UDC 629.735.017.1.083(045)

Yuriy Hryshchenko[1]
Andrey Skripets[2]
Vladimir Tronko[3]

AUTOCORRELATION FUNCTIONS AND THEIR APPLICATION FOR ASSESSING THE QUALITY OF LANDING PROCESS

[1,2,3]National Aviation University
Kosmonavta Komarova avenue 1, 03680, Kyiv, Ukraine
E-mails: [1]grischenko_u@mail.ru, [2]avionika2006@ukr.net, [3]v@tronko.kiev.ua

Abstract. *The article describes the correlation functions between the information on the flight path and distortions in tracking operations of an operator. This is due to its psychophysiological abilities in a state of high tension.*

Keywords: correlation function; dynamic stereotype; flight path

1. Introduction

Human factor is of great importance for guaranteeing high reliability of aviation equipment and aircraft flight security. Statistical data indicates that more than 80 percent of aviation incidents and occurrences/ are caused by human factors.

2. Analysis of the research

By now many models of errors have been developed in the International Civil Aviation Organization (ICAO). These models are the basic ones for consideration of human factor problems. They are the same for flight analysis under normal conditions and for flight analysis in special situations. For example, in the Chapter 1 of the ICAO Circular 238-AN/143 “Human Factor. Collected Materials №6. Ergonomics” it is noted that control over the errors of man-operator is the component of ergonomics research. The similar information is contained in other ICAO circulars and instructions on human factor, however up to now the emphasis has not been put on analysis of reasons of these errors.

Let us consider the matter and substance of our proposed approach and the action and counteraction model (ACM, fig. 1). The basis for our approach considering both actions and counteractions. And the reason for aircraft occurrence is not an error of flight crew, but the reason or reasons which produce these errors. I.e. the reason, as such, is removed from the sphere of causality, and we consider the reasons which produce this error. So, in effect we form two qualitatively different approaches to aircraft occurrence causality: occidental approach considering the error as the reason for aircraft occurrence, and our approach considering the reasons for errors as the reason for aircraft occurrence. Such a profound determinism in consideration of causality of aircraft occurrences is in complete conformity with the character of fundamental research in national engineering psychology, ergonomics, and operation theory.

In accordance with factor flight model and with due regard for ACM nature, the flights are considered as extremely complex processes and their moments; during these moments risk may come from the expected events, uncertain events, unexpected events, and external errors. The factor blunders (FB) form the most complex uncertainty in a flight. The factor blunders (FB) are the interaction between different factors. Previously it was impossible to find scientific works in the field of ACM delay training under FB influence, and our model allows to do this.

Compared to the occidental model, one more distinguishing feature of our model is the possibility of earlier incident (occurrence) prevention [1-3].

The complexity of this problem solving lies in the fact that using the factor analytics of errors causality we meet with the problem of a great number of interactive factors accounting. Ukrainian scientists have found more than 1500 such factors. That is why the problem of annihilation (elimination) of flight crew errors is very complicated, even though the reasons of those errors are known [4].

