KOŠICKÁ BEZPEČNOSTNÁ REVUE

KOSICE SECURITY REVUE

Vol. 11, No. 1 (2021), p. 120 – 127

ISSN 1338-4880 (print ver.), ISSN 1338-6956 (online ver.)

The criteria for determining hazards in the airport environment

Kritéria stanovenia nebezpečenstva v letiskovom prostredí

Jaroslav ZAREMBA[1], Pavol KURDEL[2] a Štefan KOČAN[3]

[1, 3] The university of security management in Košice
[2]Technical university of Košice

The manuscript was received on 17. 04. 2021 and was accepted after revision for publication on 01. 06. 2021

Abstract:

The current state of possible conflicts at airports is presented as risky in its essential parts of the threat to the overall security of the state. Protection and security against the penetration of elements of danger into airport complexes are represented by the criteria of sustainability and security scattered in the protection and intelligent control of the airport area. The article describes system solutions and models in the protection of aviation system security of the airport, operational-managerial and technical control activities at airports. The applicability of the criterion functions is determined for estimates of the relevance of illegal intrusions into airports. This can be assessed by the degree of risk using information security factors. Dichotomous coefficients for assessing illegal intrusions represent numerical characteristics and their readiness to assimilate the threat outcome into the airport environment. It is possible to identify the degree of safe security using methods where their level can be statistically evaluated. The article sets out the information criterion of one intelligent airport system as one of the results of an experiment presenting an airport security model, which, based on input and output variables, monitors the current state of danger at a particular airport.

Keywords: *danger, airport complex, security control system, safety models.*

Abstrakt:

Súčasný stav možných konfliktov na letiskách je prezentovaný ako rizikový v jeho podstatných častiach ohrozenia celkovej bezpečnosti štátu. Ochrana a istota pred preniknutím prvkov nebezpečia do letiskových komplexov je reprezentovaná kritériami udržateľnosti a bezpečnosti rozptýlenej do ochrany a inteligentnej kontroly letiskového priestoru. V článku sú popisované systémové riešenia a modely v ochrane leteckej systémovej bezpečnosti letiska, operačno-manažérskej a technickej kontrolnej činnosti na letiskách. Použiteľnosť kriteriálnych funkcií je stanovená pre odhady relevantnosti nedovolených prienikov do letísk. To je možné vyhodnotiť mierou rizika za pomoci koeficientov informatívnej bezpečnosti. Dichotomické koeficienty hodnotenia nedovolených *prienikov reprezentujú numerické charakteristiky a ich pripravenosť asimilovať do letiskového prostredia výsledok ohrozenia. Identifikovať stupeň istenej bezpečnosti je možné za pomoci metód, kde ich úroveň je možné štatisticky vyhodnocovať. Článok stanovuje informačné kritérium jedného inteligentného letiskového systému ako jeden z výsledkov experimentu prezentujúci model bezpečnosti letiska, ktorý na základe vstupných a výstupných premenných sleduje aktuálny stav nebezpečia na konkrétnom letisku.*

Kľúčové slová: *nebezpečenstvo, letiskový komplex, kontrolný bezpečnostný systém, bezpečnostné modely.*

Introduction

The security processes in the airport complex are represented by the obtained data for model designs, which can be conceptually described by the security properties themselves. Models and their creation will be largely identified by key safety manifestations that are verifiable by experiments [1]. One of the manifestations of the degree of danger is cognitive information about the strength of the threat, which is determined by the volume of risks. Increasing threats at airports are of serious security and economic importance. The term cognitive informativeness is the perceived ability to generate (by sensors) information, which is carried by signals. In connection with security control mechanisms, raising the level of information can be achieved by:

1) improving the quality of hardware, measurement methods, the accuracy of control airport intelligent sensors and the quality of data processing by airport systems,

2) extending the working time of airport security control systems. This requirement is determined by the lifetime of the technical equipment of the airport security systems. It has a temporal, cyclical character, up to the manifestation of security flaws. The number of start (commissioning) is also important, which should exceed the value specified by the manufacturer,

3) by setting the correct security of the airport, it is possible to reach the limit state of those critical parameters that are required to be identified. With such a set mode, this is possible by variable changes of control parameters,

4) In extreme load regimes that are predefined to identify suspects. (timely preventive control and submission of information on wanted and dangerous persons) [2].

