DEVELOPMENT OF THE WEB PORTAL FOR RESEARCH SUPPORT IN THE AREA OF ELECTRICAL IMPEDANCE TOMOGRAPHY (p. 6-15)

Grayr Aleksanyan
Platov South-Russian State Polytechnic University (NPI),
Novocherkassk, Russian Federation
ORCID: http://orcid.org/0000-0001-9611-6275

Andrey Katsupeev
Platov South-Russian State Polytechnic University (NPI),
Novocherkassk, Russian Federation
ORCID: http://orcid.org/0000-0002-7021-4114

Andrey Sulyz
Platov South-Russian State Polytechnic University (NPI),
Novocherkassk, Russian Federation
ORCID: http://orcid.org/0000-0001-8681-730X

Stanislav Pyatnitsin
Platov South-Russian State Polytechnic University (NPI),
Novocherkassk, Russian Federation
ORCID: http://orcid.org/0000-0002-2451-6832

Danil Peregorodiev
Platov South-Russian State Polytechnic University (NPI),
Novocherkassk, Russian Federation
ORCID: http://orcid.org/0000-0002-2855-9207

The concept of electrical impedance tomography is considered. Modern software solutions implementing the methods and algorithms of electrical impedance tomography are studied. It is concluded that existing solutions for applied research and development in the field of electrical impedance tomography either do not implement differential reconstruction methods, or do not provide multi-user access. This imposes a number of limitations when conducting research and creates barriers to obtaining new results in the field of electrical impedance tomography. Given the current state of development of scientific and engineering aspects of electrical impedance tomography, as well as arising problems and limitations, it is proposed to develop a specialized web portal that would systematize and accumulate the results already achieved in the field of electrical impedance tomography and offer researchers new opportunities for designing algorithmic and technical tools.

A key feature of the proposed web portal is the ability of users to remotely solve the main task of electrical impedance tomography (reconstruction and visualization of the conduction field) based on the downloaded measurement information by differential reconstruction.

The structure of the developed web portal is presented, including the following services: differential reconstruction service, media content storage service, knowledge base. In addition to using existing algorithms, the web portal has the ability to create and test the algorithm added by the user. The proposed testing algorithm will allow changing the parameters of the image reconstruction method in such a way as to provide the most flexible approach to solving a specific problem. A feature of the testing algorithm is the implementation of algorithms for comparing the accuracy of reconstruction of the conduction field. Comparison can be made both on the data provided by the portal, and on the data downloaded by the user. The results of experiments on the time of solving the problem with various models used for image reconstruction based on the obtained potential values during measurements are presented.

Keywords: electrical impedance tomography, software, image reconstruction, medical imaging, conductivity distribution.

References

1. Pekker, Ya. S., Brazovskiy, K. S., Usov, V. N. (2004). Elektroimpedansnaya tomografiya. Tomsk: NTL, 192.
2. Draeger medical. Technical Data for PulmoVista 500 (2011).
3. Electrical impedance tomography. Available at: http://www.eit.org.uk/about.html
4. Elektroimpedansnaya tomografiya (EIT). Available at: http://www.cplire.ru/rus/etomo/
5. Zheng, J., Peng, L. (2017). A platform for electrical capacitance tomography large-scale benchmark dataset generating and image reconstruction. 2017 IEEE International Conference on Imaging Systems and Techniques (IST). doi: https://doi.org/10.1109/ist.2017.8261465
6. COMSOL Multiphysics® v. 5.4. Available at: https://www.comsol.com/
7. Kryszyn, J., Wanta, D., Kulpanowski, P., Smolik, W. T. (2018). LabVIEW based data acquisition system for electrical capacitance tomography. 2018 International Interdisciplinary PhD Workshop (IIPhDW). doi: https://doi.org/10.1109/iiphdw.2018.8388388
8. Yang, Y., Jia, J. (2017). A multi-frequency electrical impedance tomography system for real-time 2D and 3D imaging. Review of Scientific Instruments, 88 (8), 085110. doi: https://doi.org/10.1063/1.4999359
9. Hidayat, I., Darpita, I. D., Wijaya, S. K., Prajitno, P. (2019). The development of magnetoacoustic tomography system with current injection. Proceedings of the 4th international symposium on current progress in mathematics and sciences (ISCPMS2018). doi: https://doi.org/10.1063/1.5132443
10. Jang, G. Y., Ayoub, G., Kim, Y. E., Oh, T. I., Chung, C. R., Suh, G. Y., Woo, E. J. (2019). Integrated EIT system for functional lung ventilation imaging. BioMedical Engineering OnLine, 18 (1). doi: https://doi.org/10.1186/s12938-019-0701-y
11. Aleksanyan, G. K., Shcherbakov, I. D., Kucher, A. I., Sulyz, A. V. (2018). Development of software monitoring module for multi-angle electric impedance tomography method research. MATEC Web of Conferences, 226, 02024. doi: https://doi.org/10.1051/matecconf/201822602024
12. Liu, B., Yang, B., Xu, C., Xia, J., Dai, M., Ji, Z. et. al. (2018). pyEIT: A python based framework for Electrical Impedance Tomography. SoftwareX, 7, 304–308. doi: https://doi.org/10.1016/j.softx.2018.09.005
13. EIDORS: Electrical Impedance Tomography and Diffuse Optical Tomography Reconstruction Software // URL: http://eidors3d.sourceforge.net.
14. Dimas, C., Sotiriadis, P. P. (2018). Electrical impedance tomography image reconstruction for adjacent and opposite strategy using FEMM and EIDORS simulation models. 2018 7th International Conference on Modern Circuits and Systems Technologies (MOCAST). doi: https://doi.org/10.1109/mocast.2018.8376604
15. JSR 168: Portlet Specification. JSRs: Java Community Process. Available at: https://www.jcp.org/en/jsr/detail?id=168
16. Elmanova, N. (2001). Web-portaly: klassifikatsiya i naznachenie. KOMP'YUTER PRESS, 2, 172–176.
17. Voriyskiy, F. S. (2003). Informatika. Noviy sistematizirovanniy tolkoviy slovar'-spravochnik. Moscow: FIZMATLIT, 760.
18. Mashnin, T. (2012). Web-servisy Java. Moscow: BHV-Peterburg, 560.
19. Aleksanyan, G. K., Gorbatenko, N. I., Tarasov, A. D. (2014). Development of Hardware-Software Complex for Electrical Impedance Tomography of Biological Objects. Research Journal of Applied Sciences, 9, 1030–1033.
20. Goryaninova, E. R., Pankov, A. R., Platonov, E. N. (2012). Prikladnye metody analiza statisticheskih dannyh. Moscow: Izdatel'skiy dom Vysshey shkoly ekonomiki, 310.

21. Izmailov, A. F., Solodov, M. V. (2008). Chislennye metody optimizatsii. Moscow: FIZMATLIT, 320.

22. Petrov, I. B., Lobanov, A. I. (2006). Lektsii po vychislitel'noy matematike. Moscow: BINOM, 523.

23. Tyrtyshnikov, E. E. (2007). Matrichniy analiz i lineynaya algebra. Moscow: FIZMATLIT, 480.

24. Kennet, R., Shlyusser, T. (2017). Avtostopom po Python. Moscow: Piter, 336.

25. Berri, P. (2017). Izuchaem programmirovanie na Python. Moscow: Izdatel'stvo «E», 624.

26. Obe, R., Hsu, L. (Eds.) (2014). PostgreSQL: Up and Running. O'Reilly Media, 234.

27. Plyusy i minusy Django. Python 3. Available at: https://python-scripts.com/django-obzor

28. ERD (OpenModelSphere) – kontseptual'naya model' dannyh. CyberPedia. Available at: https://cyberpedia.su/12xdf47.html

29. Aleksanyan, G. K., Shcherbakov, I. D., Kucher, A. I., Volchenkov, E. A. (2018). Development of a power supply for multi-angle electric impedance tomography complex. MATEC Web of Conferences, 226, 02025. doi: https://doi.org/10.1051/matecconf/201822602025

30. Karenovich Aleksanyan, G., Ivanovich Gorbatenko, N., Igorevich Kucher, A., Mikhailovich Shirokov, K., Nam Phong, C. (2015). Developing Principles and Functioning Algorithms of the Hardware-software Complex for Electrical Impedance Tomography of Biological Objects. Biosciences, Biotechnology Research Asia, 12, 709–718. doi: https://doi.org/10.13005/bbra/2251

31. Gorbatenko, N., Aleksanyan, G., Grechikhin, V., Shirokov, K., Dubrov, V., Lankin, M. (2015). Development of a computer-based stand for testing algorithms of electrical impedance tomography. Research Journal of Applied Sciences, 10 (4), 173–175.

