

NATIONAL ACADEMY OF SCIENCES OF UKRAINE  
MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL AVIATION UNIVERSITY



# PROCEEDINGS

**THE SEVENTH WORLD CONGRESS  
"AVIATION IN THE XXI-st CENTURY"**

**"Safety in Aviation  
and Space Technologies"**

**September 19-21, 2016  
Kyiv, Ukraine**

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## **COFOUNDER**

- ➔ National Aviation Academy "Azerbaijan Hava Yollari" Closed Joint-Stock Company, Azerbaijan
- ➔ Georgian Aviation University, Georgia
- ➔ Nanchang Hangkong University, China
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- ➔ Polish – Ukrainian Research Institute, Poland-Ukraine

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# **SYMPOSIA**

## **SYMPOSIUM 1. MODERN SPACE AND AVIATION TECHNOLOGIES**

- 1.1. Automation and energy saving on aviation transport
- 1.2. Modern technologies of aircrafts airworthiness support
- 1.3. Fatigue and fracture of aircraft structures
- 1.4. Modern tribotechnologies in aircraft and general-purpose mechanical engineering
- 1.5. Engines and Power Installations
- 1.6. Methods and facilities of technical and medical diagnostics
- 1.7. Automated process control systems
- 1.8. Information technology and systems in the aviation industry
- 1.9. The intellectual robot-technical measuring complexes and systems
- 1.10. Cybersecurity in civil aviation
- 1.11. Mathematical modeling and numerical methods
- 1.12. Computer systems
- 1.13. Advanced information technologies in aviation

## **SYMPOSIUM 2. UNMANNED AIRCRAFT SYSTEMS (UAS)**

## **SYMPOSIUM 3. AIR NAVIGATION AND ATM SYSTEMS**

- 3.1. Prospects aviation telecommunication systems
- 3.2. Aviation English for flight safety
- 3.3. Complex systems control
- 3.4. Avionics
- 3.5. Human Factors: engineering and technical, psychological and medical-biological aspects
- 3.6. Communication, navigation, surveillance

## **SYMPOSIUM 4. IEEE RADAR METHODS AND SYSTEMS WORKSHOP (RMSW-2016)**

/September, 27-28, 2016/

<http://ieee.nau.edu.ua/rmsw-2016/index.html>

## **SYMPOSIUM 5. ENVIRONMENT PROTECTION**

- 5.1. Biotechnology in aviation
- 5.2. Land management, cadastre and land monitoring
- 5.3. Chemical technology and engineering
- 5.4. Environmental protection

## **SYMPOSIUM 6. AVIATION CHEMMOTOLGY**

## **SYMPOSIUM 7. COMMUNICATION FACTOR IN MODERN INTERNATIONAL RELATIONS**

- 7.1. Information and legal principles of international relations
- 7.2. The transformation of journalism in the context of technologizing the world and the processes of globalization
- 7.3. The international scientific and technical cooperation of Ukraine in aerospace industry

## **SYMPOSIUM 8. ECONOMY AND MANAGEMENT IN AVIATION**

### **SYMPOSIUM 9. HUMAN FACTOR IN AVIATION**

- SESSION A. Language Modelling of Aviation Information Systems
- SESSION B. Human Factor Management: Current Situation and Prospects
- SESSION C. Psychology of Aircraft Operation Safety

### **SYMPOSIUM 10. PROBLEMS OF DEVELOPMENT OF THE MODERN AIRPORT**

- 10.1. Urban, industrial, civil and transport construction
- 10.2. Design of architectural environment
- 10.3. Technical aesthetics and design

### **SYMPOSIUM 11. AIR AND SPACE LAW: INTERNATIONAL AND NATIONAL ISSUES OF SECURITY**

### **SYMPOSIUM 12. INNOVATIVE TECHNOLOGY OF PROFESSIONAL TRAINING ON THE BASIS OF HIGHER EDUCATION**

### **SYMPOSIUM 13. ICAO SAFETY STRATEGIES**

## CONTENTS

---

### SYMPOSIUM 1. MODERN SPACE AND AVIATION TECHNOLOGIES

---

#### **1.1 Automation and energy saving on aviation transport**

---

|   |        |
|---|--------|
| <i>A.G. Kapustin, N. S. Karnauhov</i><br>The structure of the electricity system with digital control for future aircraft   | 1.1.1  |
| <i>I. Prokhorenko, S. Galchenko, N. Timoshenko</i><br>Neural network model for predicting the level of residual knowledge of the subjects of study                            | 1.1.4  |
| <i>S.S. Ilyenko</i><br>Automation and remote control of lighting airfields systems modern civil aviation  | 1.1.7  |
| <i>Y. Zaharchenko, N. Sokolova, G. Burenina</i><br>Designing an automated decision support system for energy management system of educational institutions                    | 1.1.10 |
| <i>V.P. Zakharchenko, S.S. Tovkach</i><br>Integrated automated test control systems of aviation equipment   | 1.1.15 |
| <i>S.S. Tovkach, E.A. Shkvar</i><br>CUDA-based massively parallel computing application for improving the efficiency of turbulent flows modeling and methods of their control | 1.1.17 |

#### **1.2. Modern technologies of aircrafts airworthiness support**

---

|  |        |
|--|--------|
| <i>V.A. Kasianov, A.V. Goncharenko</i><br>Multi-alternativeness of aircraft airworthiness support modern technologies                | 1.2.1  |
| <i>A.V. Goncharenko</i><br>Distinguishing minimal engineering diagnosis risks via preferences functions                              | 1.2.6  |
| <i>A.V. Goncharenko</i><br>Modeling aviation legislation influence upon airworthiness support technologies via preferences functions | 1.2.11 |

#### **1.3. Fatigue and fracture of aircraft structures**

---

|   |        |
|---|--------|
| <i>G. Seidametova, J-B. Vogt, I. Proriot Serre</i><br>AFM study of microstructure role in the fatigue of martensitic steel                          | 1.3.1  |
| <i>V.V. Astanin, O.A. Schevchenko, O.V. Dydenko</i><br>Deformation and damage of modern composites at low velocity impact event                     | 1.3.6  |
| <i>S.S. Yutskevych, I.I. Dzhavadova</i><br>Features of fatigue lifetime calculation method application for standardized variable amplitude spectrum | 1.3.11 |

|   |        |
|---|--------|
| <i>M.V.Karuskevich, T.P. Maslak, Hu Xingfeng, D. Kosteniyuk</i><br>Direct optical biaxial fatigue monitoring  | 1.3.15 |
| <i>N. I. Delas, V.A. Kasyanov</i><br>Entropy-energy model of fatigue defects  | 1.3.20 |
| <i>V.P. Golub, A.V. Plashchynska</i><br>A numerical modelling of the fatigue crack growth in a thin isotropic plate under plane stress state            | 1.3.25 |
| <i>L.I. Muravsky, T.I. Voronyak, I.V. Stasyshyn</i><br>New approach for determination of fatigue process zone parameters by surface nanorelief analysis | 1.3.30 |
| <i>S.R. Ignatovich, V.S. Krasnopolskii</i><br>Fatigue cracks growth features in aluminum alloy D16AT  | 1.3.34 |

#### **1.4. Modern tribotechnologies in aircraft and general-purpose mechanical engineering**

|   |        |
|---|--------|
| <i>M.V. Kindrachuk, V.M. Kramar, O.I. Dukhota, I.A. Gumeniuk, N.O. Naumenko</i><br>Analysis of the fretting process of surface layers based on the energy model of triboprocess         | 1.4.1  |
| <i>O.V. Bashta</i><br>Initiation and propagation of microcracks in aluminum   | 1.4.7  |
| <i>Pavlo Nosko, Oleksiy Karpov, Pavlo Fil, Grigory Boyko, Dmitriy Marchenko</i><br>Noncircular-screw gears  | 1.4.12 |
| <i>Valeriy Stavtyskyy, Pavlo Nosko, Pavel Fil, Oleksiy Karpov, Grigory Boyko</i><br>Power losses of gear systems  | 1.4.22 |
| <i>I.P. Belokur, O.V. Radko, H.A. Medvedeva</i><br>The principles of the organization of nondestructive testing at the enterprise   | 1.4.32 |
| <i>V.I. Kravtsov, V.V. Veremijchyk, A.G. Yakymchuk</i><br>The method of determining the stress-strain state of tanks of rocket constructions  | 1.4.36 |
| <i>V.F. Labunets, V.V. Zagrebelniy</i><br>Improve the stability of the cutting tool of steel R6M5 with wear-resistant coatings  | 1.4.41 |
| <i>A.O. Kornienko, S.V. Fedorchuk</i><br>Tribological investigations of composite electrolytic coatings with nickel-eutectic alloy powders  | 1.4.46 |
| <i>O.O. Mikosianchik, R.G. Mnatsakanov, A.M. Khimko, M.S. Khimko, M.S. Shakuliev</i><br>Tribotechnical characteristics of self-fluxing covering in non-stationary condition of friction | 1.4.51 |