http://www.nau.edu.ua

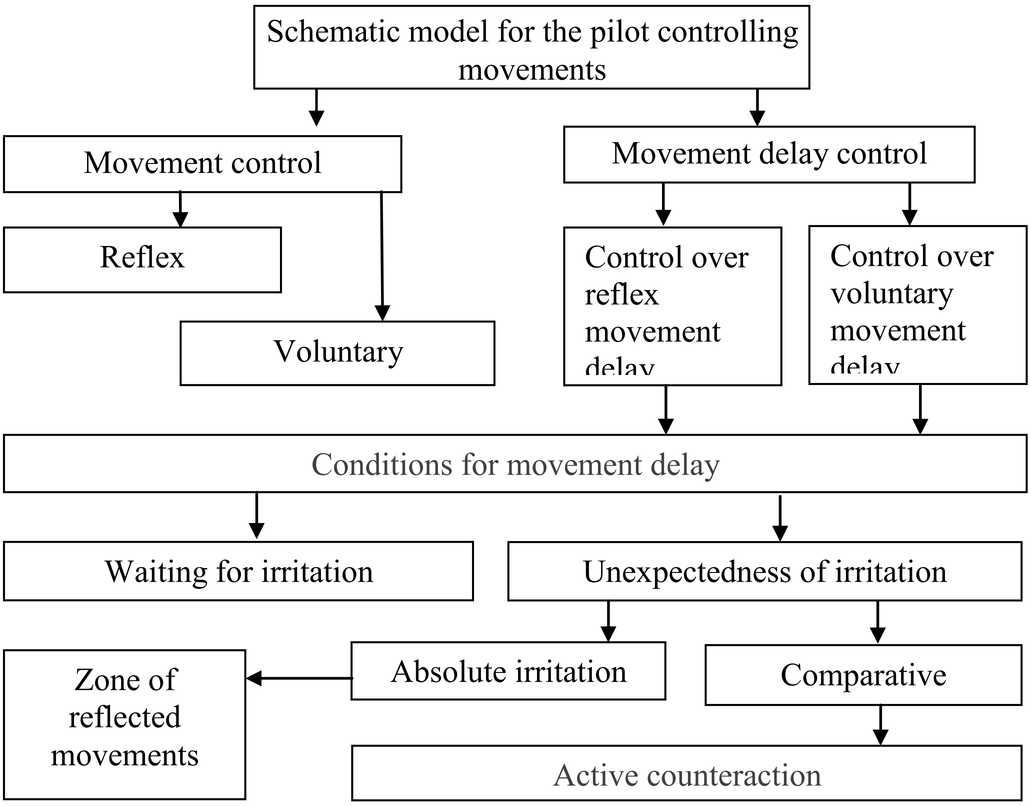

Fig. 1. Schematic model for the pilot controlling movements

Earlier research about assess of changes in the integral-differential motive dynamic stereotype (IDMS) of pilot showed that negative influence of factor overlays (FO) on the crew significantly affect the quality of piloting technique (QPT). Stress caused by FO, also leads to faulty operations. Researches in training certification centres have shown that with the same pilots, already negative as there is an increase of the amplitude of controlled movements, which the operator does not notice.

Trajectory of movement of the aircraft allows to define the degree of operator training, his psychophysiological state, quality of operating of all elements of the aircraft, especially the reliability of communication at transmitting and receiving the commands. More general formulation of the problem is how to define the technical and psychological state of a system operator-machine-environment along the trajectory of movement of aircraft especially on the glide path.

Direct measurement of the trajectory does not allow to identify characteristics and parameters we are interested in. This is due to the fact that the trajectory is influenced by various environmental fluctuations, random processes, external and internal interactions occurring in the system influencing operator and machine. Therefore we measure trajectory of the glide path and calculate the correlation function of the glide path to eliminate these effects and to study random stationary influences. The correlation function of the glide path allows to define stationary random functions of flight trajectory and therefore to identify APIDMS.

3. Correlation function of flight

We calculate the correlation function of the flight path $\rho(\tau)$ flight trajectory on which we have to fly.

$$\rho(\tau) = I(t) \cdot I(t-\tau) =$$

$$= \lim_{T\to\infty}\left(\frac{1}{T}\right)\int_0^{T_l} I(t)\cdot I(t-\tau)dt = \frac{1}{T_l}\int_0^{T_l} I(t)\cdot I(t-\tau)dt$$

where τ – time of delay, T_l – time of landing, $I(t)$ – information about flight trajectory on which we have to fly.

For an ideal system, i.e, ensuring full ergatic compatibility of operator-aircraft and perfect without errors information processing of flight trajectory, aircraft fulfills all predetermined program of flight $I(t)$ and its instruments give information about flight $I(t)$ without errors. Defined trajectory and information about the actual flight path obtained from the instruments of aircraft will be the same (fig. 1).