DEVELOPMENT OF A METHOD OF FUZZY EVALUATION OF INFORMATION AND ANALYTICAL SUPPORT OF STRATEGIC MANAGEMENT (p. 16-27)

Ihor Alieinykov
Ivan Chernyakhovsky National Defense University of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-1670-9829

Abed Thamer Khudhair
Kuliyyah Al-Maarif University College, Ramadi, Republic of Iraq
ORCID: http://orcid.org/0000-0002-1575-2294

Yurii Zhuravskyi
Zhytomyr Military Institute named after S. P. Koroliov, Zhytomyr, Ukraine
ORCID: http://orcid.org/0000-0002-4234-9732

Oleg Sova
Military institute of telecommunications and informatization named after Heroes of Kruty, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-7200-8955

Nataliia Smirnova
Kharkiv National Automobile and Highway University, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-8458-1954

Ruslan Zhyvotovskyi
Central Scientifically-Research Institute of Arming and Military Equipment of the Armed Forces of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-2717-0603

Serhiy Hatsenko
Ivan Chernyakhovsky National Defense University of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-0957-6458

Sergii Petruk
Central Scientifically-Research Institute of Arming and Military Equipment of the Armed Forces of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-0709-0032

Rostislav Pikul
Ivan Chernyakhovsky National Defense University of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-3928-9596

Andrii Shyshatskyi
Central Scientifically-Research Institute of Arming and Military Equipment of the Armed Forces of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-6731-6390

The method of fuzzy evaluation of information and analytical support of strategic management is developed. A distinctive feature of the proposed method a flexible hierarchical structure of indicators. This allows reducing the task of multicriteria evaluation of alternatives to a single criterion or using the vector of indicators for selection and it provides an opportunity of fuzzy presentation of indicators and compatibility relations between them, which can realize the different nature of relationships. Also, this method allows implementing forward and backward fuzzy evaluation and takes into account the different significance of individual indicators by using the weight of the indicator. The development of the proposed method is due to the need for processing more information and moderate computational complexity.

The research found that the proposed method has a computational complexity 10–15 % less than the methods used to evaluate the effectiveness of strategic management decisions. This method will allow evaluating the state of information and analytical support and identifying effective measures to improve the effectiveness of information and analytical support of strategic management. The method allows increasing the speed of evaluating the state of information and analytical support, reducing the use of computing resources of support and decision-making systems, developing measures aimed at improving the effectiveness of information and analytical support. It is advisable to use this method in decision support systems to evaluate strategic management issues.

Keywords: information and analytical support, fuzzy sets, computational complexity, system of indicators, fuzzy models, strategic management.

References

1. Rodionov, M. A. (2010). Informatsionno-analiticheskoe obespechenie upravlencheskih resheniy. Moscow, 400.

2. Roy, B. (1996). Multicriteria methodology for decision aiding. Springer. doi: https://doi.org/10.1007/978-1-4757-2500-1

3. Saaty, T. L. (1980). The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw-Hill, 287.

4. Bellman, R. E., Zadeh, L. A. (1970). Decision-Making in a Fuzzy Environment. Management Science, 17 (4), 141–164. doi: https://doi.org/10.1287/mnsc.17.4.b141

5. Mamdani, E. H., Assilian, S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. International Journal of Man-Machine Studies, 7 (1), 1–13. doi: https://doi.org/10.1016/s0020-7373(75)80002-2

6. Sugeno, M. (1985). Industrial applications of fuzzy control. Elsevier Science Pub. Co., 269.

7. Fuller, R. (1995). Neural Fuzzy Systems. Publishing House: Abo Akademi University, 348.

8. Onykiy, B., Artamonov, A., Ananieva, A., Tretyakov, E., Pronicheva, L., Ionkina, K., Suslina, A. (2016). Agent Technologies for Polythematic Organizations Information-Analytical Support. Procedia Computer Science, 88, 336–340. doi: https://doi.org/10.1016/j.procs.2016.07.445

9. Manea, E., Di Carlo, D., Depellegrin, D., Agardy, T., Gissi, E. (2019). Multidimensional assessment of supporting ecosystem services for marine spatial planning of the Adriatic Sea. Ecological Indicators, 101, 821–837. doi: https://doi.org/10.1016/j.ecolind.2018.12.017

10. Xing, W., Goggins, S., Introne, J. (2018). Quantifying the Effect of Informational Support on Membership Retention in Online Communities through Large-Scale Data Analytics. Computers in Human Behavior, 86, 227–234. doi: https://doi.org/10.1016/j.chb.2018.04.042

11. Ko, Y.-C., Fujita, H. (2019). An evidential analytics for buried information in big data samples: Case study of semiconductor manufacturing. Information Sciences, 486, 190–203. doi: https://doi.org/10.1016/j.ins.2019.01.079

12. Çavdar, A. B., Ferhatosmanoğlu, N. (2018). Airline customer lifetime value estimation using data analytics supported by social network information. Journal of Air Transport Management, 67, 19–33. doi: https://doi.org/10.1016/j.jairtraman.2017.10.007

13. Ballester-Caudet, A., Campíns-Falcó, P., Pérez, B., Sancho, R., Lorente, M., Sastre, G., González, C. (2019). A new tool for evaluating and/or selecting analytical methods: Summarizing the information in a hexagon. TrAC Trends in Analytical Chemistry, 118, 538–547. doi: https://doi.org/10.1016/j.trac.2019.06.015

14. Ramaji, I. J., Memari, A. M. (2018). Interpretation of structural analytical models from the coordination view in building information models. Automation in Construction, 90, 117–133. doi: https://doi.org/10.1016/j.autcon.2018.02.025

15. Pérez-González, C. J., Colebrook, M., Roda-García, J. L., Rosa-Remedios, C. B. (2019). Developing a data analytics platform to support decision making in emergency and security management. Expert Systems with Applications, 120, 167–184. doi: https://doi.org/10.1016/j.eswa.2018.11.023

16. Chen, H. (2018). Evaluation of Personalized Service Level for Library Information Management Based on Fuzzy Analytic Hierarchy Process. Procedia Computer Science, 131, 952–958. doi: https://doi.org/10.1016/j.procs.2018.04.233

17. Chan, H. K., Sun, X., Chung, S.-H. (2019). When should fuzzy analytic hierarchy process be used instead of analytic hierarchy process? Decision Support Systems, 125, 113114. doi: https://doi.org/10.1016/j.dss.2019.113114

18. Osman, A. M. S. (2019). A novel big data analytics framework for smart cities. Future Generation Computer Systems, 91, 620–633. doi: https://doi.org/10.1016/j.future.2018.06.046

19. Gödri, I., Kardos, C., Pfeiffer, A., Váncza, J. (2019). Data analytics-based decision support workflow for high-mix low-volume production systems. CIRP Annals, 68 (1), 471–474. doi: https://doi.org/10.1016/j.cirp.2019.04.001

20. Harding, J. L. (2013). Data quality in the integration and analysis of data from multiple sources: some research challenges. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XL-2/W1, 59–63. doi: https://doi.org/10.5194/isprsarchives-xl-2-w1-59-2013

21. Rybak, V. A., Ahmad, S. (2016). Analysis and comparison of existing decision support technology. Sistemniy analiz i prikladnaya informatika, 3, 12–18.

22. Rodionov, M. A. (2014). Problems of information and analytical support of contemporary strategic management. Nauchniy vestnik Moskovskogo gosudarstvennogo tehnicheskogo universiteta grazhdanskoy aviatsii, 202, 65–69.

23. Bednář, Z. (2018). Information Support of Human Resources Management in Sector of Defense. Vojenské rozhledy, 27 (1), 45–68.

24. Palchuk, V. (2017). Suchasni osoblyvosti rozvytku metodiv kontent-monitorynhu i kontent-analizu informatsiynykh potokiv. Naukovi pratsi Natsionalnoi biblioteky Ukrainy imeni V. I. Vernadskoho, 48, 506–526.

25. Mir, S. A., Padma, T. (2016). Evaluation and prioritization of rice production practices and constraints under temperate climatic conditions using Fuzzy Analytical Hierarchy Process (FAHP). Spanish Journal of Agricultural Research, 14 (4), e0909. doi: https://doi.org/10.5424/sjar/2016144-8699

26. Kljushin, V. V. (2014). Theoretical and methodological basis for the formation and evaluation of the level of the economic system's strategic economic potential. Modern Management Technology, 12 (48). Available at: https://sovman.ru/article/4805/

27. Bogomolova, I. P., Omel'chenko, O. M. (2014). Analysis of influence factors of economic efficiency on the economy of the integrated structures. Vestnik Voronezhskogo gosudarstvennogo universiteta inzhenernyh tehnologiy, 3, 157–162.