*I.N. Pohrelyuk, S.M. Lavrys*  
Tribotechnical and mechanical properties of BT22 alloy after deformation-  
diffusion surface hardening 1.4.57

## **1.5. Engines and Power Installations**

*Yu.M. Tereshchenko, K.V. Doroshenko, Yu.Yu. Tereshchenko*  
Working process of bypass gas turbine engines with turbo-fan additional unit 1.5.1

*K.I. Kapitanchuk, M.Y. Bohdanov, P.I. Grekov*  
Research of exhaust-screen devices for jet-engine 1.5.6

*A.S. Yakushenko, A.Dj. Mirzoyev, M.A. Hajiyeu*  
Application of the genetic algorithms in an aviation gas turbine engines  
diagnostics 1.5.11

*A.M. Qasem*  
Complex of the programs for support of information integrity while  
displaying the integrated dynamic scenes in automated air traffic control  
systems 1.5.17

*M.I. Kislyak*  
Study of the mesh parameters for results in CFD - calculation of fan stage  
turbofan 1.5.22

*Mikola Kulik, Mikola Koveshnikov, Larysa Volianska, Yana Petruk,  
Bogdan Petruk*  
Mathematical model of thermocyclic durability estimation of heat-resisting  
alloys on the basis of experimental diagram of boundary stresses 1.5.27

*V.V.Panin, L.G.Volyanska, I.I. Gvozdetskiy, I.F. Kinaschuk*  
Analysis change of gas-dynamic stability of gas turbine engine  
compressors at operation on transient modes 1.5.41

*Yu. Basaraba, Ye. Brodnikovskiy, M. Brychevskiy, N. Lysunenko,  
I. Polishko, O. Vasylyev, I. Perekopskyi*  
The quasi-perpetual electricity generating device based on ceramic fuel cell  
for closed systems 1.5.46

## **1.6. Methods and facilities of technical and medical diagnostics**

*S.F. Filonenko*  
Acoustic emission amplitude-energy parameter at change of composite  
properties for its thermo-activative destruction 1.6.1

*V.D. Kyzovik, A.G. Gordieiev*  
The statistical approach for diagnosis and prediction operator's  
psychophysiological states 1.6.5

*G.V. Martyniuk, L.M. Scherbak, M.E. Fryz*  
Information support of computer measuring experiments in evaluating of  
the noise processes characteristics 1.6.10

|   |        |
|---|--------|
| <b><i>N.B. Marchenko, G.V. Martyniuk, L.M. Scherbak</i></b>   |        |
| Main stages of the life cycle of virtual systems to measure characteristics of the stochastic noise processes         | 1.6.15 |
| <b><i>I. N. Pohrelyuk, S. M. Lavryys, I.V. Stasyshyn, O. V. Penkovyi</i></b>  |        |
| Assessment of the quality of the titanium surface after mechanical and chemical thermal treatments                    | 1.6.19 |
| <b><i>A.L. Pusyryov, V.V. Ushakov</i></b>   |        |
| A method of inspection to control airframe design elements  | 1.6.24 |
| <b><i>I.P. Belokur</i></b>  |        |
| Diagnosing of designs elements of the aircraft  | 1.6.29 |
| <b>1.7. Automated process control systems</b>   |        |
| <b><i>A.V. Statsenko</i></b>  |        |
| Inverter solar panel control by the criterion of maximum generated power  | 1.7.1  |
| <b><i>N. Vasylenko</i></b>  |        |
| Noise method of temperature measuring with correlation processing of noise signal                                     | 1.7.5  |
| <b><i>T.F. Shmelova, Yu.V. Sikirda, A.V. Zemlyansky</i></b>   |        |
| Neural network model of evaluating the timeliness of desicion-making during simulator training                        | 1.7.9  |
| <b><i>A.K. Ablesimov</i></b>  |        |
| Method of selecting the corrective devices of automatic control systems   | 1.7.14 |
| <b><i>I.Yu. Sergeyeu</i></b>  |        |
| Analysis of the potentiation digital-to-analog converter with accounting of imperfection of integrator                | 1.7.19 |
| <b><i>M.K. Filyashkin</i></b>   |        |
| Automated system of air-to-air refueling civil aircraft   | 1.7.24 |
| <b><i>A.V. Brykalov</i></b>   |        |
| Computer-aided design system of unmanned aerial vehicles during preliminary design                                    | 1.7.29 |
| <b><i>S.P. Borsuk, A.V. Kusyik</i></b>  |        |
| Corrected testing algorithms components based on pilots education process limitations                                 | 1.7.34 |
| <b><i>V.M. Sineglazov, G.I. Kryvoboka, O.M. Skrynnyk, A.M. Silvestrov</i></b>   |        |
| Review of some important innovations not yet implemented in aviation  | 1.7.39 |
| <b><i>V.M. Sineglazov, A.P. Godny, O.Yu. Yuhymenko</i></b>  |        |
| Formation of an integrated model based on dynamic data integration and simulation procedures of the production system | 1.7.49 |
| <b><i>M.P. Mukhina</i></b>  |        |
| Algorithm of correlation-extreme correction of inertial dead reckoning by linear landmark                             | 1.7.53 |

|   |        |
|---|--------|
| <b>A.P. Kozlov, O.S. Yurchenko</b><br>Onboard monitoring system of ground aircraft download   | 1.7.60 |
| <b>O.Yu. Krasnousova</b><br>Quality estimation of an unmanned aerial vehicle in acceptance sampling   | 1.7.64 |
| <b>V.P. Kharchenko, O.N. Alexeiev, R.I. Yurchik</b><br>General principles of decision-making support in provision of guaranteed level of safety | 1.7.67 |

## **1.8. Information technology and systems in the aviation industry**

|   |        |
|---|--------|
| <b>P.M. Pavlenko, Y.V. Vlasenko</b><br>Information technology of integrated competency assessment of specialists in 3D modeling   | 1.8.1  |
| <b>O. Palagin, M. Vasyuhin, O. Tkachenko, V. Shelestovskyi</b><br>Modern information technologies and prospects of precision agriculture in Ukraine                                     | 1.8.5  |
| <b>M.Vasyuhin, M. Kasim, A. Sinitsyn, I. Ivanyk,</b><br>Programmatic means for forming and reflection movable symbol of air object on the map   | 1.8.9  |
| <b>O.V. Zaritskyi, P.M. Pavlenko, V.V. Sudik</b><br>Professional activity informational model database structure  | 1.8.12 |
| <b>T.A. Prokopenko</b><br>Optimize selection strategy in systems of technological complex continuous type   | 1.8.16 |
| <b>O.M. Prokhorenko, G.L. Baranov</b><br>The adaptive strategy collision risks avoidance for a high quality service and unprecedented traffic safety of the vehicles operations drivers | 1.8.19 |
| <b>V.M. Kurochkin</b><br>Geoinformational technology for aerial data analysis   | 1.8.24 |
| <b>B. Ahmetov, V. Tretyak, D. Sviridenko</b><br>Information technology for data exchange between production purpose integrated automated systems  | 1.8.28 |
| <b>S.V. Koziyakov</b><br>Method and technology management motivation IT-specialists   | 1.8.33 |
| <b>V. Kudriakov, T. Zaharchuk</b><br>Disruptive industry 4.0 technologies. Opportunities and challenges of the industrial internet  | 1.8.36 |
| <b>I. Teslia, I. Khlevna, O. Yehorchenkov</b><br>Implementation project management methodologies in airspace industries on the basis impact theory                                      | 1.8.40 |

## **1.9 The intellectual robot-technical measuring complexes and systems**

|  |        |
|--|--------|
| <b>V.S. Martyniuk</b><br>Bioresonance  | 1.9.1  |
| <b>A.V. Rudyk, V.P. Kvasnikov</b><br>Characterization of objects moving in the decomposition of functions in Fourier series  | 1.9.6  |
| <b>V.P. Kvasnikov, N.I. Kulik</b><br>Calculation of industrial LED device  | 1.9.11 |
| <b>L.V. Kuzmych, M.O. Katayeva</b><br>Features of measuring mechanical quantities into account water and heat  | 1.9.15 |
| <b>V.V. Kovalchuk, N.G. Serbov, T.V. Krighanivs'ka, V. M. Ilchenko</b><br>Nano-Cluster Structure as Elements of the Optical System                                 | 1.9.19 |
| <b>A.V. Kharchenko, S.V. Golub, O.I. Osmolovskyi</b><br>Multi-pattern recognition technology in autonomous systems   | 1.9.22 |
| <b>O.M. Bezvesilna, A.G. Tkachuk, L.O. Chepiuk, V.P. Kvasnikov</b><br>Aviation gravimetric system with the vibrating string gravimeter                             | 1.9.27 |
| <b>R.V. Petrosyan, O.I. Osmolovskyi</b><br>Synthesis of window function to improve the estimation accuracy of the amplitude spectral component of periodic signals | 1.9.31 |