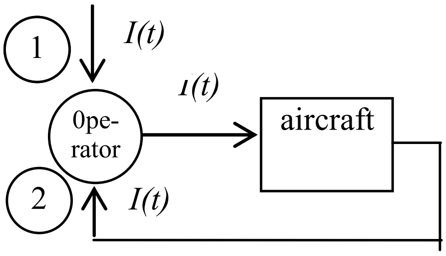

Fig. 1. Ideal system

Any deviation of these two pieces of information, i.e. the deviation from the flight mode is immediately processed by operator. The operator compares the information obtained by the first and the second channels, and will process to zero the difference between the information given and the actual trajectory.

Now let us imagine the following scene: the operator is inexperienced or has APIDMS and he uses the information supplied externally *I*(*t*), he controls the machine using misleading information *I'*(*t*) or rather not using *I*(*t*) (partially). In this case, the information of the operator will be different *I'*(*t*) (fig. 2).

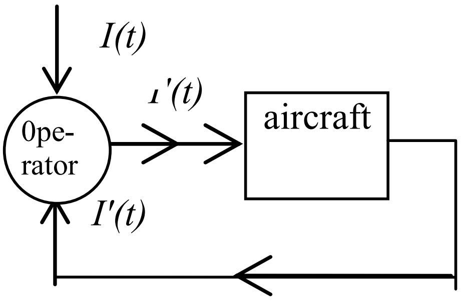

Fig. 2. Imperfect system

Assume that at the output of APIDMS (to control the aircraft) operator movements correspond to supposedly obtained information

$$I^{'}(t) = I(t) \cdot (1 + m\cos\Omega t),$$

where $\Omega = 2\pi f$ is angular velocity, f - frequency

Such an assumption is made on the basis of the experimental fact of existence of APIDMS.

In 1986, the qualities of the functioning of the System "the pilot-simulator" in complex simulator of aircraft (CSA) Tu-154 were assessed. The methods of quality assessment of functioning of the ergatic system were developed. Also, the recommendations on the organization of pilots' and crew members' counteraction against "Superposition Factors" (SF) and unexpected stimuli in special flight situations were implemented. Experimental data was processed by the APIDMS proof (flight handwriting) under the action of complex failures.

In Scientific Research (SR), were developed methods to improve the ergonomic portrait of airlines, the need and practical levels of recoverability of flight personnel were determined. In this SR historical background of development of the theory of humans' working movements and outlined priority areas for work were presented.

As a result of analyzed statistics in SRs the refutation opinion that during the special flight situations pilot often has "breaking" in dynamic stereotype of action was justified. It was proved that instead of "breaking" a phenomenon of amplitude APIDMS occurs.

If operator has any APIDMS, he enters in the zone of so-called enhanced reflected movements when acts unconsciously, but the "face" of movements is maintained. However, there may be illogical actions. It is shown that by teaching pilots to fly without APIDMS, we teach them not to commit wrong actions [5].

The necessity of automation of instructor's workplace for analyzing APIDMS is shown. The analysis of the operating pressure on the crew of the Tu-154B2 by the action of complex failures on CSA that mimic the SF in real-world missions is held [6].

Methodological recommendations for the preparation of the flight personnel at the STT to the effects of SF were developed. A System of Objective Control (SOC) "Anti-stress" and methods of its use in the simulator training of pilots were developed.

During the research it was also found that about 70 % of the pilots need anti-stress preparation. There were highlighted the main types of pilot's differentiated dynamic stereotypes (flight handwriting) [7].

The possibility of determining the counteraction of a pilot against negative superposition factors on modern aircraft flight parameters, evaluating the effectiveness of its work was shown. In the course of further investigation it was established that the invariance of the "man-machine" allows to determine the invariant properties and characteristics of the human operator for the machine output without placing a contact and contactless psychophysiological sensors which basically carry the information about characteristics of the human-operator that is mathematically described by the general theory of oscillations.

The oscillatory nature of the output characteristics of the human operator allows to make a conclusion for tracking systems, that the engine output systems are invariant with respect to the input characteristics of the system, if in the input of such system a human operator works.