28. Sherafat, A., Yavari, K., Davoodi, S. M. R. (2014). Evaluation of the Strategy Management Implementation in Project-Oriented Service Organizations. Acta Universitatis Danubius, 10 (1), 16–25.

29. Alieinykov, I. V. (2018). Analiz faktoriv, shcho vplyvaiut na operatyvnist protsesu zboru, obrobky i peredachi informatsiyi pro protyvnyka pid chas pidhotovky ta vedennia oboronnoi operatsiyi operatyvnoho uhrupuvannia viysk. XVIII naukovo-tekhnichnoi konferentsiyi "Stvorennia ta modernizatsiya ozbroiennia i viyskovoi tekhniky v suchasnykh umovakh". Chernihiv, 38.

30. Alieinykov, I. V., Zhyvotovskyi, R. M. (2018). Udoskonalennia informatsiyno-analitychnoho zabezpechennia za rakhunok formuvannia intehrovanoi informatsiynoi systemy upravlinnia viyskamy. Zbirnyk materialiv VI mizhnarodnoi naukovo-praktychnoi konferentsiyi "Problemy koordynatsiyi voienno-tekhnichnoi ta oboronno-promyslovoi polityky v Ukraini. Perspektyvy rozvytku ozbroiennia ta viiskovoi tekhniky". Kyiv, 165–166.

31. Kalantaievska, S., Pievtsov, H., Kuvshynov, O., Shyshatskyi, A., Yarosh, S., Gatsenko, S. et. al. (2018). Method of integral estimation of channel state in the multiantenna radio communication systems. Eastern-European Journal of Enterprise Technologies, 5 (9 (95)), 60–76. doi: https://doi.org/10.15587/1729-4061.2018.144085

DEVELOPMENT OF THE QUANTITATIVE METHOD FOR AUTOMATED TEXT CONTENT AUTHORSHIP ATTRIBUTION BASED ON THE STATISTICAL ANALYSIS OF N-GRAMS DISTRIBUTION (p. 28-51)

Vasyl Lytvyn
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-9676-0180

Victoria Vysotska
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-6417-3689

Ihor Budz
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-5400-0984

Yaroslav Pelekh
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-4339-8093

Nataliia Sokulska
Hetman Petro Sahaidachnyi National Army Academy, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-3425-5517

Roman Kovalchuk
Hetman Petro Sahaidachnyi National Army Academy, Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-8337-8591

Lyudmyla Dzyubyk
Hetman Petro Sahaidachnyi National Army Academy, Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-6942-9436

Oksana Tereshchuk

Hetman Petro Sahaidachnyi National Army Academy, Lviv, Ukraine

ORCID: http://orcid.org/0000-0002-6444-0609

Myroslav Komar

Ternopil National Economic University, Ternopil, Ukraine

ORCID: http://orcid.org/0000-0001-6541-0359

The peculiarities of the application of linguo-statistics technologies for the identification of the style of the author of text content of scientific and technical profile are considered. Quantitative linguistic analysis of a text uses the benefits of content monitoring based on the NLP methods to identify and analyze the set of stop words, keywords, set phrases and to study N-gram. The latter are used in the linguometry methods to determine in per cent if the given text belongs to a particular author. The quantitative method for automatic text content authorship attribution was developed based on statistical analysis of the 3-gram distribution. The approach to the implementation of identification of the author of the text in the Ukrainian language of the scientific and technical profile was proposed. Experimental results of the proposed method to determine the belonging of the analyzed text to a specific author in the presence of the reference text were obtained. Application of the linguo-statistical analysis of the 3-grams to a set of articles will make it possible to form a subset of publications that are similar in linguistic descriptions. Imposing additional conditions in the form of statistical and quantitative analyses (a set of keywords, set expressions, stylometric, linguometric analyses, etc.) on a subset will allow a significant reduction of this subset by specifying the list of the most likely author. For qualitative and effective content analysis when determining the degree of authorship of a particular author, we propose to analyze the reference text and the one under consideration at several stages: linguometric analysis of the coefficients of the diversity of the author's speech, stylometric analysis, analysis of set expressions, linguo-statistical analysis of 3-grams. For automated text processing, not only the frequency of occurrence of a certain category, but also its existence in the studied text in general are important. Quantitative computation makes it possible to draw objective conclusions about the orientation of materials by the number of using the units of analysis in the studied texts. Qualitative analysis does the same, but as a result of the study of whether (and in what context) there is a certain important original category in general.

Keywords: NLP, content, content-monitoring, stop-words, content-analysis, statistical linguistic analysis, quantitative linguistics, statistical linguistics, linguometry.

References

1. Lytvyn, V., Vysotska, V., Pukach, P., Nytrebych, Z., Demkiv, I., Kovalchuk, R., Huzyk, N. (2018). Development of the linguometric method for automatic identification of the author of text content based on statistical analysis of language diversity coefficients. Eastern-European Journal of Enterprise Technologies, 5 (2 (95)), 16–28. doi: https://doi.org/10.15587/1729-4061.2018.142451

2. Lytvyn, V., Vysotska, V., Uhryn, D., Hrendus, M., Naum, O. (2018). Analysis of statistical methods for stable combinations determination of keywords identification. Eastern-European Journal of Enterprise Technologies, 2 (2 (92)), 23–37. doi: https://doi.org/10.15587/1729-4061.2018.126009

3. Buk, S. (2008). Osnovy statystychnoi linhvistyky. Lviv, 124.

4. Lytvyn, V., Vysotska, V., Pukach, P., Brodyak, O., Ugryn, D. (2017). Development of a method for determining the keywords in the slavic language texts based on the technology of web mining. Eastern-European Journal of Enterprise Technologies, 2 (2 (86)), 14–23. doi: https://doi.org/10.15587/1729-4061.2017.98750

5. Lytvyn, V., Vysotska, V., Pukach, P., Bobyk, I., Uhryn, D. (2017). Development of a method for the recognition of author's style in the Ukrainian language texts based on linguometry, stylemetry and glottochronology. Eastern-European Journal of Enterprise Technologies, 4 (2 (88)), 10–19. doi: https://doi.org/10.15587/1729-4061.2017.107512

6. Lytvyn, V., Pukach, P., Bobyk, I., Vysotska, V. (2016). The method of formation of the status of personality understanding based on the content analysis. Eastern-European Journal of Enterprise Technologies, 5 (2 (83)), 4–12. doi: https://doi.org/10.15587/1729-4061.2016.77174

7. Lytvyn, V., Vysotska, V., Pukach, P., Vovk, M., Ugryn, D. (2017). Method of functioning of intelligent agents, designed to solve action planning problems based on ontological approach. Eastern-European Journal of Enterprise Technologies, 3 (2 (87)), 11–17. doi: https://doi.org/10.15587/1729-4061.2017.103630

8. Khomytska, I., Teslyuk, V. (2016). The Method of Statistical Analysis of the Scientific, Colloquial, Belles-Lettres and Newspaper Styles on the Phonological Level. Advances in Intelligent Systems and Computing, 149–163. doi: https://doi.org/10.1007/978-3-319-45991-2_10

9. Khomytska, I., Teslyuk, V., Holovatyy, A., Morushko, O. (2018). Development of methods, models, and means for the author attribution of a text. Eastern-European Journal of Enterprise Technologies, 3 (2 (93)), 41–46. doi: https://doi.org/10.15587/1729-4061.2018.132052

10. Khomytska, I., Teslyuk, V. (2018). Authorship and Style Attribution by Statistical Methods of Style Differentiation on the Phonological Level. Advances in Intelligent Systems and Computing III, 105–118. doi: https://doi.org/10.1007/978-3-030-01069-0_8

11. Khomytska, I., Teslyuk, V. (2016). Specifics of phonostatistical structure of the scientific style in English style system. 2016 XIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2016.7589887

12. Khomytska, I., Teslyuk, V. (2017). Modelling of phonostatistical structures of English backlingual phoneme group in style system. 2017 14th International Conference The Experience of Designing and Application of CAD Systems in Microelectronics (CADSM). doi: https://doi.org/10.1109/cadsm.2017.7916144

13. Khomytska, I., Teslyuk, V. (2017). Modelling of phonostatistical structures of the colloquial and newspaper styles in english sonorant phoneme group. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098738

14. Khomytska, I., Teslyuk, V. (2018). Authorship Attribution by Differentiation of Phonostatistical Structures of Styles. 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2018.8526739

15. Khomytska, I., Teslyuk, V. (2019). The Software for Authorship and Style Attribution. 2019 IEEE 15th International Conference on the Experience of Designing and Application of CAD Systems (CADSM). doi: https://doi.org/10.1109/cadsm.2019.8779346

16. Khomytska, I., Teslyuk, V. (2019). Mathematical Methods Applied for Authorship Attribution on the Phonological Level. CSIT: Proceedings of the XIVth Scientific and Technical Conference, 7–11.