## **1.10. Cybersecurity in civil aviation**

|   |         |
|---|---------|
| <b>O.V. Gavrylenko, D.S. Matviiv</b><br>Regulatory and technical control providing information security, that requiring protection under the law, based on the international standards of information security management | 1.10.1  |
| <b>V.G. Kononovich, J.V. Dubovoj, I.V. Kononovich</b><br>Transformation of cybersecurity critical infrastructure and robot's security   | 1.10.4  |
| <b>O.G. Korchenko, O.S. Illyash</b><br>The generalized classifications of threats on unmanned aircraft systems in un-segregated airspace/non-segregated airspace  | 1.10.10 |
| <b>Igor Ivanov</b><br>Infosec for civil aviation  | 1.10.14 |
| <b>V.A. Lakhno, T.A. Petrenko</b><br>A model developed for teaching an adaptive system of recognising cyberattacks in information systems   | 1.10.17 |
| <b>S.G. Semenov, V. V. Davydov, D.S. Hrebeniuk</b><br>Software copyright protection using identification key  | 1.10.20 |
| <b>A.V. Ilyenko</b><br>Cryptographic system Gentry: basic concepts and mathematical aspects   | 1.10.24 |
| <b>G.B. Vilsky</b><br>Qualitativity of methods and models of navigation information security  | 1.10.27 |

|   |         |
|---|---------|
| <b>V.V. Glovatskyi</b><br>Analytical basis of physical security determination   | 1.10.31 |
| <b>A.Ja. Beletsky</b><br>Matrix exchange encryption keys protocol on open communication channels  | 1.10.35 |
| <b>Sergey Semenov, Svetlana Gavrilenko, Illia Sheverdin</b><br>Development of antivirus security system   | 1.10.39 |
| <b>S. Dobrovolskyi, Wang Bo, S. Volhonskyi, V. Klobukov, O. Zykov, S. Ermak</b><br>Information protection in automated information systems. Definition, threats, approaches and measures to protect information | 1.10.42 |
| <b>Boris Zhurilenko, Nadezhda Nikolaeva, Kirill Nikolaev</b><br>The methodology of information technical protection complex design  | 1.10.46 |

### **1.11. Mathematical modeling and numerical methods**

|   |         |
|---|---------|
| <b>Petr V.Lukianov</b><br>Sound generation by vortex flow – helicopter’s rotor blade interaction  | 1.11.1  |
| <b>Pavlo.V.Lukianov</b><br>Vortex description for non-compressible fluid and compact vortex models  | 1.11.6  |
| <b>Y.O. Krashanytsya, Amir Hoshmandi</b><br>Triangulation method of bearing surfaces of aircraft systems  | 1.11.12 |
| <b>A.E. Istomin, N.E. Khatsko</b><br>Statistical research and simulation of MEMS gyros measurements   | 1.11.17 |
| <b>Yu. A. Plaksiy</b><br>Multiplicative three-frequency models of a rigid body rotation in error analysis for algorithms of determination of orientation  | 1.11.22 |
| <b>H. Ye. Deshko</b><br>Numerical simulation of supersonic chemically reacting combustion products jets under parabolic Navier-Stokes equations   | 1.11.27 |
| <b>A.M. Pavlyuchenko, O.M. Shyiko</b><br>Modeling of the Aerophysical characteristics of supersonic aerodynamic objects along the flight trajectory   | 1.11.31 |
| <b>A.G. Kapustin, E.V. Balich</b><br>Analysis of ventilation systems of aircraft electrical generators taking into account changes the aircraft flight parameters   | 1.11.35 |
| <b>V.V. Mityukov</b><br>Problems the universality of the computational schemes for the processes approximation  | 1.11.39 |
| <b>Y.Z. Leschyshyn, O.B. Nazarevych, G.V. Shymchuk, E.A. Revutskyi, L.M. Shcherbak</b><br>The Methods of Change Point Detection and Statistical Estimating of Dynamic of the Noise Stochastic Signals Characteristics | 1.11.43 |

|  |         |
|--|---------|
| <i>S.V. Shengur, O.V. Dergunov</i><br>Methods of spherical data modeling overview  | 1.11.47 |
| <i>N.P. Tupko, Y.G. Lyashenko</i><br>Investigation of estimation of the mixed second-order moment in bilinear unbiased estimates class | 1.11.51 |
| <i>N.M. Glazunov</i><br>Motivic models and applications  | 1.11.55 |

## **1.12. Computer systems**

|  |         |
|--|---------|
| <i>Y.B. Artamonov, O.V. Panforov</i><br>Realization approaches of hardware and software complex for braille font reading                           | 1.12.1  |
| <i>O.M. Glazok</i><br>The Lattice Boltzmann method with temperature-dependent transfer coefficients  | 1.12.6  |
| <i>A.O. Dluzhevskiy, Y.P. Don</i><br>Input data filtration in the identification systems   | 1.12.9  |
| <i>S.V. Egorov, T.Yu. Shkvarnytska</i><br>Research of the method for determining the reliability and diagnosis of computer-aided technical systems | 1.12.14 |
| <i>G. Kvita, O. Kucheryava</i><br>Modern methods of analysis of unstructured data in information systems   | 1.12.19 |
| <i>M. Kuklinskyi, I. Gyza</i><br>Distributed security systems of information resources in corporate networks                                       | 1.12.22 |
| <i>O.O. Zholdakov</i><br>Aircraft maintenance routing for single air company   | 1.12.25 |

## **1.13. Advanced information technologies in aviation**

|   |         |
|---|---------|
| <i>N.A. Sidorov</i><br>Software engineering and aviation safety   | 1.13.1  |
| <i>N.N. Sidorova</i><br>Instrumental software for aviation safety   | 1.13.8  |
| <i>M.V. Olenin, D.Y. Likhachov</i><br>Constructing augmented reality applications   | 1.13.14 |
| <i>Y.M. Ryabokin</i><br>Review methods of software cost estimation  | 1.13.22 |
| <i>A.M. Qasem</i><br>Complex of the programs for support of information integrity while displaying the integrated dynamic scenes in automated air traffic control systems | 1.13.25 |

**E.V. Chebanyuk, K.K. Markov**

About mathematical foundations for software model to model transformation approaches

1.13.30

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## SYMPOSIUM 2. UNMANNED AIRCRAFT SYSTEMS (UAS)

---

**A. Leheida, A. Serhiychuk, S. Vorobyov, I. Ermolenko, V. Alexandrov, P. Garnets** 2.1

Cooperation between science and defense in the unmanned aviation field

**D.E. Prusov**

State and Prospects for Development of Unmanned Aviation Technologies at the National Aviation University 2.3

**V.A. Sereda, M. V. Ambrozhevich**

Formation of a compact system shape of a mortar launch unmanned aerial vehicle 2.8

**V.M. Mel'nick, G.V. Boiko, V.P. Kosova**

Combat robots. Flying underwater-ground robot-racer 2.11

**Rahmati Ahmad, D.N. Zinchenko**

Experimental study of aerodynamic characteristics of closed parabolic wing 2.14

**V.V. Konin, T.I. Olevinska**

Determination of the indicated air speed without data from pitot tubes 2.22

**M. Lacane, Aleksandrs Urbahs**

Main Factors to be Taken into Consideration When Planning a Route for Remotely Piloted Aircraft System in riga flight information region 2.27

**V.V. Konin, E.A. Kovalevskiy, F.O. Shyshkov**

Concept of group debris cleaning using unmanned servicing spacecraft 2.34

**V.V. Kabaniachyi**

Rules, requirements and procedures for private remote pilot training 2.38

**D.I. Bondarev, O.N. Alexeiev, T.F. Shmelova, A.I. Sedina**

Unmanned Aircraft Usage in The Municipal Air Transport of Ukraine 2.43

**T.F. Shmelova, A.V. Stratiy**

Distributed control system for remotely piloted aircraft 2.46

**Yulia Kondrashevska**

Unmanned Aircraft Systems of Ukraine: production and using 2.51

**P. Buryi, P. Pristavka**

Automated system of definition the field of view of camera of unmanned aerial vehicle 2.55

**B.I. Dolintse**

Modern trends and issues of the development and improve the accuracy of navigation systems for UAVs 2.59

|  |      |
|--|------|
| <i>S. Dobrovolskiy, Wang Bo, O. Nechyporuk, Y. Nakonechny, V. Klobukov</i><br>UAV flight mechanics   | 2.63 |
| <i>M.P. Matiychyk</i><br>Ways of improving flight characteristics of normal design UAV of<br>"battlefield" class   | 2.68 |
| <i>S. Dobrovolskiy, Wang Bo, O. Zykov, V. Ryabokon, L. Klobukova, A. Sorokun</i><br>Automatic wing leading edge airplane aerodynamic diagnostics system in<br>flight condition | 2.70 |

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### SYMPOSIUM 3. AIR NAVIGATION AND ATM SYSTEMS

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#### 3.1. Prospects aviation telecommunication systems

|   |         |
|---|---------|
| <i>T.O. Herasymenko</i><br>Fourier transform                              | 3.1.1   |
| <i>V.I. Iaremchuk</i><br>The Wavelet Transform                            | 3. 1.4  |
| <i>D.O. Mandrov</i><br>Hidden Markov model                                | 3. 1.7  |
| <i>K.V. Maruk</i><br>Linear predictive coding using voice excited vocoder | 3. 1.10 |
| <i>D.S. Mihailenko</i><br>Speech Recognition Technology and Applications  | 3.1.13  |
| <i>O.C. Repetiy</i><br>Automatic speech recognition                       | 3.1.16  |
| <i>V.O. Safonov</i><br>A Comparison of MPEG-1, MP3, MPEG-2                | 3.1.19  |