From the general theory of automation and automatic control systems it is well known, that in relation to all types of oscillations (sinusoidal, modulated, with a random spectrum, etc.), existing systems are invariant under the scheme "input-process-output" [4, 5].

Qualitative assessment of presence or absence of APIDMS for pilots is also possible with identification of regularities in the analysis of the autocorrelation functions of "paired flights" by the size and form of the function. For the analysis, we used digital data of γ changes from the end of the fourth turn before landing. Much larger variances and gain at the "flight" of pilots with the presence of APIDMS can be seen from the obtained data of the above schemes of autocorrelation functions and "tails' of autocorrelation functions have definitely divergent view [8].

If we assume that $m(t)$, I(t) are stationary random functions, φ_i = const, i – number of test (approach) by the known categories of tests (landings) this function of known parameter t – time is completely determined by the result of each test, landing.

The use of random, stationary functions has the advantage that allows to make analytical analysis. The use of stationary random functions is possible where the nature of the phenomenon can be described by them. This is probably related to APIDMS.

We define the function of correlation dependence of information flight trajectory

$$\begin{aligned}
&\rho'(\tau)=\{I(t)[1+m_i(t)\cos(\Omega_i t+\varphi_i)]\}\times\\
&\times\{I(t-\tau)[1+m_i(t-\tau)\cos[\Omega_i(t-\tau)+\varphi_i]\}=\\
&=I(t)I(t-\tau)+I(t)I(t-\tau)m_i(t)\times\\
&\times\cos(\Omega_i t+\varphi_i)+I(t)I(t-\tau)\cdot\cos[\Omega_i(t-\tau)+\varphi_i]+\\
&+I(t)I(t-\tau)m_i(t)m_i(t-\tau)\cos(\Omega_i t+\varphi_i)\times\\
&\times\cos[\Omega_i(t-\tau)+\varphi_i],
\end{aligned}$$

where $\varphi=\Omega_i\tau$.

We choose the most significant by the magnitude values of the four components $m_i(t) < 1$.

$$\begin{aligned}
&\rho'(\tau)=\rho(\tau)+I(t)I(t-\tau)m_i(t)\times\\
&\times m_i(t-\tau)\cos(\Omega_i t+\varphi_i)\cdot\cos[\Omega_i(t-\tau)+\varphi_i].
\end{aligned}$$

Some components are neglected due to $m_i(t), m_i(t-\tau)$ smallness.

Indeed, using the inequality of Bunyakovskii-Schwartz we can write

$$\begin{aligned}
&|I(t)I(t-\tau)m_i(t)\cos(\Omega_i t+\varphi_i)|\\
&\le|I(t)I(t-\tau)m_i(t)|\cdot\cos(\Omega_i t+\varphi_i)
\end{aligned}$$

For events that occur long enough, in our case it is landing time T_l and magnitude $T_i=\dfrac{2\pi}{\Omega_i}$ (period of the oscillation process of APIDMS, as evidenced by the experimental curves) are incommensurable in magnitude $T_l \gg T_i$.

Therefore

$$\cos^2(\Omega_i t+\varphi_i)\approx 0,$$

$$\cos^2[\Omega_i(t-\tau)+\varphi_i]\approx 0.$$

Therefore, components 2 and 3 are neglected.

Let us compute component

$$\begin{aligned}
&I(t)I(t-\tau)m_i(t)m_i(t-\tau)\times\\
&\times\cos(\Omega_i t+\varphi_i)\cos[\Omega_i(t-\tau)+\varphi_i]=\\
&=\frac{1}{2}I(t)I(t-\tau)m_i(t)m_i(t-\tau)\cos\Omega_i\tau+\\
&+\frac{1}{2}I(t)I(t-\tau)m_i(t)\times\\
&\times m_i(t-\tau)\cos(2\Omega_i t-\Omega_i\tau+2\varphi_i]=\\
&=\frac{1}{2}I(t)I(t-\tau)m_i(t)\times\\
&\times m_i(t-\tau)\cos\Omega_i\tau.
\end{aligned}$$

The second component (2) is neglected, since it is close to zero due to the fact that $2\Omega_i=\dfrac{4\pi}{T_i}>>\dfrac{1}{t_l}$, where T_i and t_l respectively are the period of oscillation of APIDMS, t_l – landing time.

