет собой сложную и динамичную структуру, части которой взаимодействуют между собой, влияют друг на друга и их взаимодействие должно быть максимально безопасным. От безопасного функционирования этой системы в конечном итоге зависят жизни людей как в воздухе, так и на земле. Подготовка и переподготовка пилотов, как известно, идет в несколько этапов, и тренажерная подготовка занимает значительное и безусловное место в наземной подготовке будущих пилотов. При прохождении тренажерной подготовки пилот приобретает, поддерживает и совершенствует практические навыки и умения с помощью устройств, имитирующих кабину и полет воздушного судна.

Ключевые слова: авиационная техника, тренажер, имитация полета, системы подвижности, системы визуализации, безопасность.

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