#### 3.2. Aviation English for flight safety

|   |        |
|---|--------|
| <i>N. Pazyura</i><br>Important issues of teaching English to aviation personnel                                     | 3.2.1  |
| <i>T.N. Fursenko</i><br>Linguistic redundancy phenomenon in radiotelephony communication<br>between a pilot and ATC | 3.2.5  |
| <i>N.L. Drobysheva</i><br>Lingua-cognitive aspects of professional communication (based on aviation<br>English)     | 3.2.10 |
| <i>Lyudmila Nemliy</i><br>A new approach to aviation English training   | 3.2.14 |
| <i>L. Korol</i><br>European requirements for aviation engineer's training in the UK                                 | 3.2.18 |

*Ya. M. Pylynskyi*  
Culture and linguistic education as important security factors in civil aviation 3.2.21

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*T.P. Kuchai*  
The problem of formation professional qualities aviation specialists to learn English 3.2.26

---

### **3.3. Complex systems control**

---

*S. Devyatkina, S. Vanetsyan*  
Collision risk modeling of the airborne aircraft with obstacles in adjoining aerodrome area 3.3.1

---

*Ye. Gayev, V. Kalmikov*  
The Travelling Salesman Problem in the engineering education programming curriculum 3.3.6

---

*O. Nadsadna*  
Gain-scheduled lateral control system for an UAV 3.3.11

---

*O. Sushchenko*  
Features of inertially stabilized platforms research by means of simulation 3.3.16

---

*L. Zhiteckii, A. Pilchevsky, K. Solovchuk*  
Synthesis of the Digital Autopilot for an Aircraft Using 11-Approach 3.3.21

---

*M. Vasyliiev, D. Kucherov*  
Features the diagnosis of mental and emotional state of a person 3.3.26

---

*V. Azarskov, L. Zhiteckii, K. Solovchuk*  
Robust adaptive stabilization of multivariable static systems with unknown 3.3.30

---

*V. Kirichenko*  
Features information UAV control system 3.3.35

---

*N. I. Delas*  
Entropy analysis for interacting macrosystems 3.3.40

---

*A. Vozniuk*  
Stabilization and pointing system for wheel-track vehicle based on AHRS 3.3.46

---

*A.V. Petrenko, H.V. Tsiрук*  
Damper for vibratory gyroscope that is used in rigid conditions with mechanical impact 3.3.51

---

### **3.4. Avionics**

---

*V. Tronko, V. Romanenko, A. Bieliatynskyi, A. Klochan, D. Vasiliev, Al-Ammouri Ali*  
Polarimetric method for forming aircraft landing glideslope 3.4.1

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*O.G. Sytnyk, L.M. Sytianskykh, Assistant, V.V. Omeliukh, O.P. Korchazhnov*  
Environmental monitoring airspace and the environment in the process of registration UAV for processing and correction control center 3.4.5

|  |        |
|--|--------|
| <i>O.G. Sytnyk, L.M. Sytianskykh, V.V. Omeliukh</i><br>Analysis of the model of human relations in the aviation emergency causes stress                        | 3.4.8  |
| <i>V.M. Gribov, Y.V. Hryshchenko, Y.Y. Hryshchenko</i><br>Empirical evaluation of dependability of avionics components under conditions of after-sales service | 3.4.11 |

### **3.5. Human Factors: engineering and technical, psychological and medical-biological aspects**

|   |        |
|---|--------|
| <i>L.V. Dotsenko, I.V. Karyaka</i><br>Psychological features of future creative thinking of air traffic managers  | 3.5.1  |
| <i>S.K. Meshaninov, K.A. Klochko</i><br>The Human Factor as an Informative Parameter of Integrated System of Biometric Control and Handle of Complex Technical System | 3.5.6  |
| <i>A. G. Guziy, A. G. Kapustin, N. S. Karnauhov</i><br>The evolution of the concept of safety and accident prevention   | 3.5.11 |
| <i>O.V. Petrenko</i><br>The Development of Ideas about Human Factor   | 3.5.16 |
| <i>T.F. Shmelova, Yu.N. Kovalyov, O.S. Sechko, O.V. Shostak, M.V. Vasyliiev</i><br>Intellectual automated control of human state monitoring systems                   | 3.5.21 |

### **3.6. Communication, navigation, surveillance**

|   |        |
|---|--------|
| <i>I.V. Ostroumov</i><br>Analysis of DME/DME positioning facility for Ukrainian airspace  | 3.6.1  |
| <i>I.V. Ostroumov</i><br>Timing problem of multi DME/DME approach   | 3.6.5  |
| <i>V. H. Melkumyan, E.A. Kovalevskiy, T.L. Maliutenko</i><br>Determination of geographical coordinates of the spacecraft at limited number of visible navigation satellites | 3.6.8  |
| <i>N.V. Ladogubets, V.N. Mel'nick, V.P. Kosova</i><br>Noise-protective screen   | 3.6.12 |
| <i>V.V. Karachun, N.V. Ladogubets, S.V. Fesenko</i><br>The nature of resonance features in the suspension of the gyroscope due to diffraction effects                       | 3.6.16 |
| <i>G.V. Boiko, V.V. Karachun, S.V. Fesenko</i><br>Noise-protective case to fight the penetrating acoustic radiation   | 3.6.20 |
| <i>Ing. Victor Julio Hernández González</i><br>Development of aeronautical industry and engineering in Costa Rica   | 3.6.23 |
| <i>V. H. Melkumyan, E.A. Kovalevskiy, T.L. Maliutenko</i><br>Navigation and ballistic support spacecrafts   | 3.6.26 |

**V.P. Kharchenko, V.V. Konin, V.M. Kondratiuk, S.I. Ilnytska, F.O. Shyshkov**

Activities of the National Aviation University in "UKRAINE" project of Horizon2020 to foster EGNSS implementation in aviation sphere in Ukraine 3.6.31

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## SYMPOSIUM 5. ENVIRONMENT PROTECTION

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### 5.1. Biotechnology in aviation

---

**N.A. Nidialkova, L.D. Varbanets, K.G. Garkava, L.O. Troshina**  
Properties of novel protease of *Streptomyces* sp. required for fuel ethanol production 5.1.1

**K.A. Dovgopola, K.G. Garkava**  
Soil pollution with heavy metals and *Plantago major* L. on the territory adjacent to airfields 5.1.4

**E.N. Yablonska, L.A. Kosogolova**  
The use of dandelion root (*Taraxacum officinale* Wigg.) as non-traditional raw materials in technology of functional beverages fermentation 5.1.6

**V.G. Lazariev, A.V. Drajnikova, V.I. Karpenko**  
Impact of hypobaria and air pressure fluctuations on the initial stages of *Beta sativa* growth as an object for prospective artificial ecosystems in extraterrestrial conditions 5.1.8

**A.A. Kirilova, V.I. Matukhin, V.I. Karpenko**  
The study of the processes of accumulation of biomass of algae *Chlorella vulgaris* and *Monoraphidium tortile* for production of biofuel 5.1.13

**T.V. Bulyhina, L.D. Varbanets**  
Characterization of *Pantoea agglomerans* endotoxin as potential components in air and settled dust from commercial aircraft cabins 5.1.18

**Y.O. Groza, O.A. Vasylichenko**  
Interleukin 7 properties and prospects of its clinical application 5.1.22

**O.M. Kovalev, O.Iu. Bielikova, O.A. Havryliuk, N.M. Oleynikova**  
Overcoming stress. The outputs of the stress state 5.1.25

**M.A. Kuibida**  
The technology of neutralization of the microflora that is disposed to ruining fuel-oil materials 5.1.28

### 5.2. Land management, cadastre and land monitoring

---

**A.F. Dankevich**  
Justification of requirements' to large -scale mapping with use of unmanned aircraft systems 5.2.1

|   |        |
|---|--------|
| <b><i>S.O. Shevchenko</i></b>   |        |
| The concept of state regulation of the circulation of agricultural land and the possible prospects of its development | 5.2.6  |
| <b><i>I.O. Novakovska</i></b>   |        |
| Problems of community land ownership formation  | 5.2.11 |
| <b><i>G.V. Zhavoronkova, V.O. Zhavoronkov, V.V. Klymenko</i></b>  |        |
| Economic aspects of space information technologies for environmental monitoring                                       | 5.2.15 |
| <b><i>L.V. Samoilenko</i></b>   |        |
| Legal aspects of land allotment for road transport  | 5.2.20 |
| <b><i>I.O. Novakovska, N.F. Ischenko, A.S. Taran</i></b>  |        |
| Features creation of agricultural land use in modern conditions   | 5.2.23 |
| <b><i>Nagorna Liliia, Novakovska Irina</i></b>  |        |
| The impact of air transport on the qualitative state of land resources: problems and ways of their solution           | 5.2.26 |
| <b><i>I.M. Kapelista</i></b>  |        |
| The problems of the use of project cart-roads ways of their solution  | 5.2.31 |
| <b><i>I.V. Chunya., I.O. Novakovska</i></b>   |        |
| The impact of local factors on the size of the regulatory monetary value of land within settlements                   | 5.2.34 |