1. The cognitive informative function of safety

The need to increase informative accuracy about threats at airports is usually of a one-factor nature. In a specific case, the proposed model may have one of the following approximation functions:

$$y_i = a_0 + a_i . x_i + \varepsilon_i, \tag{1}$$

$$y_i = a_0 . x_i^{a_i} + \varepsilon_i, \tag{2}$$

$$y_i = a_0 + a_0 . a_i^{x_i} + \varepsilon_i. \tag{3}$$

It follows from the approximation functions that the awareness of threats is conditioned by the variability of external security factors x_i, which is characteristic of the congested airport. In those cases, it is necessary to include another parameter when the experiment changes from a single factor to a multi-factor character. The security coefficients of the aircraft complex with the object of controlled security control are determined by the number of external factors x_i, which cause synergistic changes due to their reciprocity. In addition, when we compare the number of security levels with each other, we get combinations that e.g. on the reliability of airport security significantly increase the informativeness of the experiment [3].

The whole issue can be narrowed down to the method of controlled security. Assume that responding to threat A changes the security level [4]. Thus, we will further approximate the threat to second-degree polynomials. An experiment aimed at identifying threats, responds sensitively to changes e.g. recording of camera systems with intelligent systems of a modern airport fig. 1.

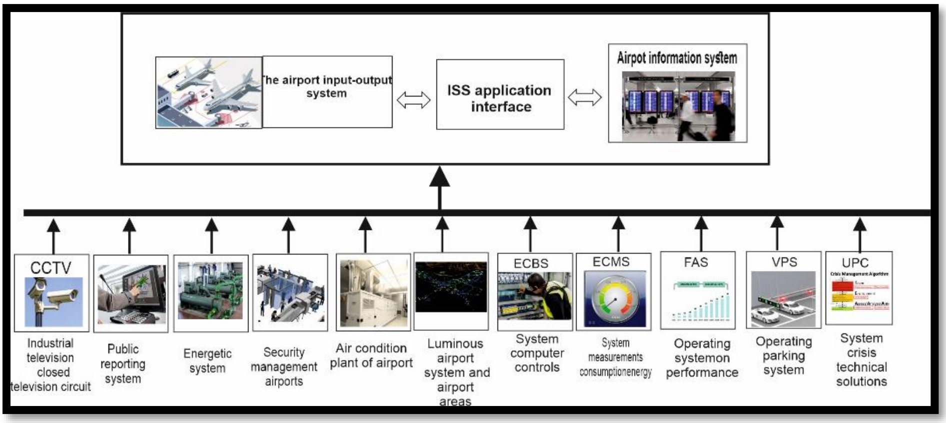

Fig. 1 Conceptual airport system as an element of information security intelligence

The experiment in the given area will therefore be performed in a relatively narrow area of changes in safety factors. The results of the experiment indicate that the idea of using a linear model is adequate only for the local area of the airport "a", in a manner similar to that shown:

$$E(x, y) = y_A(x) - y_a(x), \tag{4}$$

where $E(x, y)$ - the difference between the measured value $yA(x)$ and modelled value $ya(x)$.

It follows from equation (4) that if the variable factors change in the range $inf\, x_{01} \leq x_{01} \leq sup\, x_{01}$, then the approximation error approaches the limit by zero. If the factor values are exceeded during the experiment, the approximation error may increase. The result is the recognition that the sensitivity of the model has too narrow a band and it is necessary to use another polynomial, which will expand the informativeness of the performed experiment. However, if the diapason (range) of factor changes is obviously small and the informativeness is not significantly affected, then they may be excluded from further experimentation. The result of security is limited not only by the saturation of information but also by the way it is used, especially in the decision-making and implementation process of the plan on how to perform automated control. The rational use of measurement results makes it possible to solve complex situation situations even with a small number of safety control devices[5]. An example of this statement will be provided by examples, the input values of which will be taken from experimental measurements at Košice Airport. Assume that the set of factors contains sufficient information about threats, based on which we can determine the order of importance and thus the need to monitor selected hazard factors that may acquire critical states. According to the mentioned method, a mathematical model would be created from the observed situations and model situations, which would be taken as constant (ideal) for the simplicity of the calculation.