Finally we can write

$$\begin{aligned}
&\rho_{APIDMS}(\tau)=\rho(\tau)+I(t)\times\\
&\times I(t-\tau)m_i(t)\cdot m_i(t-\tau)\cos\Omega_i\tau.
\end{aligned}$$

The correlation function of the trajectory of landing APIDMS equals the sum of the correlation function of the trajectory of landing without APIDMS and unit which depends on statistics of "clean" landing and statistics of APIDMS.

If APIDMS is stationary over time $m_i(t)$ = const = m.

$$\rho_{APIDMS}(\tau)=\rho(\tau)+\rho(\tau)\cos\varphi.$$

If APIDMS is not stationary, then

$$\begin{aligned}
&I(t)I(t-\tau)m_i(t)m_i(t-\tau)\le\\
&\le I(t)I(t-\tau)m_i(t)m_i(t-\tau)\\
&I(t)I(t-\tau)m_i(t)m_i(t-\tau)\le\rho(\tau)\rho_{APIDMS}(\tau).
\end{aligned}$$

Thus when landing with APIDMS with random "switching" APIDMS has form of shifted correlation function

$$\rho_{\Sigma\, APIDMS}(\tau) = \rho(\tau) + \rho(\tau)\rho_{APIDMS}(\tau)\cos\varphi.$$

Now we shall make a calculation of the correlation function in the general form.

$$\rho_{full}(\tau) = \frac{1}{T_l}\int_0^{T_l}[I(t) +$$

$$+I_{APIDMS}(t)][I(t-\tau)] + I_{APIDMS}(t-\tau)]dt =$$

$$= \frac{1}{T_l}\int_0^{T_l}[I(t)I(t-\tau) + I_{APIDMS}(t)\times$$

$$\times I_{APIDMS}(t-\tau) + I(t)I_{APIDMS}(t-\tau)] +$$

$$+I(t-\tau)I_{APIDMS}(t)]dt = \frac{1}{T_l}\int_0^{T_l} I(t)I(t-\tau)dt +$$

$$+\frac{1}{T_l}\int_0^{T_l} I(t)I_{APIDMS}(t-\tau)dt +$$

$$+\frac{1}{T_l}\int_0^{T_l} I(t-\tau)I_{APIDMS}(t)dt =$$

$$= \rho(\tau) + \rho_{APIDMS}(\tau) + \frac{1}{T_l}\int_0^{T_l} I(t)I_{APIDMS}(t-\tau)dt +$$

$$+\frac{1}{T_l}\int_0^{T_l} I(t-\tau)I_{APIDMS}(t)dt\,*.$$

Using the inequality of Bunyakovskii-Schwarz we obtain

$$\int_0^{T_l} I(t)\cdot I_l(t-\tau)dt \le \sqrt{\int_0^{T_l} I^2(t)dt}\times$$

$$\times\sqrt{\int_0^{T_l} I^2{}_{APIDMS}(t-\tau)dt}. \qquad [1]$$

Using the preliminary experimental results we define $I_{APIDVS}(t\text{-}\tau)$

$$I_{APIDMS}(t-\tau) = I_{APIDMS}\cos(\Omega t + \varphi_{APIDMS} - \Omega\tau),$$

then

$$\sqrt{\int_0^{T_l} I^2{}_{APIDMS}(t-\tau)dt} = \sqrt{I^2{}_0\int_0^{T_l}\cos^2(\Omega t + \varphi_{APIDMS} - \Omega\tau)} =$$

$$= I_{APIDMS}\sqrt{\frac{1}{2}\int_0^{T_l}[1 + \cos 2(\Omega t + \varphi_{APIDMS} - \Omega\tau)]dt} =$$