17. Bol'shakova, E., Klyshinskiy, E., Lande, D., Noskov, A., Peskova, O., Yagunova, E. (2011). Avtomaticheskaya obrabotka tekstov na estestvennom yazyke i komp'yuternaya lingvistika. Moscow: MIEM, 272.

18. Anisimov, A., Marchenko, A. (2002). Sistema obrabotki tekstov na estestvennom yazyke. Iskusstvennyy intellekt, 4, 157–163.

19. Perebyinis, V. (2000). Matematychna linhvistyka. Ukrainska mova. Kyiv, 287–302.

20. Perebyinis, V. (2013). Statystychni metody dlia linhvistiv. Vinnytsia, 176.

21. Braslavskiy, P. I. (2006). Intellektual'nye informatsionnye sistemy. Tema 7 Tematicheskaya kategorizatsiya. Available at: https://docplayer.ru/36866470-Intellektualnye-informacionnye-sistemy-tema-

7-tematicheskaya-kategorizaciya-pavel-isaakovich-braslavskiy-ve-senniy-semestr-2006.html

22. Lande, D., Zhyhalo, V. (2008). Pidkhid do rishennia problem poshuku dvomovnoho plahiatu. Problemy informatyzatsiyi ta upravlinnia, 2 (24), 125–129.

23. Varfolomeev, A. (2000). Psihosemantika slova i lingvostatistika teksta. Kaliningrad, 37.

24. Marchenko, O. (2006). Modeliuvannia semantychnoho kontekstu pry analizi tekstiv na pryrodniy movi. Visnyk Kyivskoho universytetu, 3, 230–235.

25. Jivani, A. G. (2011). A Comparative Study of Stemming Algorithms. Int. J. Comp. Tech. Appl., 2 (6), 1930–1938.

26. Linhvometriya. Victana. Available at: http://victana.lviv.ua/nlp/linhvometriia

27. Sushko, S. O., Fomychova, L. Ya., Barsukov, Ye. S. (2010). Chastoty povtoriuvanosti bukv i bihram u vidkrytykh tekstakh ukrainskoiu movoiu. Ukrainian Information Security Research Journal, 12 (3 (48)). doi: https://doi.org/10.18372/2410-7840.12.1968

28. Kognitivnaya stilometriya: k postanovke problemy. Available at: http://www.manekin.narod.ru/hist/styl.htm

29. Kocherhan, M. (2005). Vstup do movoznavstva. Kyiv, 368.

30. Rodionova, E. (2008). Metody atributsii hudozhestvennyh tekstov. Strukturnaya i prikladnaya lingvistika, 7, 118–127.

31. Meshcheryakov, R. V., Vasyukov, N. S. (2005). Modeli opredeleniya avtorstva teksta. Izmereniya, avtomatizatsiya i modelirovanie v promyshlennosti i nauchnyh issledovaniyah, 25–29.

32. Morozov, N. A. Lingvisticheskie spektry. Available at: http://www.textology.ru/library/book.aspx?bookId=1&textId=3

33. Mobasher, B. (2007). Data Mining for Web Personalization. The Adaptive Web. Lecture Notes in Computer Science, 90–135. doi: https://doi.org/10.1007/978-3-540-72079-9_3

34. Dinucă, C. E., Ciobanu, D. (2012). Web Content Mining. Annals of the University of Petroşani. Economics, 12 (1), 85–92.

35. Xu, G., Zhang, Y., Li, L. (2010). Web Content Mining. Web Mining and Social Networking, 71–87. doi: https://doi.org/10.1007/978-1-4419-7735-9_4

36. Mishler, A., Crabb, E. S., Paletz, S., Hefright, B., Golonka, E. (2015). Using Structural Topic Modeling to Detect Events and Cluster Twitter Users in the Ukrainian Crisis. HCI International 2015 - Posters' Extended Abstracts, 639–644. doi: https://doi.org/10.1007/978-3-319-21380-4_108

37. Bubleinyk, L. (2000). Osoblyvosti khudozhnoho movlennia. Lutsk, 179.

38. Kowalska, K., Cai, D., Wade, S. (2012). Sentiment Analysis of Polish Texts. International Journal of Computer and Communication Engineering, 1 (1), 39–42. doi: https://doi.org/10.7763/ijcce.2012.v1.12

39. Kotsyba, N. (2009). The current state of work on the Polish-Ukrainian Parallel Corpus (PolUKR). Organization and Development of Digital Lexical Resources, 55–60.

40. Lytvyn, V., Vysotska, V., Rzheuskyi, A. (2019). Technology for the Psychological Portraits Formation of Social Networks Users for the IT Specialists Recruitment Based on Big Five, NLP and Big Data Analysis. Proceedings of the 1st International Workshop on Control, Optimisation and Analytical Processing of Social Networks (COAPSN-2019), 2392, 147–171.

41. Lytvyn, V., Vysotska, V., Rusyn, B., Pohreliuk, L., Berezin, P., Naum, O. (2019). Textual Content Categorizing Technology Development Based on Ontology. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 2386, 234–254.

42. Lytvyn, V., Kuchkovskiy, V., Vysotska, V., Markiv, O., Pabyrivskyy, V. (2018). Architecture of System for Content Integration and Formation Based on Cryptographic Consumer Needs. 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2018.8526669

43. Berko, A., Alieksieiev, V. (2018). A Method to Solve Uncertainty Problem for Big Data Sources. 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP). doi: https://doi.org/10.1109/dsmp.2018.8478460

44. Gozhyj, A., Kalinina, I., Vysotska, V., Gozhyj, V. (2018). The Method of Web-Resources Management Under Conditions of Uncertainty Based on Fuzzy Logic. 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2018.8526761

45. Lytvyn, V., Vysotska, V., Dosyn, D., Burov, Y. (2018). Method for ontology content and structure optimization, provided by a weighted conceptual graph. Webology, 15 (2), 66–85.

46. Nytrebych, Z. M., Malanchuk, O. M., Il'kiv, V. S., Pukach, P. Ya. (2017). Homogeneous problem with two-point conditions in time for some equations of mathematical physics. Azerbaijan Journal of Mathematics, 7 (2), 180–196.

47. Nytrebych, Z., Il'kiv, V., Pukach, P., Malanchuk, O. (2018). On nontrivial solutions of homogeneous Dirichlet problem for partial differential equations in a layer. Kragujevac Journal of Mathematics, 42 (2), 193–207. doi: https://doi.org/10.5937/kgjmath1802193n

48. Nytrebych, Z., Malanchuk, O., Il'kiv, V., Pukach, P. (2017). On the solvability of two-point in time problem for PDE. Italian Journal of Pure and Applied Mathematics, 38, 715–726.

49. Pukach, P. Ya., Kuzio, I. V., Nytrebych, Z. M., Ilkiv, V. S. (2017). Analytical methods for determining the effect of the dynamic process on the nonlinear flexural vibrations and the strength of compressed shaft. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 5, 69–76.