The source of information is the results of observations, which we gradually refine mathematical models. A prerequisite for a successful experiment is reliability, which preserves the level of informativeness of each threat until the first manifestation of a successful attack with the manifestation of the final response to an airport element of the system. However, a change in informativeness does not have to be associated with a change in reliability. In the process of experimental identification, various types of security (in the sense of definition) come to the fore [6]:

- functional safety,
- technical safety,
- economic security,
- information security.

2. The Coefficients of experimental identification of functional safety

The Experimental identification of the local security of airport systems appears to the observer as a complex of operations associated with observation or surveillance. All similar security control systems are characterized by errors that cause real danger. This has an impact, for example, on the efficiency of airport systems. Every manifestation of error, change of characteristics, the occurrence of danger, reduces the efficiency and utility value of the monitored airport system. The degree of loss of efficiency of these systems is associated with the concept of the loss function, which is determined by time existence and has a notation $\ell(y,t)$. For example. the loss function may make an unacceptable difference $\Delta y(t)$ between the actual output - $y(t)$ and modelling situation $y_M(t)$, which requires the interruption of the tracking action at the moment t**Chyba! Nenašiel sa žiaden zdroj odkazov.**:

$$\ell(y,t) = \Delta y(t) = y(t) - y_M(t). \tag{5}$$

When $y_M(t)$ represents an ideal situation of danger and $\varepsilon_X(t)$ interfering effect on the control object (its hazard factors x_i) it works. Where F the transformation operator of the resulting hazard estimation is projected into the process functions of experimental identification, then the loss function has the form:

$$\ell(y,t) = F[x_0(t) + \varepsilon_x(t)] - F[x_0(t)] \tag{6}$$

According to (6), the effectiveness of the intervention is then affected only by the emerging problems posed by the function $\varepsilon_x(t)$. Another example of a loss function is the square of the difference between the real and ideal dangers of a process experiment:

$$\ell(y,t) = \{F[x_0(t) + \varepsilon_x(t)] - F[x_0(t)]\}^2 \quad (7)$$

Equations (5), (6) make it possible to define the loss function of the security efficiency of experimental identification as follows:

When the control task is given to estimate the security of the experimental identification defined by level A, which represents the maximum quality, then we request that the loss function be minimal. In this case, the loss function will be expressed by a mathematical hope in the form:

$$W(t,A) = M[\ell(y,t)]. \quad (8)$$

For case (8) the functional safety will be determined by the mathematical hope of the error of the output situation (intervention) on the object for time t and case (7) by the mean square error.

If the condition for the success of the intervention is the quality of its level, the value of which is known in advance, i. if the loss function does not exceed its specified level, then the probability of achieving it is chosen as the criterion of functional efficiency.

$$W(t,A) = P\{t,A\} = Probability\,\{\ell(y,t) < \ell(y,t)_d\}, \quad (9)$$

where:

$P\{\ell(y,t)_d\}$ - the value of the loss function is reached.

The criterion of functional safety is of a universal nature. In particular, criterion (9) makes it possible to estimate the safety of aerodrome complex systems because physical knowledge of their function is not required for the estimation and is independent of their complexity and interconnectedness. The security of experimental identification also includes airport service systems, which are elements of the efficiency of the airport system [8]. The criterion of mathematical hope of performing experimental identification tasks is not always applicable, because the physical meaning and expression of its level are considerably different for different airport systems that are part of the aviation complex.