$$= \frac{I_{APIDMS}}{\sqrt{2}}\sqrt{T_l + \int_0^{T_l}\cos 2(\Omega t + \varphi_{APIDMS} - \Omega\tau)dt} =$$

$$= \frac{I_{APIDMS}}{\sqrt{2}}\sqrt{T_l + \frac{1}{2\Omega}\sin(2\Omega t + \varphi_{APIDMS} - \Omega\tau)dt} =$$

$$= \sin(2\Omega t + \varphi_{APIDMS} - \Omega\tau)dt \le 2;$$

$$\frac{I_{APIDMS}}{2}\sqrt{T_l + \frac{1}{\Omega}} = \frac{I_{APIDMS}}{\sqrt{2}}\sqrt{T_l + \frac{T_{APIDMS}}{2\pi}} = \sqrt{\frac{T_l}{2}},$$

$$T_l >> \frac{T_{APIDMS}}{2\pi}. \qquad (2)$$

Hence equation (1) can be written using (2) so:

$$\int_0^{T_l} I(t)I_l(t-\tau) \le \sqrt{\int_0^{T_l} I^2(t)dt}\cdot I_0\sqrt{\frac{T_l}{2}}. \qquad (3)$$

Equality (3) does not depend on time t and shift τ. We have a similar situation with a unit

$$\frac{1}{\mathrm{T_l}} = \int_0^{T_l} I(t)I_l(t-\tau) \le \sqrt{\int_0^{T_l} I^2(t-\tau)dt}\cdot I_{APIDMS}\sqrt{\frac{\mathrm{T_l}}{2}} = \mathrm{const}.$$

We substitute expressions (2) and (3) into *, and obtain

$$\rho_{APIDMS}(\tau) = \rho(\tau) + \rho_{APIDMS}(\tau) + const.$$

$$\rho_{APIDMS}(\tau) = \frac{1}{\mathrm{T_l}}\int_0^{T_l} I_{APIDMS}(t)I_{APIDMS}(t-\tau)dt =$$

$$= \frac{1}{\mathrm{T_l}}\int_0^{T_l} I_0\cos(\Omega t + \varphi_{APIDMS})\cdot I_0\cos[(\Omega(t-\tau) + \varphi_{APIDMS})dt =$$

$$= \frac{I^2_{APIDMS}}{\mathrm{T_l}}\int_0^{T_l}\cos(\Omega t + \varphi_{APIDMS})\cdot[\cos(\Omega t + \varphi_{APIDMS})\cdot\cos\Omega t +$$

$$+\sin(\Omega t + \varphi_{APIDMS})\sin\Omega t]dt =$$

$$= \frac{I^2_{APIDMS0}}{\mathrm{T_l}}\int_0^{T_l}\cos^2(\Omega t + \varphi_{APIDMS})\cos\Omega\tau dt +$$

$$+\frac{I^2_{APIDMS}}{\mathrm{T_l}}\int_0^{T_l}\cos(\Omega t + \varphi_{APIDMS})\sin(\Omega t + \varphi_{APIDMS})\sin\Omega t dt =$$

$$= \frac{I^2_{APIDMS}}{\mathrm{T_l}}\cos\Omega\tau\int_0^{T_l}\frac{1}{2}[1 + \cos 2(\Omega t + \varphi_{APIDMS})dt +$$

$$+\frac{I^2_{APIDMS}}{\mathrm{T_l}}\sin\Omega\tau\int_0^{T_l}\frac{1}{2}[1 + \sin 2(\Omega t + \varphi_{APIDMS})dt =$$

$$= \frac{I^2_{APIDMS}}{\mathrm{T_l}}\cos\Omega\tau\frac{T_l}{2} + \frac{I^2_0}{\mathrm{T_l}}\cos\Omega\tau\times$$

$$\times\frac{1}{4\Omega}\sin 2(\Omega t + \varphi_{APIDMS})\Big|^{T_{\Pi}}_{APIDMS} -$$