### **5.3. Chemical technology and engineering**

|   |        |
|---|--------|
| <b><i>E.F. Novoselov, O.I.Tkachenko</i></b>   |        |
| Triterpenoids carboxylic acid derivatives   | 5.3.1  |
| <b><i>V.N. Ledovskikh, S.V. Levchenko</i></b>   |        |
| Electrical spark and mechanical preparation of steel surfaces to enhance its corrosion resistance | 5.3.5  |
| <b><i>A. Davydenko, V. Ledovskykh</i></b>   |        |
| Electrochemical processes in the technology of regeneration of used oils.                         | 5.3.10 |
| <b><i>O.I. Kosenko, A.D. Kustovska</i></b>  |        |
| Laws of hydrothermal modification of nickel-silica gels structure                                 | 5.3.15 |
| <b><i>O.E. Chygyrynets', V.I. Vorobyova, M.I. Skiba, A.S. Shakun</i></b>                          |        |
| Volatile components of grape pomaces from cultivars of Ukraine <i>Vitis vinifera L.</i>           | 5.3.21 |
| <b><i>V.I. Vorobyova, O.E. Chygyrynets', I.M. Trus, M.I. Skiba</i></b>                            |        |
| Volatile inhibitorof mild steel corrosion   | 5.3.24 |

### **5.4. Environmental protection**

|  |       |
|--|-------|
| <b><i>O. Zaporozhets</i></b>   |       |
| Airports geographic information system supports the safety and environment protection management | 5.4.1 |

|   |        |
|---|--------|
| <b><i>M.M. Radomska, O.V. Samsoniuk</i></b>   | 5.4.8  |
| Energy saving programs at airports for environmental impacts reduction  |        |
| <b><i>V. Gavrylenko, D. Gulevets, O. Kokhan, Ya. Movchan, S. Savchenko</i></b>  | 5.4.13 |
| Development of environmental express remote sensing for detection the state of ecosystems                                 |        |
| <b><i>V. Glyva, N. Kichata, L. Levchenko</i></b>  | 5.4.18 |
| Measures for electromagnetic safety of radiotechnical objects of civil aviation   |        |
| <b><i>V.M. Makarenko, V.I. Tokarev</i></b>  | 5.4.22 |
| Efficiency of small unmanned aerial vehicle detection based on acoustic signal analysis                                   |        |
| <b><i>M. Yildiz, I. Dincer, H. Karakoc</i></b>  | 5.4.27 |
| Future of More Electric Aircraft  |        |
| <b><i>M. Yildiz, H.Karakoc, I. Dincer</i></b>   | 5.4.30 |
| Advantages and Future of Electric Propulsion in UAVs  |        |
| <b><i>O. Zaporozhets, A. Jagniatinskis, B. Fiks</i></b>   | 5.4.34 |
| Considerations to assess the environmental noise level inside the building  |        |
| <b><i>O. Zaporozhets, A. Jagniatinskis, B. Fiks, M. Smiesek, A.Chyla, M. Bukala</i></b>                                   | 5.4.39 |
| Monitoring as an instrument for aircraft noise nuisance reduction   |        |
| <b><i>O. Zaporozhets, L. Levchenko, V. Zbrozhek</i></b>   | 5.4.42 |
| Considerations to assess accurately the aircraft noise level in rearward arc  |        |
| <b><i>V. Kovalenko, O. Tykhenko</i></b>   | 5.4.46 |
| Wireless communication safety analysis  |        |
| <b><i>L.M. Hladchenko, O.L. Matvyeyeva</i></b>  | 5.4.49 |
| Usage of biotesting methods for rating treatment efficiency of aviation enterprises wastewater polluted with oil products |        |
| <b><i>O. Kokhan</i></b>   | 5.4.52 |
| Review of European Union road safety policy for monitoring on vehicle collisions and adaptation it for Ukraine            |        |
| <b><i>O. Matvyeyeva, O. Aliieva, P. Grzybowski</i></b>  | 5.4.55 |
| Influence of electric field on a soil moisture during biodegradation of hexadecane  |        |
| <b><i>V. Pohrebennyk, E. Dzhumelia</i></b>  | 5.4.59 |
| Soil environmental control of Rozdil state mining and chemical enterprise “Sirka”   |        |
| <b><i>O. Zaporozhets, K. Synylo</i></b>   | 5.4.64 |
| Air pollution at the airports by pm produced by aircraft under the operations   |        |
| <b><i>V.D. Gulevets</i></b>   | 5.4.69 |
| Estimation of efficiency and reliability in the systems of management for industrial safety and health                    |        |

|   |        |
|---|--------|
| <b>S.M. Madzhd, A.O. Panchenko, A.S. Aleksandrova, O.V. Lapan</b><br>Assessment of biotic potential of aquatic ecosystems in the influence area of aviation enterprises | 5.4.73 |
| <b>O. Skazheniuk</b><br>Integral environmental evaluation of airports activity's of civil aviation  | 5.4.77 |
| <b>S.G. Boychenko, V.M. Voloshchuk, Ya.I. Movchan, V.S. Tkachenko</b><br>Features of climate change on Ukraine: scenarios, consequences and adaptation                  | 5.4.82 |
| <b>V.V. Huts, I.M. Trus, M.D. Gomelya, H.U. Fleysher,</b><br>Ion-exchange extraction nitrates from water  | 5.4.87 |
| <b>O.Yu. Ocheretyaniy, I.M. Trus, M.D. Gomelya, V.I. Vorobyova</b><br>Purification of mineralized water   | 5.4.92 |
| <b>M.I. Skiba, A.A. Pivovarov, V.I. Vorobyova, A.K. Makarov</b><br>Contact nonequilibrium low-temperature plasma for treatment of water and wastewater purification     | 5.4.96 |
| <b>Ya.S. Korobeinykova, Iu.I. Murava, P.M. Raïter</b><br>Study of ecological changes factors of the tourist destinations environment                                    | 5.4.99 |
| <b>O.O. Vovk, M.A. Koltsov, K.O. Sytnyk</b><br>The use of biogas technologies in open sea conditions  | 5.103  |

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#### SYMPOSIUM 6. AVIATION CHEMMOTOLGY

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|  |      |
|--|------|
| <b>L.M. Cherniak, M.M. Radomska, V.G. Lanetskyj, O.G. Kondakova</b><br>Modern methods of improving operation properties  | 6.1  |
| <b>L.S. Yanovskiy, A.I. Goulienko, V.M. Ezhov, A.A. Molokanov, K.V. Sharanina, Y.M. Shchurovsky</b><br>Investigation of aircraft gas turbine engine lubrication system operation | 6.4  |
| <b>L.S. Yanovskiy, V.M. Ezhov, A.A. Molokanov, K.V. Sharanina</b><br>New approach for creation of aviation lubricating oils  | 6.8  |
| <b>S.V. Boichenko, O.G. Kondakova, O.V. Ivanchenko, A.P. Pushak</b><br>Aliphatic alcohols as a component of aviation gasoline  | 6.12 |
| <b>S. Boichenko, A. Iakovlieva, O. Vovk, K. Lejda, H. Kuszewski</b><br>Study of the low-temperature properties of biofuels for jet engines                                       | 6.16 |
| <b>I.M. Popov, P.V. Borodako, E.P. Fedorov, M.N. Patsina, N.I. Varlamova, L.S. Yanovskiy</b><br>Development trends of modern aviation gasoline                                   | 6.18 |
| <b>I.L. Trofimov, L.S. Veriagina, L.B. Pryimak</b><br>Research electrization of aviation fuels   | 6.21 |
| <b>A. Stelmah, V. Radzievskiy, O. Kushev, A. Zhitnitskiy</b><br>Non-contact pulsed magnetic turbulent cleaning of ball bearings in aviation engine building                      | 6.32 |

|  |      |
|--|------|
| <i>A.U. Stelmakh, V.A. Radzievskiy, A.V. Kushchev</i>  |      |
| Comparison of differential-phase method and method of dynamic focusing in defining of roughness parameters of surfaces | 6.36 |
| <i>A.U. Stelmakh, R.E. Kostyunik, A.V. Stelmakh</i>  |      |
| Tribo-cavitation effect for aviation kerosene  | 6.41 |
| <i>M. Koverha, O. Vovk, Professor, S. Zaychenko</i>  |      |
| The noise of the airplanes as a source of energy   | 6.46 |
| <i>O.S. Shtyka, J.P. Sęk</i>   |      |
| Saturation of hydrophilic/oleophilic granular structures with emulsions during imbibition process                      | 6.50 |
| <i>O.S. Shtyka, A.V. Bondaruk, J.P. Sęk</i>  |      |
| Process of hydrophilic/oleophilic granular media imbibition with oil emulsions   | 6.55 |
| <i>M. Jaszczyńska, M. Dziubiński</i>   |      |
| Sedimentation of microparticles in non-Newtonian fluids  | 6.58 |
| <i>O. Vovk, N. Shevchuk, A. Onyshchenko</i>  |      |
| Obtaining of alternative fuels from aquabiomass  | 6.63 |
| <i>O.Ya. Tverda, Yu.S. Oliinyk</i>   |      |
| Assessment of the impact of radioactivity from deposits granites at ecological environment                             | 6.67 |