2.1. Special factors of functional safety

By *"specific security factors"* we mean the quantification of the quality of each process of experimental identification of threats and hazards. The criteria that determine the accentuated functional safety thus directly affect the values of the safety estimate expressed by the calculation of the loss functions of the individual monitoring functions. Experimental identification at such speeches quantifies the quality of the protection of airport systems, the degree of backup protection, diagnostic and safety alarms.

2.2. The coefficients of information security

The entropy of the state of the i-th safe object, when the j-th object is excluded from the efficiency estimate, is determined by the approximate equation:

$$H_{ij} = -\int_{y_{min}}^{y_{max}\int} f_i(y)\, log_2 f_i\,(y)dy, \tag{10}$$

Where $f_i(y)$ - is the density of the distribution of the output coordinate y, of the activities identified object,

y_{max}; y_{min} – the minimum and maximum values of the output coordinate that are reached in the interval $(-\infty\ \ldots\ +\infty)$. In the practical inspection of the object, it is useful to use an even distribution:

$$H_{ij} = log_2(ymin_{max}). \tag{11}$$

The coefficient of informative security of the j-th inspected object, for which the process of experimental identification takes place, is determined by the relation:

$$y_{ij} = 1 - \frac{H_{ij}}{H_{i\bar{j}}}, \tag{12}$$

where:

y_{ij} – the information security factor,

H_{ij} – the entropy of the i-th controlled airport object,

$H_{i\bar{j}}$ the entropy of all airport objects.

It follows from relation (12) that the smaller the entropy of the object that is subject to detailed control (H_{ij}),($\bar{j}$ represents the exclusion of a cooperating object), the higher the coefficient (y_{ij}). The coefficient of information security is usually synthesized from the previous criteria and includes readiness, reliability, serviceability, controllability, normativity, etc. According to the above principles, an informative function is determined, the model of which will be analyzed in the *MATLAB Simulink* environment [9]. Let the response to the controlled control be a change in the angle of view of the intelligent systems recording α and the speed in the recording from intelligent surveillance systems is fig.2:

alfa=0:.1:30; V=0:.3:90; Critical and allowed values are:
alfakr=90; degree of control,
alfapov=45; degree of control,
Vvkr=4; Mbit/s; speed of recording intelligent systems.
Vdov=0.5; Mbit/s; allowed speed of recording intelligent systems.
Then (12) is:
Fneb=1-[1-((alfa-30)./10).^0.5].[1-((0.5-Vv)./20).^(10./(40-alfa))];*
X=real (Fneb);
Y=imag(Fneb);
absFbneb=(X.^2+Y.^2). ^0.5.
%Normovanie:
absFbnebN=absFbneb./1.6221;
Fneb=1-absFbnebN.

Safety:
Fbesp=1-Fneb.
tlg1=0:.1:30; tlg2=0:.3:90;
figure(1);plot(tlg1,Fbesp,'b','LineWidth',3),grid on,hold on,
figure(1);plot(tlg1,Fneb,'r','LineWidth',3),grid on,
title(' Intelligent airport systems' record security information functions,'FontSize',14),
ylabel('Information function values','FontSize',14),
xlabel ('Airport area recording time slots','FontSize',14),
xlabel('Time slots for positioning and switching of airport complex areas','FontSize',14),