50. Pukach, P. Y., Kuzio, I. V., Nytrebych, Z. M., Il'kiv, V. S. (2018). Asymptotic method for investigating resonant regimes of nonlinear bending vibrations of elastic shaft. Scientific Bulletin of National Mining University, 1, 68–73. doi: https://doi.org/10.29202/nvngu/2018-1/9

51. Nytrebych, Z., Ilkiv, V., Pukach, P., Malanchuk, O., Kohut, I., Senyk, A. (2019). Analytical method to study a mathematical model of wave processes under two¬point time conditions. Eastern-European Journal of Enterprise Technologies, 1 (7 (97)), 74–83. doi: https://doi.org/10.15587/1729-4061.2019.155148

52. Pukach, P., Il'kiv, V., Nytrebych, Z., Vovk, M., Pukach, P. (2017). On the Asymptotic Methods of the Mathematical Models of Strongly Nonlinear Physical Systems. Advances in Intelligent Systems and Computing, 421–433. doi: https://doi.org/10.1007/978-3-319-70581-1_30

53. Lavrenyuk, S. P., Pukach, P. Y. (2007). Mixed problem for a nonlinear hyperbolic equation in a domain unbounded with respect to space variables. Ukrainian Mathematical Journal, 59 (11), 1708–1718. doi: https://doi.org/10.1007/s11253-008-0020-0

54. Pukach, P. Y. (2016). Investigation of Bending Vibrations in Voigt–Kelvin Bars with Regard for Nonlinear Resistance Forces. Journal of Mathematical Sciences, 215 (1), 71–78. doi: https://doi.org/10.1007/s10958-016-2823-0

55. Pukach, P., Il'kiv, V., Nytrebych, Z., Vovk, M. (2017). On nonexistence of global in time solution for a mixed problem for a nonlinear evolution equation with memory generalizing the Voigt-Kelvin rheological model. Opuscula Mathematica, 37 (45), 735. doi: https://doi.org/10.7494/opmath.2017.37.5.735

56. Pukach, P. Y. (2012). On the unboundedness of a solution of the mixed problem for a nonlinear evolution equation at a finite time. Nonlinear Oscillations, 14 (3), 369–378. doi: https://doi.org/10.1007/s11072-012-0164-6

57. Pukach, P. Y. (2014). Qualitative Methods for the Investigation of a Mathematical Model of Nonlinear Vibrations of a Conveyer Belt. Journal of Mathematical Sciences, 198 (1), 31–38. doi: https://doi.org/10.1007/s10958-014-1770-x

58. Bezobrazov, S., Sachenko, A., Komar, M., Rubanau, V. (2016). The Methods of Artificial Intelligence for Malicious Applications Detection in Android OS. International Journal of Computing, 15 (3), 184–190.

59. Dunets, O., Wolff, C., Sachenko, A., Hladiy, G., Dobrotvor, I. (2017). Multi-agent system of IT project planning. 2017 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS). doi: https://doi.org/10.1109/idaacs.2017.8095141

60. Vysotska, V., Lytvyn, V., Burov, Y., Berezin, P., Emmerich, M., Basto Fernandes, V. (2019). Development of Information System for Textual Content Categorizing Based on Ontology. CEUR Workshop Proceedings, 53–70.

61. Vysotska, V., Lytvyn, V., Burov, Y., Gozhyj, A., Makara, S. (2018). The consolidated information web-resource about pharmacy networks in city. Proceedings of the 1st International Workshop on Informatics & Data-Driven Medicine (IDDM 2018), 2255, 239–255. Available at: http://ceur-ws.org/Vol-2255/paper22.pdf

62. Rusyn, B., Vysotska, V., Pohreliuk, L. (2018). Model and Architecture for Virtual Library Information System. 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2018.8526679

63. Lytvyn, V., Vysotska, V., Dosyn, D., Lozynska, O., Oborska, O. (2018). Methods of Building Intelligent Decision Support Systems Based on Adaptive Ontology. 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP). doi: https://doi.org/10.1109/dsmp.2018.8478500

64. Lytvyn, V., Vysotska, V., Burov, Y., Bobyk, I., Ohirko, O. (2018). The Linguometric Approach for Co-authoring Author's Style Definition. 2018 IEEE 4th International Symposium on Wireless Systems within the International Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS). doi: https://doi.org/10.1109/idaacs-sws.2018.8525741

65. Zdebskyi, P., Vysotska, V., Peleshchak, R., Peleshchak, I., Demchuk, A., Krylyshyn, M. (2019). An Application Development for Recognizing of View in Order to Control the Mouse Pointer. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 55–74.

66. Veres, O., Rusyn, B., Sachenko, A., Rishnyak, I. (2018). Choosing the method of finding similar images in the reverse search system. Proceedings of the 2nd International Conference on Computational Linguistics and Intelligent Systems. Volume I: Main Conference (COLINS 2018), 2136, 99–107.

67. Vysotska, V., Lytvyn, V., Hrendus, M., Kubinska, S., Brodyak, O. (2018). Method of Textual Information Authorship Analysis Based on Stylometry. 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2018.8526608

68. Gozhyj, A., Chyrun, L., Kowalska-Styczen, A., Lozynska, O. (2018). Uniform Method of Operative Content Management in Web Systems. Proceedings of the 2nd International Conference on Computational Linguistics and Intelligent Systems. Volume I: Main Conference (COLINS 2018), 2136, 62–77. Available at: http://ceur-ws.org/Vol-2136/10000062.pdf

69. Vysotska, V., Burov, Y., Lytvyn, V., Demchuk, A. (2018). Defining Author's Style for Plagiarism Detection in Academic Environment. 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP), 128–133. doi: https://doi.org/10.1109/dsmp.2018.8478574

70. Chyrun, L., Vysotska, V., Kis, I., Chyrun, L. (2018). Content Analysis Method for Cut Formation of Human Psychological State. 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP). doi: https://doi.org/10.1109/dsmp.2018.8478619

71. Gozhyj, A., Vysotska, V., Yevseyeva, I., Kalinina, I., Gozhyj, V. (2018). Web Resources Management Method Based on Intelligent Technologies. Advances in Intelligent Systems and Computing III, 206–221. doi: https://doi.org/10.1007/978-3-030-01069-0_15

72. Chyrun, L., Kis, I., Vysotska, V., Chyrun, L. (2018). Content Monitoring Method for Cut Formation of Person Psychological State in Social Scoring. 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2018.8526624

73. Demchuk, A., Lytvyn, V., Vysotska, V., Dilai, M. (2019). Methods and Means of Web Content Personalization for Commercial Information Products Distribution. Lecture Notes in Computational Intelligence and Decision Making, 332–347. doi: https://doi.org/10.1007/978-3-030-26474-1_24

74. Lytvyn, V., Vysotska, V., Kuchkovskiy, V., Bobyk, I., Malanchuk, O., Ryshkovets, Y. et. al. (2019). Development of the system to integrate and generate content considering the cryptocurrent needs of users. Eastern-European Journal of Enterprise Technologies, 1 (2 (97)), 18–39. doi: https://doi.org/10.15587/1729-4061.2019.154709

75. Vysotska, V., Fernandes, V. B., Lytvyn, V., Emmerich, M., Hrendus, M. (2018). Method for Determining Linguometric Coefficient Dynamics of Ukrainian Text Content Authorship. Advances in Intelligent Systems and Computing III, 132–151. doi: https://doi.org/10.1007/978-3-030-01069-0_10

76. Kravets, P. (2010). The control agent with fuzzy logic. Perspective Technologies and Methods in MEMS Design, 40–41.

77. Kravets, P. (2007). The Game Method for Orthonormal Systems Construction. 2007 9th International Conference - The Experience of Designing and Applications of CAD Systems in Microelectronics. doi: https://doi.org/10.1109/cadsm.2007.4297555

78. Kravets, P. (2016). Game Model of Dragonfly Animat Self-Learning. Perspective Technologies and Methods in MEMS Design, 195–201.

79. Basyuk, T. (2015). The main reasons of attendance falling of internet resource. 2015 Xth International Scientific and Technical Conference "Computer Sciences and Information Technologies" (CSIT). doi: https://doi.org/10.1109/stc-csit.2015.7325440

80. Chyrun, L., Kowalska-Styczen, A., Burov, Y., Berko, A., Vasevych, A., Pelekh, I., Ryshkovets, Y. (2019). Heterogeneous Data with Agreed Content Aggregation System Development. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 2386, 35–54.

81. Chyrun, L., Burov, Y., Rusyn, B., Pohreliuk, L., Oleshek, O. et. al. (2019). Web Resource Changes Monitoring System Development. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 2386, 255–273.

82. Vysotska, V., Burov, Y., Lytvyn, V., Oleshek, O. (2019). Automated Monitoring of Changes in Web Resources. Lecture Notes in Computational Intelligence and Decision Making, 348–363. doi: https://doi.org/10.1007/978-3-030-26474-1_25

83. Chyrun, L., Gozhyj, A., Yevseyeva, I., Dosyn, D., Tyhonov, V., Zakharchuk, M. (2019). Web Content Monitoring System Development. Proceedings of the 3rd International Conference on Computational Linguistics and Intelligent Systems (COLINS-2019). Volume I: Main Conference, 2362, 126–142.

84. Rzheuskyi, A., Gozhyj, A., Stefanchuk, A., Oborska, O., Chyrun, L., Lozynska, O. et. al. (2019). Development of Mobile Application for Choreographic Productions Creation and Visualization. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 2386, 340–358.