$$-\frac{I^2_{APIDMS}}{\mathrm{T}_1}\cdot\frac{\sin\Omega\tau}{4\Omega}\cos 2(\Omega t+\varphi_{APIDMS})\Big|_0^{T_1}\leq$$

$$\leq\frac{I^2_{APIDMS}}{\mathrm{T}_1}\left(1+\frac{T_{APIDMS}}{\mathrm{T}_1}\cdot\frac{1}{4\pi}\right)\cos\Omega\tau+$$

$$+\frac{I^2_{APIDMS}}{2}\frac{T_{APIDMS}}{\mathrm{T}_1}\frac{1}{2\pi}+\sin\Omega\tau=\frac{I_0^2}{2}\cos\Omega\tau=$$

$$=\rho_{full}(\tau)+\rho(\tau)+\rho_{APIDMS}(\tau)+\mathrm{const}=$$

$$=\rho(\tau)+\frac{I^2_{APIDMS}}{2}\cos\Omega\tau+$$

$$+\mathrm{const}<\frac{I^2_{APIDMS}}{2}\cdot\cos\Omega\tau$$

$$\textit{differs by }\ \frac{1}{2\pi}\frac{T_{APIDMS}}{\mathrm{T}_1}-\text{times.}$$

On the basis of the foregoing we can make a calculation $\rho_{\sum APIDMS}$ at the landing glidepath.

If length of landing (L_l) is equal length (Lg) of glide path the calculation of ρ (χ) with given APIDMS on glide path is more precisely

$$\rho(\chi)=\frac{1}{L_\Pi}\int_0^{L_\Pi}[y(x)+y_{\text{я}}(x)][y(x-\chi)]dx=$$

$$=\frac{1}{L_\Pi}\int_0^{L_\Pi}y(x)\cdot y(x-\chi)dx+$$

$$+\int_0^{L_\Pi}y_{\text{я}}(x)\cdot y(x-\chi)dx+$$

$$+\frac{1}{L_\Pi}\int_0^{L_\Pi}y(x)\cdot y_{\text{я}}(x-\chi)dx+$$

$$+\int_0^{L_\Pi}y_{\text{я}}(x)\cdot y_{\text{я}}(x-\chi)dx,$$

where χ is the deviation from the glide path.

4. Conclusions

1. The restrictions on the domain of error existence by normal (non-emergency) flights and introduction of conditioned reflexes for the flights under the conditions of suddenness and unexpectedness form the foundation and logical concept which provide such an important (for practical work) transition from availability of crashes to the sphere of total absence of crashes.

2 APIDMS now is formulated as a function of a single spectral component cosΩt, which can be seen in the experimental curve. However, it should be generalized and written in the general form, based on experimental data..

3. Modulation function obtained as a result of analysis of the shape of the correlation functions obtained under the influence of APIDMS function.

4. The autocorrelation function is built on the basis of experimental curves, and on its basis we construct a function of APIDMS

References

[1] *Hryshchenko Yu.V.* Ways of increasing safety of flying processes by removing negative effects // Problems of occupational safety and the environment protection in the manufacturing processes of civil aviation: Collection of scientific papers – K. : KCAEI. 1989. – P. 81-84 (in Russian).

[2] *Hryshchenko Yu.V., Kurushkina Ya.O.* Using the invariance principle of management systems in assessing of strengthened reflexes I.M. Sechenov. // Cybernetics and computer engineering: Interdepartmental collection of scientific papers. – K.: Publishing house "Academperiodics" NAS of Ukraine, 2004. – Edition 143. – P. 39-44 (in Russian).

[3] *Hryshchenko Yu.V., Solomencev A.V.* The justification for applying the principle of invariance at analysis of processes in man-machine systems by nonclassical methods // Cybernetics and computer engineering: Interdepartmental collection of scientific papers. – K.: Publishing house "Academperiodics" NAS of Ukraine, 2009. – Edition. 156. – P. 71-76 (in Russian).