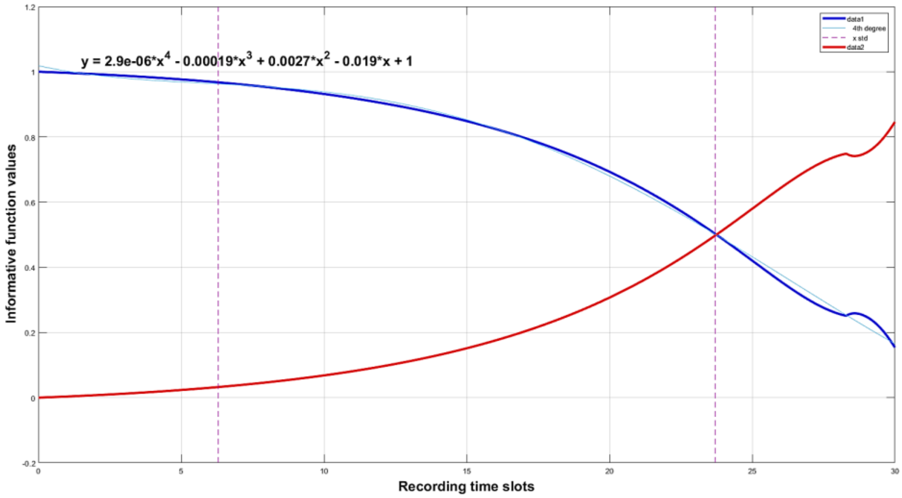

Fig. 2 The intelligent airport systems' record security information functions

Conclusion

The performed analysis is in accordance with the valid rules and the direction of information security, especially with the precise control of the surrounding airport environment. The resulting effect is a methodology for designing models with impossible intrusions into security and its routing to aviation security control systems. The scientific and technical character of the subject of research is concretized and illustrated so that it can be used in pedagogical and aviation practice. The used methodology of analysis and synthesis points to the principle of creating information functions and its shift through critical areas to ongoing dangerous situations. Information for the procedure is performed by intelligent sensory control systems. The used non-thematic models of flight situations in the form of the presented equations accepted the basic properties of airport control systems. The special contribution of the authors is:

- theoretical basis of the design of the method of analysis of air safety information insurance
- methodology of shaping informative functions in semilogarithmic coordinates,

- methodology of selection and placement of xi sensors in the situational state of the airport.

References

(Books)

[1] MADARÁSZ, L. *Stochastické procesy a teória informácií.* Alfa, Bratislava, 1984. 230 pp.

[2] VAVŘÍN, P. *Malá encyklopedie elektrotechniky.* Automatizační technika. SNTL. Praha, 1983. 660 pp.

[3] LAZAR, T., BRÉDA, R., KURDEL, P. *Inštrumenty istenia letovej bezpečnosti.* TU Košice, 2011. 232 pp. ISBN 978-80-553-0655-1.

[4] ADAMČÍK, F., KURDEL, P., LAZAR, T., MADARASZ, L.*Veda a experiment v doktorandskom štúdiu*, TUKE 2015 vysokoškolská učebnica, ISBN 978-80-

[5] LAZAR, T, MADARASZ, L, GAŠPAR, V. *Procesná analýza odhadu efektívnosti identifikácie MPM s inteligentným riadením*, Elfa, s.r.o. Košice , 2013, 70-73 pp. ISBN 978-80-8086-200-8

[6] SCHIMIDT, D.T.,: Cooperative synthesis of control and display augmentation, Wiliamsburg, 1996, Colect. Techn. Pap. New York, s 732-742.

[7] JADLOVSKÁ, A., JADLOVSKÁ, S.: Moderné metódy modelovania a riaenia nelineárnych systémov: Elfa s.r.o., 2013,ISBN 978-80-8086-228-2

(Journals)

[8] ZAREMBA, J., KURDEL, P., KORBA, L.: Situational management of complex airport systems, 13. ročník medzinárodnej vedeckej konferencie: *Bezpečné Slovensko a európska únia 2019*, Košice, 14.-15.11.2019, ISBN 978-80-8185-036-3

(Data, reports, thesis)

[9] KURDEL, P. *Vedecko-pedagogické aspekty experimentu a modelovania so zložitými leteckými systémami* Ph.D. Dissertation – Technical University of Košice, Aeronautical faculty; Avionics department. Košice: TUKE LF, 2015, 148 strán.

Autori:

[1]**Jaroslav Zaremba** – External PhD. student**,** The University of Security Management in Košice, Košťova 1, Slovakia, jaroslav.zaremba@vsbm.sk

[2]**Pavol Kurdel –** Technical university of Košice, Rampová 7, Slovakia, e-mail: Pavol.kurdel@tuke.sk

[3]**Štefan KOČAN –** The University of Security Management in Košice, Košťova 1, Slovakia, stefan.kocan@vsbm.sk