85. Lytvynenko, V., Savina, N., Krejci, J., Voronenko, M., Yakobchuk, M., Kryvoruchko, O. (2019). Bayesian Networks' Development Based on Noisy-MAX Nodes for Modeling Investment Processes in Transport. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 2386, 1–10.

86. Lytvynenko, V., Lurie, I., Krejci, J., Voronenko, M., Savina, N., Taif, M. A. (2019). Two Step Density-Based Object-Inductive Clustering Algorithm. Workshop Proceedings of the 8th International Conference on "Mathematics. Information Technologies. Education", 2386, 117–135.

87. Antonyuk, N., Medykovskyy, M., Chyrun, L., Dverii, M., Oborska, O., Krylyshyn, M. et. al. (2019). Online Tourism System Development for Searching and Planning Trips with User's Requirements. Advances in Intelligent Systems and Computing, 831–863. doi: https://doi.org/10.1007/978-3-030-33695-0_55

88. Rzheuskyi, A., Kutyuk, O., Voloshyn, O., Kowalska-Styczen, A., Voloshyn, V., Chyrun, L. et. al. (2019). The Intellectual System Development of Distant Competencies Analyzing for IT Recruitment. Advances in Intelligent Systems and Computing, 696–720. doi: https://doi.org/10.1007/978-3-030-33695-0_47

89. Rusyn, B., Pohreliuk, L., Rzheuskyi, A., Kubik, R., Ryshkovets, Y., Chyrun, L. et. al. (2019). The Mobile Application Development Based on Online Music Library for Socializing in the World of Bard Songs and Scouts' Bonfires. Advances in Intelligent Systems and Computing, 734–756. doi: https://doi.org/10.1007/978-3-030-33695-0_49

90. Chyrun, L., Leshchynskyy, E., Lytvyn, V., Rzheuskyi, A.,Vysotska, V., Borzov, Y. (2019). Intellectual Analysis of Making Decisions Tree in Information Systems of Screening Observation for Immunological Patients. CEUR Workshop Proceedings, of the 2nd International Workshop on Informatics & Data-Driven Medicine (IDDM 2019), 281–296. Available at: http://ceur-ws.org/Vol-2488/paper25.pdf

91. Lytvyn, V., Burov, Y., Kravets, P., Vysotska, V., Demchuk, A., Berko, A. et. al. (2019). Methods and Models of Intellectual Processing of Texts for Building Ontologies of Software for Medical Terms Identification in Content Classification. CEUR Workshop Proceedings, of the 2nd International Workshop on Informatics & Data-Driven Medicine (IDDM 2019), 354–368. Available at: http://ceur-ws.org/Vol-2488/paper31.pdf

92. Antonyuk, N., Chyrun, L., Andrunyk, V., Vasevych, A., Chyrun, S., Gozhyj, A. et. al. (2019). Medical News Aggregation and Ranking of Taking into Account the User Needs. CEUR Workshop Proceedings, of the 2nd International Workshop on Informatics & Data-Driven Medicine (IDDM 2019), 369–382. Available at: http://ceur-ws.org/Vol-2488/paper32.pdf

93. Babichev, S., Taif, M. A., Lytvynenko, V., Osypenko, V. (2017). Criterial analysis of gene expression sequences to create the objective clustering inductive technology. 2017 IEEE 37th International Conference on Electronics and Nanotechnology (ELNANO). doi: https://doi.org/10.1109/elnano.2017.7939756

94. Babichev, S., Korobchynskyi, M., Lahodynskyi, O., Korchomnyi, O., Basanets, V., Borynskyi, V. (2018). Development of a technique for the reconstruction and validation of gene network models based on gene expression profiles. Eastern-European Journal of Enterprise Technologies, 1 (4 (91)), 19–32. doi: https://doi.org/10.15587/1729-4061.2018.123634

95. Babichev, S., Lytvynenko, V., Osypenko, V. (2017). Implementation of the objective clustering inductive technology based on DBSCAN clustering algorithm. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098832

96. Babichev, S. A., Gozhyj, A., Kornelyuk, A. I., Lytvynenko, V. I. (2017). Objective clustering inductive technology of gene expression profiles based on sota clustering algorithm. Biopolymers and Cell, 33 (5), 379–392. doi: https://doi.org/10.7124/bc.000961

97. Pasichnyk, V., Shestakevych, T. (2016). The Model of Data Analysis of the Psychophysiological Survey Results. Advances in Intelligent Systems and Computing, 271–281. doi: https://doi.org/10.1007/978-3-319-45991-2_18

98. Zhezhnych, P., Markiv, O. (2017). Linguistic Comparison Quality Evaluation of Web-Site Content with Tourism Documentation Objects. Advances in Intelligent Systems and Computing, 656–667. doi: https://doi.org/10.1007/978-3-319-70581-1_45

99. Davydov, M., Lozynska, O. (2017). Information system for translation into ukrainian sign language on mobile devices. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098734

100. Davydov, M., Lozynska, O. (2017). Mathematical Method of Translation into Ukrainian Sign Language Based on Ontologies. Advances in Intelligent Systems and Computing, 89–100. doi: https://doi.org/10.1007/978-3-319-70581-1_7

101. Davydov, M., Lozynska, O. (2016). Linguistic models of assistive computer technologies for cognition and communication. 2016 XIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2016.7589898

102. Vysotska, V., Chyrun, L. (2015). Methods of information resources processing in electronic content commerce systems. Proceedings of 13th International Conference: The Experience of Designing and Application of CAD Systems in Microelectronics, CADSM 2015-February.

103. Andrunyk, V., Chyrun, L., Vysotska, V. (2015). Electronic content commerce system development. Proceedings of 13th International Conference: The Experience of Designing and Application of CAD Systems in Microelectronics, CADSM 2015-February.

104. Alieksieieva, K., Berko, A., Vysotska, V. (2015). Technology of commercial web-resource processing. Proceedings of 13th International Conference: The Experience of Designing and Application of CAD Systems in Microelectronics, CADSM 2015-February.

105. Mykich, K., Burov, Y. (2016). Uncertainty in situational awareness systems. 2016 13th International Conference on Modern Problems of Radio Engineering, Telecommunications and Computer Science (TCSET). doi: https://doi.org/10.1109/tcset.2016.7452165

106. Mykich, K., Burov, Y. (2016). Algebraic Framework for Knowledge Processing in Systems with Situational Awareness. Advances in Intelligent Systems and Computing, 217–227. doi: https://doi.org/10.1007/978-3-319-45991-2_14

107. Mykich, K., Burov, Y. (2016). Research of uncertainties in situational awareness systems and methods of their processing. Eastern-European Journal of Enterprise Technologies, 1 (4 (79)), 19–27. doi: https://doi.org/10.15587/1729-4061.2016.60828

108. Mykich, K., Burov, Y. (2016). Algebraic model for knowledge representation in situational awareness systems. 2016 XIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2016.7589896

DEVELOPMENT OF AN AUTOMATED HYDRAULIC BRAKE CONTROL SYSTEM FOR TESTING AIRCRAFT TURBOSHAFT GAS TURBINE ENGINES (p. 52-57)

Petro Kachanov
National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-0781-0853

Oleksandr Lytviak
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-0242-1859

Oleksandr Derevyanko
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-3602-2055

Sergii Komar
Ivan Kozhedub Kharkiv University of Air Force, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-8961-2614

To absorb the power generated by a free turbine, hydraulic brake systems of various designs are used in ground tests of aircraft turboshaft gas turbine engines. Ground tests of aircraft turboshaft gas turbine engines with the use of such hydraulic brakes can result in emergency modes of automated engine control in the area of operation of a free turbine speed regulator. Mismatch between the hydraulic brake loading characteristics and the loading characteristics of the rotor driven by a free turbine of the engine is the main cause of emergency operation of automated control systems.

The presented experimental loading characteristics of the hydraulic brake and the helicopter rotor show their significant difference in terms of gain. To eliminate this difference, a possibility of modeling dynamic parameters of rotors by simple automation means was considered. To solve this problem, a linear dynamic model and a block diagram of an automated hydraulic brake control system for ground testing of turboshaft gas turbine engines were elaborated. The law of regulation of the hydraulic brake loading was substantiated. A structurally dynamic diagram of the developed automated control system was presented and calculation formulas for determining the regulator parameters were given. Transient characteristics of the hydraulic brake unit without automation means and with the use of an automated loading control system were calculated. The presented calculation results have shown that the use of automation make it possible to fully emulate characteristics of the helicopter rotors.

Keywords: hydraulic brake automation, loading characteristic, dynamic parameters, regulation law, transient characteristics.