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## SYMPOSIUM 7. COMMUNICATION FACTOR IN MODERN INTERNATIONAL RELATIONS

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### **7.1. Information and legal principles of international relations**

|  |        |
|--|--------|
| <i>M. Y. Yatsyshyn</i>   |        |
| International legal opposition to cyberwars  | 7.1.1  |
| <i>I.Yu. Shcherbyna, V.N. Kubalskiy</i>  |        |
| Characteristics of the universal norms of International Law in the sphere of combating human trafficking           | 7.1.5  |
| <i>O.M. Polishchuk</i>   |        |
| Enforcement of competition rules and antitrust policies under the Association Agreement between the EU and Ukraine | 7.1.10 |

### **7.2. The transformation of journalism in the context of technologizing the world and the processes of globalization**

|   |       |
|---|-------|
| <i>O.M. Ryzhko</i>  |       |
| Facebook as a platform for counteraction to plagiarism  | 7.2.1 |
| <i>H.I. Nazarenko, PhD in Philology,</i>  |       |
| Method of concealed search and collection of information as used by Max Winter, an Austrian originator and founder of investigative reporting | 7.2.6 |

|                                 |   |        |
|---------------------------------|---|--------|
| <b><i>O.M. Koshak</i></b>       | Transformation, prediction of development and expansion of an informative opportunities of the Ukraine broadcasting | 7.2.9  |
| <b><i>A.D. Lichenko</i></b>     | Social media as a tool of manipulating public opinion: issues of astroturfing and sock puppet                       | 7.2.15 |
| <b><i>T. M. Andreeva</i></b>    | Nominations of the leaders of the parties in the Ukrainian media  | 7.2.18 |
| <b><i>V.M. Vasylychenko</i></b> | Pragmatic functions of the punctuation symbol "quotations" in media texts   | 7.2.22 |
| <b><i>V.I. Kravchenko</i></b>   | Local government of Ukraine in within the context of the experience of European Union countries                     | 7.2.26 |
| <b><i>E.G. Kravchenko</i></b>   | The local self-governing in Ukraine   | 7.2.30 |

### **7.3. The international scientific and technical cooperation of Ukraine in aerospace industry**

|   |   |        |
|---|---|--------|
| <b><i>S.O. Bila</i></b>                       | Strategic priorities of aviation services market's competitiveness growth in Ukraine within globalization               | 7.3.1  |
| <b><i>K.V. Antonenko, V.V. Havryliuk</i></b>  | Features and trends in the market of consulting services in the aviation industry of Ukraine                            | 7.3.6  |
| <b><i>M.P. Vysotska, Y.V. Mikusheva</i></b>   | Prospects and problems of the airline industry in Ukraine   | 7.3.10 |
| <b><i>L.M. Pobochenko</i></b>                 | The development of business aviation in the world   | 7.3.14 |
| <b><i>Studinska Galina Y.</i></b>             | Brand as an effective management tool of the air-transport business   | 7.3.17 |
| <b><i>Vasyl H. Gerasymchuk</i></b>            | Forming of competitive edges leaders of market of aircraft building   | 7.3.22 |
| <b><i>G.A. Klimenko, D.R. Mukhamedova</i></b> | Research experience the world of formation integrated structures in the aviation industry in the case of Boeing Company | 7.3.27 |

### **SYMPOSIUM 8. ECONOMY AND MANAGEMENT IN AVIATION**

|   |   |     |
|---|---|-----|
| <b><i>Ostapenko Tetyana G., Prishchepa Natalia P.</i></b> | Aviation transport enterprises management as a factor of activation of globalization processes in economy | 8.1 |
|---|---|-----|

|   |      |
|---|------|
| <i>Ali Emre SARILGAN</i><br>The Relation between Turkish Tourism Industry and Air Transportation  | 8.4  |
| <i>M.B. Yanchuk, N.V. Otlivanskaya</i><br>Formation of quasi-integrative aircraft construction structure in Ukrainian defense system in terms of small-scale aircraft production (on example of SE "Antonov") | 8.9  |
| <i>S. Dobrovolskyi, Wang Bo, V.Klobukov, L. Klobukova, M. Glivenko</i><br>Algorithm of forming the estimating method of total logistic costs based on artificial neural networks                              | 8.14 |

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## SYMPOSIUM 9. HUMAN FACTOR IN AVIATION

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### SESSION A. Language Modelling of Aviation Information Systems

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|  |      |
|--|------|
| <i>K. Lienig</i><br>Modelling of aviation vocabulary   | 9.1  |
| <i>O. Kovtun, A. Gudmanian, G. Simoncini</i><br>Communicative approach to aviation English teaching  | 9.4  |
| <i>A. Lukács, A. Rati</i><br>Aviation terminology translation: dominant translation transformations in use                                   | 9.8  |
| <i>A. Mikhailov, T. Zhuravel, N. Khaidari</i><br>English as the official aviation language   | 9.11 |
| <i>A. Ozhohan, O. Yashchuk</i><br>Language collisions of the globalized world in a modern aviation   | 9.14 |
| <i>L. Fedchuk</i><br>Improving the professional speech culture of the aviation sector's future employees by compiling non-normative glossary | 9.19 |
| <i>A. Golovnia, S. Shurma</i><br>Translating suffixal English aviation terms in classroom  | 9.23 |
| <i>M. Pylypchuk</i><br>Language deviation in EARD as an interpretation challenge   | 9.26 |
| <i>G. Encheva, T. Semyhinivska</i><br>Intra-branch homonyms and ways of their translation in the aviation industry                           | 9.30 |
| <i>T. Smirnova</i><br>English aviation terminology: translation problems   | 9.33 |
| <i>O. Akmaldinova, L. Budko, T. Shulga</i><br>Professional language training in flight safety provision                                      | 9.36 |
| <i>N. Balatska, I. Kozeletska, T. Anpilohova</i><br>English language competence in the context of aviation safety                            | 9.40 |
| <i>S. Grytsai, S. Tkachenko</i><br>Effective language training for air traffic controllers   | 9.45 |
| <i>Y. Ivanov</i><br>Typical pilot's mistakes in radio traffic communication  | 9.50 |

|   |       |
|---|-------|
| <i>S. Miroshnyk</i><br>Standardized and non-standard phraseology in aviation  | 9.53  |
| <i>I. Burlakova, N. Romanchenko</i><br>Primary focus on effective communication in aviation: linguistic and cultural aspect                             | 9.56  |
| <i>I. Burlakova, O. Shved, T. Diachuk</i><br>Economy of term formal structure as a means to laconic speech of professionals in aviation sphere          | 9.60  |
| <i>O. Shved, H. Onufriichuk</i><br>Peculiarities of phraseological units forming in aviation sphere   | 9.64  |
| <b>SESSION B. Human Factor Management: Current Situation and Prospects</b>  |       |
| <i>T. Shkoda</i><br>Human factor impact on safety of aviation in Ukraine  | 9.67  |
| <i>L. Konoplianyk, O. Kovalenko</i><br>Professional communicative competence of future air traffic controllers as a required component of flight safety | 9.70  |
| <i>T. Klynina, O. Yurchenko</i><br>Chicago Convention and safety in aviation  | 9.75  |
| <i>N. Zakharchuk</i><br>Cross-cultural communication aspects in aviation  | 9.78  |
| <i>Yu. Kondrashevska</i><br>Unmanned aircraft systems of Ukraine: production and usage  | 9.82  |
| <i>I. Bratus, Yu. Smolnikov</i><br>The dream of wings (life and scientific achievements of Stepan Hryzodubov)   | 9.86  |
| <i>S. Lytvynska</i><br>Website “Aviation Safety Network” as a communication channel and a source of information about flight safety                     | 9.89  |
| <i>V. Grebennikov, Yu. Smolnikov</i><br>The human factor in the engineering activity of I.I. Sikorsky in the early 20th century                         | 9.92  |
| <i>N. Bereznikova</i><br>On importance of human factor training to aviation maintenance technicians for ensuring airworthiness                          | 9.97  |
| <i>S. Gryniuk</i><br>Crew resource management in aviation   | 9.100 |
| <i>L. Baranovska, M. Baranovsky</i><br>Multicultural orientation of modern Ukrainian higher education (based on National Aviation University)           | 9.107 |
| <i>E. Luzik, N. Ladogubets</i><br>Features of aviation experts training in the system of “people-machinery”   | 9.111 |

|  |       |
|--|-------|
| <i>M. Abysova, A. Matyukhina, T. Shorina</i><br>Ecologization of Cosmos: problems and perspectives   | 9.116 |
| <i>L. Drotianko, O. Kravchenko, S. Yahodzynskyi</i><br>Aviation security as a social and cultural issue  | 9.120 |
| <i>L. Kadnikova, L. Mokliak, N. Sukhova</i><br>Airport as aesthetically organized living space   | 9.123 |
| <i>I. Skyba, O. Skyba, T. Poda, O. Sidorkina</i><br>Information technologies and human factor in civil aviation                                    | 9.126 |
| <i>K. Nastoyashaya, L. Chupriy, M. Kliov</i><br>The safety of aviation industry in terms of modern challenges and promoting the aviation education | 9.130 |