[4] *Grishchenko Y.V., Gulenko V.D., Hohlov E.M.* The ways for indeterminism overcoming in the analysis of flight crew errors. // The fourth world congress “Aviation in the XXI century”, “Safety in aviation and space technology”, September 21-23, 2010. – P. 33.22 – 33.25.

[5] *Hryshchenko Yu.V.* Amplification phenomenon of the dynamic stereotype of pilot under the influence of complex failures // Ergonomic flight safety issues: Collection of scientific tracts. – K. : KCAEI,K. 1987. – P. 87-91 (in Russian)..

[6] *Hryshchenko Yu.V.* Determination of phenomenon of amplification of the dynamic stereotype of pilot at the workplace of instructor during flight // Ergonomic methods of certification and rationalization of workplaces and manufacturing processes in civil aviation: Collection of scientific papers – K.: KCAEI, 1988. – P. 43-47 (in Russian).

[7] *Hryshchenko Yu.V.* Scientific research on the anti-stress preparation of specialists in a quarter century // Proceedingss of the National Aviation University. – 2014. – №1 (58). – P. 53-58.

[8] *Hryshchenko Y.V.* Training of pilots to fly in special situations considering the phenomenon of amplification of the dynamic stereotype // Cybernetics and computer engineering: Interdepartmental collection of scientific papers. – K. : Publishing house "Academperiodics" NAS of Ukraine, 2003. – Edition. 139. – P. 81-85 (in Russian)

Received 19 December 2014.

Ю. В. Грищенко[1], А. В. Скрипець[2], В. Д. Тронько[3]. Автокореляційні функції та їх застосування для оцінки якості заходу на посадку

[1,2,3]Національний авіаційний університет, просп. Космонавта Комарова, 1, Київ, Україна, 03680
E-mails: [1]grischenko_u@mail.ru, [2]avionika2006@ukr.net, [3]v@tronko.kiev.ua

У цій статті описуються функції кореляції між інформацією про траєкторію польоту і викривленнями при операції слідкування оператора. Це пов'язано з його психофізіологічними особливостями в стані високої напруженості.

Ключові слова: динамічний стереотип; кореляційна функція; траєкторія польоту

Ю. В. Грищенко[1], А. В. Скрипец[2], В. Д. Тронько[3]. Автокорреляционные функции и их применение для оценки качества захода на посадку

[1,2,3]Национальный авиационный университет, просп. Космонавта Комарова, 1, Киев, Украина, 03680
E-mails: [1]grischenko_u@mail.ru, [2]avionika2006@ukr.net, [3]v@tronko.kiev.ua

В этой статье описываются функции корреляции между информацией о траектории полета и искажениями при операции слежения оператора. Это связано с его психофизиологическими особенностями в состоянии высокой напряженности.

Ключевые слова: динамический стереотип; корреляционная функция; траектория полета

Hryshchenko Yurii (1958). Candidate of Engineering. Associate Professor.
Associate Professor of the Department of avionics, National Aviation University, Kyiv, Ukraine.
Education: National Aviation University, Kyiv, Ukraine (1987).
Research area: flight safety and dependability of technical and ergonomics systems.
Publications: 37.
E-mail: grischenko_u@mail.ru

Skripets Andrey (1945). Candidate of Engineering. Professor.
Head of the Department of avionics, National Aviation University, Kyiv, Ukraine.
Education: National Aviation University, Kyiv, Ukraine (1969).
Research area: technical operation, engineer psychology, ergonomics and human factor in aviation
Publications: 250.
E-mail: avionika2006@ukr.net

Tronko Vladimir (1939). Doctor of Physics and Mathematics . Professor.
Professor of the Department of avionics, National Aviation University, Kyiv, Ukraine.
Education: Kyiv State Taras Shevchenko University, Ukraine (1962).
Research area: optoelectronics and laser technique and avionics link.
Publications: 250.
E-mail: v@tronko.kiev.ua