References

1. Popov, G. M., Novikova, Yu. D., Goryachkin, E. S. (2016). Ispol'zovanie kompressora nizkogo davleniya dlya sozdaniya gidrotormoznoy sistemy ispytatel'nogo stenda gazoturbinnyh dvigateley. Materialy dokladov mezhdunar. nauch.-tehn. konf. Samara, 132–133.

2. Ahmedzyanov, D. A., Yamaliev, R. R., Kishalov, A. E., Suhanov, A. V. (2009). Automation of process of test aviation GTE on the basis of SCADA-system LabView. Vestnik Ufimskogo gosudarstvennogo aviatsionnogo tehnicheskogo universiteta, 13 (2), 61–68.

3. Hait, L., Husainov, R., Soldatov, V., Golovin, M. (2018). Sistema avtomatizatsii seriynyh stendovyh ispytaniy aviatsionnyh dvigateley. Zhurnal «STA», 4, 76–81.

4. Sedristiy, V. A., Loznya, S. V., Pustovoy, S. A., Stepanenko, I. I. (2009). Opyt razrabotki i primeneniya intellektual'nyh ispytatel'nyh stendov aviatsionnyh gazoturbinnyh dvigateley pri dovodke tsifrovyh SAU. Vestnik inzhenernoy akademii Ukrainy, 1, 158–164.

5. Sykes, C., Sagehorn, K. H. United States Pat. No. US7.942.249 B2. Systems and Methods for Controlling the Stability of a Water Brake Dynamometer.

6. Gruenbacher, E., del Re, L., Kokal, H., Schmidt, M., Paulweber, M. (2008). Adaptive Control of Engine Torque with Input Delays. IFAC Proceedings Volumes, 41 (2), 9479–9484. doi: https://doi.org/10.3182/20080706-5-kr-1001.01602

7. Passenbrunner, T. E., Sassano, M., Trogmann, H., del Re, L., Paulweber, M., Schmidt, M., Kokal, H. (2011). Inverse torque control of hydrodynamic dynamometers for combustion engine test benches. Proceedings of the 2011 American Control Conference. doi: https://doi.org/10.1109/acc.2011.5991317

8. Van den Braembussche, R. A., Malys, H. (1998). Dynamic Stability of a Water Brake Dynamometer. Journal of Engineering for Gas Turbines and Power, 120 (1), 89–96. doi: https://doi.org/10.1115/1.2818092

9. Gimadiev, A. G., Bukin, V. A., Greshchnyakov, P. I., Utkin, A. V. (2016). Eksperimental'noe issledovanie kolebatel'nyh protsessov pri ispytaniyah turbovintovogo dvigatelya na gidrotormoznoy ustanovke. Materialy dokladov mezhdunar. nauch.-tehn. konf. Samara, 20–21.

10. Torabnia, S., Banazadeh, A. (2014). Development of a Water Brake Dynamometer With Regard to the Modular Product Design Methodology. Volume 1: Applied Mechanics; Automotive Systems; Biomedical Biotechnology Engineering; Computational Mechanics; Design; Digital Manufacturing; Education; Marine and Aerospace Applications. doi: https://doi.org/10.1115/esda2014-20232

11. Golovashchenko, A. (2004). Os'minog ili o roli tormoza v progresse turbostroeniya. Dvigatel', 4, 16–54.

12. Inozemtsev, A. A., Nihamkin, M. A. et. al. (2008). Avtomatika i regulirovanie aviatsionnyh dvigateley i energeticheskih ustanovok. Moscow: Mashinostroenie, 200.

ANALYSIS OF OPTIMIZATION CRITERIA FOR THE PROCESS OF SWITCH DISPLACEMENT IN A DC RAILROAD TURNOUT (p. 58-69)

Serhii Buriakovskyi
National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-2469-7431

Vasyl Smirnov
PJSC «ELAKS», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-6663-3447

Larysa Asmolova
National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-0208-2380

Ihor Obruch
National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-8239-1428

Oleksandr Rafalskyi
PJSC «ELAKS», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9292-0925

Artem Maslii
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-0554-8150

This paper reports a study into the dynamics of displacing a railroad turnout's switches with a direct start of electric motor and a controlled DC electric drive in the MATLAB environment. The emphasis of simulation was the investigation of processes taking place in the kinematic links of a railroad turnout in the dynamics of its switch displacement. The estimation was based on the optimization criteria for a switch displacement process: the pulse of the impact of a switch against the frame rail, elasticity force in the working rod and a switch turning time. The result of the simulation of a non-controlled electric drive in a railroad turnout of switches has revealed that the values of these parameters are unsatisfactory.

Mathematical models of the regulated electric drive for a railroad switch turnout were considered as two-mass electromechanical systems with subordinate regulation of basic coordinates and based on the principle of modal control. The results from mathematical modelling of the switch turning process convince that the numerical values of the optimization criteria for a regulated turning process are improved. Increasing the time of a regulated turning by up to 6 % of direct start results in a decreased impact in the kinematic links. Under the assumption of eliminating a technological gap in the reducer, a decrease in the impact of switches at the turning onset amounts to 6–8 %. At the same time, comparison of impacts at the onset of switch

turning, when taking into consideration a technological gap in the reducer, as well as without it, shows a decrease in the elastic force amplitude by 250 %. The impact (a switch momentum pulse) could be reduced by 20–24 % upon turning completion.

Our analysis of optimization criteria for the switch displacement process has demonstrated efficiency of the regulated electric drive compared to the direct start of an electric motor. That makes it possible not only to extend the operational functionality of a railroad switch turnout, but also to reduce costs for the current technical inspection, repairs in general, as well as to prolong the inter-repair period.

Keywords: electromechanical system, DC electric motor, control system, displacement process optimization criteria.

References

1. Matveeva, O. L., Seliverov, D. I. (2013). Issledovanie ekonomicheskoy effektivnosti zameny v strelochnykh privodakh elektrodvigateley postoyannogo toka na universal'nye elektrodvigateli. Nauchnoe soobshchestvo studentov XXI stoletiya. Tehnicheskie nauki: sb. st. po mat. VIII stud. mezhdunar. nauch.-prakt. konf. Novosibirsk, 63–74. Available at: http://sibac.info/archive/technic/8.pdf

2. Buryakovskiy, S. G., Lyubarskiy, B. G., Petrushin, A. D., Masliy, A. S. (2011). Matematicheskoe modelirovanie ventil'no-induktornogo dvigatelya dlya privoda strelochnogo perevoda. Elektrotekhnichni ta kompiuterni systemy, 3, 157–158.

3. Abuseridze, Z. V. (2010). Elektrodvigatel' s magnitoelektricheskoy sistemoy vozbuzhdeniya v privode strelochnogo perevoda. Elektrichestvo, 10, 56–60.

4. Matveeva, O. L., Seliverov, D. I. (2012). Elektroprivody dlya zheleznodorozhnykh strelochnykh perevodov. Nauchnoe soobshchestvo studentov XXI stoletiya. Tehnicheskie nauki: sb. st. po mat. VII mezhdunar. stud. nauch.-prakt. konf. Novosibirsk, 79–91. Available at: http://sibac.info/archive/technic/7.pdf

5. Bogatyr', Yu. I. (2009). Analiz sushchestvuyushchih metodov i sredstv upravleniya strelkami i signalami na zheleznodorozhnykh stantsiyah. Inform.-keruiuchi systemy na zalizn. transp., 4, 60–65.

6. Orunbekov, M. B., Nauryzbay, D. K. (2018). Razrabotka sistemy GSM upravleniya udalennykh obektov zheleznodorozhnoy avtomatiki i telemehaniki na platforme ARDUINO. Innovatsionnoe razvitie nauki i obrazovaniya: sb. st. po mat. II Mezhdunar. nauch.-prakt. konf. Ch. 1. Penza, 122–125.

7. Maslennikov, E. V., Gorb, P. E., Serdyuk, T. N., Ivanov, A. V. (2013). Strelochnye privoda skorostnyh zheleznodorozhnyh magistraley. Elektromahnitna sumisnist ta bezpeka na zaliznychnomu transporti, 5, 63–82. Available at: https://www.researchgate.net/publication/292995753_Switch_motors_of_speed_railway

8. Lagos, R. F., San Emeterio, A., Vinolas, J., Alonso, A., Aizpun, M. (2014). The Influence of Track Elasticity when travelling on a Railway Turnout. Proceedings of the Second International Conference on Railway Technology: Research, Development and Maintenance. doi: https://doi.org/10.4203/ccp.104.208

9. Kaewunruen, S. (2014). Monitoring structural deterioration of railway turnout systems via dynamic wheel/rail interaction. Case Studies in Nondestructive Testing and Evaluation, 1, 19–24. doi: https://doi.org/10.1016/j.csndt.2014.03.004

10. Chen, R., Ping, W. (2012). Dynamic Characteristics of High Speed Vehicle Passing over Railway Turnout on Bridge. Advanced Materials Research, 455-456, 1438–1443. doi: https://doi.org/10.4028/www.scientific.net/amr.455-456.1438

11. Shrirao, S., Rojatkar, D. (2016). A Review - Automatic Railway Gate Control System. International Journal of Scientific Research in Science, 2 (6), 681–684.