### **SESSION C. Psychology of Aircraft Operation Safety**

|  |       |
|--|-------|
| <i>A. Medvediv, A. Davidenko</i><br>Human factor in aircraft maintenance   | 9.134 |
| <i>V. Biletska, L. Yasko, O. Pryimakov</i><br>Physical education syllabus optimization for students with poor health                                 | 9.137 |
| <i>V. Sanzharovets, K. Sanzharovets</i><br>Social work with airports passengers  | 9.141 |
| <i>Ya. Absaliyeva, L. Kucheriava, G. Mikhnenko</i><br>Intellectual mobility of the flight crew members   | 9.144 |
| <i>I. Vrzhesnevsky, V. Korchytsky, N. Turchyna</i><br>The factor of cognitive dissonance in the context of physical training of future pilots        | 9.147 |
| <i>T. Vasheka, O. Dolgova</i><br>Practical recommendations for cabin crew members dealing with unmanaged aircraft passengers                         | 9.150 |
| <i>M. Polukhina</i><br>Peculiar features of crisis conditions experienced by workers in special activities   | 9.154 |
| <i>L. Pomytkina</i><br>The human experience while decision-making  | 9.159 |
| <i>M.-M. Rybalko</i><br>Basic values of a flight attendant's career  | 9.164 |
| <i>O. Shostak, N. Glushanytsia</i><br>Human factor in aviation maintenance engineering   | 9.169 |
| <i>H. Babii, O. Hurska, N. Murkina, L. Tereminko</i><br>The impact of cross-culture on airline pilots' safety performance                            | 9.175 |
| <i>O. Blinov, Yu. Shatylo</i><br>Anti-stress self-help of professionals in aviation industry   | 9.180 |
| <i>V. Fotyniuk</i><br>Results and evaluation of professionally applied physical training effectiveness of future bachelors in aviation and aerospace | 9.183 |

---

**SYMPOSIUM 10. PROBLEMS OF DEVELOPMENT OF THE MODERN  
AIRPORT**

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**10.1. Urban, industrial, civil and transport construction**

---

|  |          |
|--|----------|
| <i>O.V. Rodchenko</i><br>Finite Element Modeling of Concrete Airfield Pavement   | 10.1.1   |
| <i>V.V. Savchenko, G.M. Agieieva</i><br>Project proposals for the construction of the passenger terminal at the airport «VINNITSA»   | 10. 1.5  |
| <i>A.O. Bieliatynskiy, M.V. Sytnichenko, B.S. Malyna</i><br>Considering the Loss of Precipitation on the Earth's Surface in the Design of Culverts and Drainage System of Objects on Motor Roads | 10. 1.9  |
| <i>Aleksandra Skrypchenko, Katerina Krayushkina, Tetiana Khymerik</i><br>Features of reinforcing materials for the layers of the road with increased roughness                                   | 10. 1.13 |
| <i>V.I. Kolchunov, I.A. Yakovenko, E.A. Dmitrenko,</i><br>Analytical modeling of nonlinear problem bond armature with concrete   | 10. 1.17 |
| <i>L.I. Storozhenko, G.M. Gasii</i><br>Composite steel and concrete large-span constructions for airport structures  | 10. 1.22 |
| <i>A.V. Volkova, G. M. Agieieva</i><br>New face of air traffic service's objects   | 10. 1.27 |
| <i>Talakh Svetlana, Dubik Olexandr</i><br>Determination of stress-strain state hard cement constructions airport paving the presence of weak soil layers   | 10. 1.31 |
| <i>S.Y. Timkina, V.S. Stepura</i><br>Identification of options construction of roads on the basis comparative economic efficiency  | 10. 1.36 |
| <i>A.E. Gul</i><br>Innovation technological support heavy regulation intersections of urban areas  | 10. 1.43 |

**10.2. Design of architectural environment**

---

|   |         |
|---|---------|
| <i>I.V. Birillo</i><br>Features of architectural education contents in Poland and Ukraine                           | 10.2.1  |
| <i>V.A. Shchetinin, G.I. Bolotov</i><br>Houses similar in scope for psycho different person                         | 10.2.5  |
| <i>O.V. Kravchenko</i><br>Features of location under airports technogenic landscapes                                | 10.2.8  |
| <i>O.V. Kravchenko</i><br>Optimization environment urban development in different conditions of degraded landscapes | 10.2.10 |

### **10.3. Technical aesthetics and design**

---

|  |         |
|--|---------|
| <i>O.V. Kardash, V.A.Svirko, N.O. Dzhuryk, O.G. Tserkovnaya</i><br>Ecological planning in a design and quality of life                 | 10.3.1  |
| <i>L.R. Gnatiuk</i><br>Recommendation for individual protection of sacral objects  | 10.3.5  |
| <i>A.A. Tretiak</i><br>Energy saving due to underground construction parking, classification   | 10.3.9  |
| <i>O.V. Vasilevskiy</i><br>Geometrical method of automated designing of torsos surfaces  | 10.3.12 |
| <i>Yu. R. Kholkovsky</i><br>The construction of the geometric models of ecosystems discrete interpolation method                       | 10.3.14 |
| <i>N.O. Dzhuryk, O.V. Kardash, O.V.Dzhuryk, O.T.Bashta</i><br>Determination of conditions of the visual load video terminals operators | 10.3.18 |
| <i>L.V. Obukhovska</i><br>Modern tendencies in the design of small architectural forms   | 10.3.22 |
| <i>S.T. Trykolenko</i><br>Concept interior design in modern scenography  | 10.3.26 |
| <i>I.O. Kuznetsova, V.F. Us, S.P. Shvets</i><br>History of design of planes  | 10.3.29 |
| <i>S.S. Kysil</i><br>Interior features of design areas: reception, storage and maintenance of cars in the multi-storey parking garages | 10.3.37 |

---

### **SYMPOSIUM 11. AIR AND SPACE LAW: INTERNATIONAL AND NATIONAL ISSUES OF SECURITY**

---

|   |       |
|---|-------|
| <i>D.O. Bezzubov</i><br>Transportation security administration bases  | 11.1  |
| <i>V.S. Volostnykh</i><br>The legal regime of the national airspace during military activities  | 11.5  |
| <i>O. Gusar</i><br>Administrative - legal means of ensuring safe civilian aircraft  | 11.9  |
| <i>Kh.V. Kmetyk</i><br>The US Aviation and Transportation Security Act of 2001  | 11.15 |
| <i>S.Ya. Lykhova</i><br>Criminal liability for the commission of the professional activities of the members of the crew in a state of intoxication (art. 276-1 of the Criminal Code of Ukraine) | 11.18 |

|   |       |
|---|-------|
| <b><i>N.V. Malyarchuk</i></b><br>Aviation of special purpose and regulation of civil aviation and air transport within the European Union | 11.20 |
| <b><i>O.M. Myronets</i></b><br>Legal regulation of luggage air carriage in conditions of transformation in Ukrainian society              | 11.23 |
| <b><i>I.O. Roshchina, A. Kochneva,</i></b><br>Criminological characteristics crimes against flight safety and operation of air transport  | 11.28 |
| <b><i>I.A. Slobodska</i></b><br>Legislative regulation of administrative responsibility of legal entities in civil aviation               | 11.30 |
| <b><i>I.M. Sopilko</i></b><br>Directions to improve protection of copyright objects in context of development of education and science    | 11.33 |
| <b><i>I. Ustynova, O. Gusar</i></b><br>Normative - legal regulation of inspections operators and maintenance organizations                | 11.40 |
| <b><i>V.I. Ryzhyy, V.A. Rybachok</i></b><br>Improvement of Legal Regulation of Inspectors' Oversight over Ukraine's Civil Aviation Safety | 11.45 |

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**SYMPOSIUM 12. INNOVATIVE TECHNOLOGY OF PROFESSIONAL TRAINING ON THE BASIS OF HIGHER EDUCATION**

---

|   |       |
|---|-------|
| <b><i>Olegas Prentkovskis, Raimundas Junevičius, Edgar Sokolovskij, Giedrius Garbinčius, Romualdas Kliukas</i></b><br>Analysis of the peer-reviewing process of the manuscripts being submitted to the research journal TRANSPORT | 12.1  |
| <b><i>A. G. Kapustin, N.I. Siomkina, H.M. Alzaki</i></b><br>Application of modern computer technologies in systems of preparation of communication aviation experts   | 12.6  |
| <b><i>Grinyova Marina V.</i></b><br>Problems to create model of education manager   | 12.9  |
| <b><i>V.S. Grinyova</i></b><br>On the issue of establishment of the project of happy person   | 12.11 |
| <b><i>I.A. Dudka</i></b><br>Public activity of student organizations abroad   | 12.13 |
| <b><i>S.P. Shkolyar</i></b><br>Influence realities of today on the formation of bases training future managers of marketing activities  | 12.16 |

|  |   |       |
|--|---|-------|
| <b><i>M.V. Holovko, S.G. Holovko</i></b>                               | Innovation in Higher Education as a Condition for Integration into the Common European Educational Space                              | 12.18 |
| <b><i>N.Bulhakova, T.Dovgodko, N.Vasylyshyna</i></b>                   | Contemporary Approaches of Foreign Students Propaedeutic Preparation  | 12.21 |
| <b><i>D.E. Prusov</i></b>  | Innovative Trends in Training Highly Qualified Specialists of Phd Degree on the New Model of the Third Cycle in Engineering Education | 12.26 |
| <b><i>N.G. Chaika, A.M. Ovsyankin, V.D. Shpylyovi</i></b>              | The relevance of teaching disciplines of audit of management activities while training the specialists in management                  | 12.31 |
| <b><i>G.A. Kyrychevskiy, V.D. Shpylovyi</i></b>                        | Application of the method of projects in the master's program of project managers   | 12.35 |
| <b><i>V.D. Shpylovyi, A.M.Ovsyankin, N.G.Chaika, L.V. Vdovenko</i></b> | Quality Management (QMS) as a part of training in management  | 12.38 |
| <b><i>N.V. Vanda</i></b>   | Theories of activity in concepts of P.K. Anokhin, O.M. Leontiev, S.L. Rubinstein  | 12.42 |
| <b><i>L.I. Vdovenko</i></b>  | The problems of the use of intellectual property in the innovation system   | 12.46 |

---

### SYMPOSIUM 13. ICAO SAFETY STRATEGIES

---

|   |   |       |
|---|---|-------|
| <b><i>O.V. Bashta</i></b>   | ICAO's view on MID region safety  | 13.1  |
| <b><i>Oleksandr Bilous</i></b>                                    | Why the Air Marshal Service is important for Aviation Safety                      | 13.4  |
| <b><i>Volodymyr Kharchenko, Dmytro Bugayko, Anna Antonova</i></b> | Aviation safety management system: problem of balanced allocation of resources    | 13.9  |
| <b><i>Igor Dobrovolskyi</i></b>                                   | Air Cargo Supply Chain Overview   | 13.18 |
| <b><i>Oleksandr Kirichenko</i></b>                                | Human Factors in Aircraft Maintenance   | 13.22 |
| <b><i>Andriy Kopylov</i></b>                                      | Considering the requirements of ECAC Doc 30 when training airport X-ray screeners | 13.26 |
| <b><i>Vitalina Maslyuk</i></b>                                    | Lithium Batteries as Cargo  | 13.29 |
| <b><i>Tetiana Zagnii</i></b>                                      | FAA approaches to the method of determining the acceptable level of risk          | 13.32 |

### **Timing problem of multi DME/DME approach**

*The main problem of multi DME/DME positioning approach has been discussed. Timing problem related to avionics structure of civil aircraft that is result of possibility of operation with one pair of DMEs at one time. Recurrent investigation was proposed to solve the timing problem.*

#### **Introduction.**

Detection of aircraft location is one of the most important tasks in air navigation. Each navigation task is grounded on positioning method. Successful movement depends on accuracy of coordinate detection of the vehicle. In air navigation sphere availability and accuracy of positioning provides flight safety. Nowadays Global Navigation Satellite System (GNSS) provides more accurate global position data than other techniques. GNSS is represented by GPS, GLONASS and GALILEO. Each airspace user has to use GNSS equipment for positioning purposes as the main source of coordinate location. But, sometimes in some regions an accuracy of positioning may be not enough to guarantee the required level of flight safety. It is a result of influence of different factors like pure satellite geometry, process inside of ionosphere, interference etc [1]. There are some specific techniques to solve this problem on board of each modern aircraft.

Nowadays many manufactures of GNSS receivers integrate inertial principle inside of equipment to improve positioning accuracy and increase availability of coordinate data. There are several different approaches to use inertial principle into different levels of data computation inside of receivers. Besides, positive effect of such kind of integration is limited in operation time. Inertial navigation can be useful only in limited time period according to additional nature of errors.

In case of high errors of inertial navigation and absence of data from GNSS, positioning by NAVAIDS is used [2-4]. Many modern flight management systems (FMS) have preinstalled algorithms of location detection by distance and angle data from Automatic directional finder (ADF), on-board part of Distance measurement equipment (DME) or receivers of VOR [2-4]. Usually, it includes the following geometrical principles: DME/DME, DME/VOR, VOR/VOR, NDB/NDB, etc.

In classical scheme of avionics structure (fig. 1) FMS will find radio beacons according to flight planed trajectory and send this data to Radio management equipment that will tune radio navigational equipment of aircraft. Result of measurements will come back to FMS directly from DME, VOR, ADF [5]. Two blocks of each equipment should to be installed on-board of aircraft according to the main avionics requirements. Each equipment of NAVAIDS can operate only with one ground equipment at time. Therefore, at least two distance to DMEs, two angles to VOR and NDB can be proceed at one moment of time.

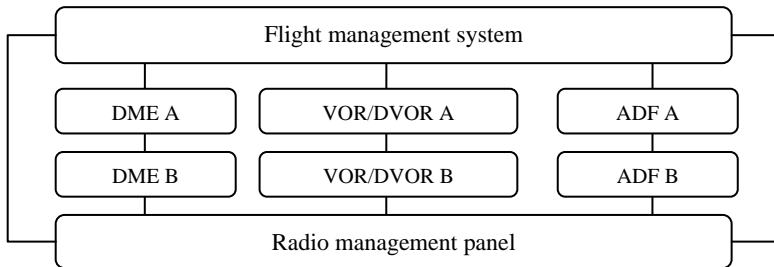


Fig.1. Interchange of NAV AIDS data inside of on-board equipment

### Timing in DME/DME positioning

According to data limitation only one pair of DMEs can be used to aircraft location detection. In [3] the main limitation for pairs of DME choosing has been discussed. The direction crossing angle in  $30\text{-}150^\circ$  is strongly required for RNAV.

Many investigations indicate increasing accuracy of positioning in the result of using multi DME approach. In this case the possibility to get data on board of aircraft from all available DME in operational range is regarded. But multi DME approach can not be realized in hardware, because it will be the result of increasing sizes and prices for equipment. In other hand, there are some mathematical approaches to use multi DME approach. The main problem in multi DME approach is timing. Let's discuss a situation with four DMEs (fig.2) and aircraft that flies in their operational range.

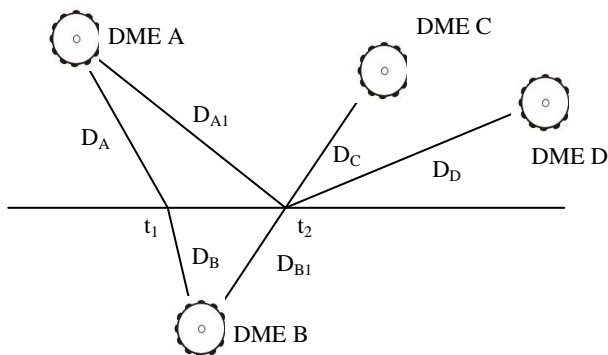


Fig. 2. DME pairs operation

FMS operates with ground stations A and B at time  $t_1$ , because at one time FMS can get information only from two DMEs. As a result distances  $D_A$  and  $D_B$  can be measured. Later at time  $t_2$  FMS tune DME equipment for operation with the next pair of DMEs which is represented by C and D ground stations. After distance measurement  $D_C$  and  $D_D$  will appear. Also, at time  $t_2$  data from previous DME pair are not active, because aircraft has changed the location. Therefore, distances

$DA \neq DA1$  and  $DB \neq DB1$  and as a result can not be used in multi DME approach together with a second pair CD.

Many algorithms loose difference between  $D_A$  and  $D_{A1}$  and consider a result in total errors.

In other hand timing problem of multi DME can be solved by using classical approach to predict distances  $D_{A1}$  and  $D_{B1}$  by previous measurements.

If we can use that aircraft acceleration is absent, we can estimate aircraft location by two previous measurements. But, at first we should use data from the first DME pair to calculate radial speed:

$$V_D = (D_i - D_{i-1}) / T,$$

where

$i$  – iteration number,

$T$  – time of observation.

After second observation we can use radial speed to extrapolate DME data for the next period of time:

$$D_i = D_{i-1} + V_D T.$$

Extrapolated distance for DME A and DME B can be used together with distances to DME C and DME D in multi DME approach.

### Conclusion

Multi DME/DME approach in positioning is more accurate than positioning by pairs of DMEs. Represented approach can be easily used in typical avionics structure to use multi DME algorithms inside of FMS.

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