12. Efanov, D. V., Khoroshev, V. V. (2018). Algorithms optimization for diagnostics of railway switch point electric drives with the account of statistical data on failure. Transport of the Urals, 1, 19–25. doi: https://doi.org/10.20291/1815-9400-2018-1-19-25

13. Buryakovskiy, S. G., Masliy, A. S., Rafalskiy, A. A., Smirnov, V. V. (2016). Application of the subordinate position control of rails of exploited DC turnout. Informatsiyno-keruiuchi systemy na zaliznychnomu transporti, 2 (117), 47–51.

14. Kuznetsov, B. I., Nikitina, T. B., Kolomiets, V. V., Bovdyj, I. V. (2018). Improving of electromechanical servo systems accuracy. Electrical Engineering & Electromechanics, 6, 33–37. doi: https://doi.org/10.20998/2074-272x.2018.6.04

15. Environmental Product Declaration. Available at: https://www.bombardier.com/content/dam/Websites/bombardiercom/supporting-documents/Sustainability/Reports/BT/Bombardier-Transportation-EPD-EBI-Switch-2000-en.pdf

16. Moiseienko, V. I., Lazariev, O. V. (2010). Udoskonalennia metodu vyznachennia stanu ta resursu prystroiv zaliznychnoi avtomatyky. Zb. nauk. prats. Donetskyi instytut zaliznychnoho transportu, 21, 63–70.

17. Buriakovskyi, S., Maslii, A., Maslii, A. (2016). Determining parameters of electric drive of a sleeper-type turnout based on electromagnet and linear inductor electric motor. Eastern-European Journal of Enterprise Technologies, 4 (1 (82)), 32–41. doi: https://doi.org/10.15587/1729-4061.2016.75860

18. Sinamics DCM DC Converter. Available at: https://cache.industry.siemens.com/dl/files/240/109478240/att_851818/v1/manual-DC-Converter_en.pdf

CONSTRUCTION OF METHODS FOR ENSURING THE REQUIRED LEVEL OF SAFETY INTEGRITY IN THE AUTOMATED SYSTEMS OF CONTROL OVER TECHNOLOGICAL PROCESSES (p. 70-78)

Vitalii Ivanov
Volodymyr Dahl East Ukrainian National University,
Severodonetsk, Ukraine
ORCID: http://orcid.org/0000-0002-8698-0972

Oleksandr Baturin
Volodymyr Dahl East Ukrainian National University,
Severodonetsk, Ukraine
ORCID: http://orcid.org/0000-0003-2350-4036

Volodymyr Lyfar
Volodymyr Dahl East Ukrainian National University,
Severodonetsk, Ukraine
ORCID: http://orcid.org/0000-0002-7860-9663

Serhii Mytrokhin
Volodymyr Dahl East Ukrainian National University,
Severodonetsk, Ukraine
ORCID: http://orcid.org/0000-0001-7357-8637

Lilia Lyhina
Volodymyr Dahl East Ukrainian National University,
Severodonetsk, Ukraine
ORCID: http://orcid.org/0000-0002-2855-3729

The tasks of the study were stated, the theoretical and methodological concept of determining the indicators of reliability and safety of hardware and software (S) for the systems of control of technological processes (ASCTP) was proposed. We presented the aspects of modern approaches to solving the scientific and technical problem of ensuring the necessary safety integrity level (SIL) of technical facilities of the ASCTP for sites of increased danger. As a result of analysis and studying the regulatory framework, the separate methods for determining quantitative indicators of safety control were proposed. It is offered to determine the SIL of the studied hardware of the ASCTP component using the hybrid methods of expert analysis. It is proposed to carry out

the hazards and operability analysis with the use of special protocols, which show the relations between possible causes of faults of source elements, their influence on functioning of control system and effect of a fault on the functions of the system. The existing methods were explored and the original methods for determining the standardized indicators of reliability in the analysis of SIL (safety integrity level) were proposed. Problems of ensuring the required SIL during development of the systems of control of technological processes were considered. The existing models and the methods for determining the safety integrity level of the systems of controlling dangerous sites fully meet modern requirements for certification procedures. Rational methods for assessing the probability of hardware faults include the FTA (fault tree analysis), which determine the probability of initiating dangerous events, and the ETA (event tree analysis) to account for the faults of protection systems and determining the scenarios of consequences of such faults.

Keywords: safety integrity level, electronic programmable devices, information technologies.

References

1. Ouazraoui, N., Nait-Said, R. (2019). An alternative approach to safety integrity level determination: results from a case study. International Journal of Quality & Reliability Management, 36 (10), 1784–1803. doi: https://doi.org/10.1108/ijqrm-02-2019-0065

2. Ouazraoui, N., Bourareche, M., Nait-Said, R. (2015). Fuzzy modelling of uncertain data in the layers of protection analysis. 2015 International Conference on Industrial Engineering and Operations Management (IEOM). doi: https://doi.org/10.1109/ieom.2015.7093769

3. Ouazraoui, N., Nait-Said, R., Bourareche, M., Sellami, I. (2013). Layers of protection analysis in the framework of possibility theory. Journal of Hazardous Materials, 262, 168–178. doi: https://doi.org/10.1016/j.jhazmat.2013.08.042

4. Nait-Said, R., Zidani, F., Ouzraoui, N. (2009). Modified risk graph method using fuzzy rule-based approach. Journal of Hazardous Materials, 164 (2-3), 651–658. doi: https://doi.org/10.1016/j.jhazmat.2008.08.086

5. Zhao, X., Malasse, O., Buchheit, G. (2019). Verification of safety integrity level of high demand system based on Stochastic Petri Nets and Monte Carlo Simulation. Reliability Engineering & System Safety, 184, 258–265. doi: https://doi.org/10.1016/j.ress.2018.02.004

6. Calixto, E. (2016). Gas and oil reliability engineering: modeling and analysis. Gulf Professional Publishing, 808.

7. Smith, D. J. (2017). Reliability, maintainability and risk: practical methods for engineers. Butterworth-Heinemann, 478.

8. Ahn, J., Noh, Y., Joung, T., Lim, Y., Kim, J., Seo, Y., Chang, D. (2019). Safety integrity level (SIL) determination for a maritime fuel cell system as electric propulsion in accordance with IEC 61511. International Journal of Hydrogen Energy, 44 (5), 3185–3194. doi: https://doi.org/10.1016/j.ijhydene.2018.12.065

9. Musyafa', A., Nuzula, Z. F., Asy'ari, M. K. (2019). Hazop evaluation and safety integrity level (SIL) analysis on steam system in ammonia plant Petrokimia Gresik Ltd. AIP Conference Proceedings. doi: https://doi.org/10.1063/1.5095281

10. Lee, B. C., Lee, H. S., Rhim, J. K. (2018). A Study on Safety Integrity Improvement of Oxidation Reactor on Propylene Oxide Process by Installed Safety Instrumented System (SIS). Advances in Intelligent Systems and Computing, 244–255. doi: https://doi.org/10.1007/978-3-319-94391-6_23

11. Simon, C., Mechri, W., Capizzi, G. (2019). Assessment of Safety Integrity Level by simulation of Dynamic Bayesian Networks considering test duration. Journal of Loss Prevention in the Process Industries, 57, 101–113. doi: https://doi.org/10.1016/j.jlp.2018.11.002

12. Kim, S. K., Kim, Y. S. (2018). An Optimal Design Procedure based on the Safety Integrity Level for Safety-related Systems. KSII Transactions on Internet and Information Systems, 12 (12), 6079–6097. doi: https://doi.org/10.3837/tiis.2018.12.025

13. Śliwiński, M. (2018). Safety integrity level verification for safety-related functions with security aspects. Process Safety and Environmental Protection, 118, 79–92. doi: https://doi.org/10.1016/j.psep.2018.06.016

14. Morillo, J. L., Zéphyr, L., Pérez, J. F., Lindsay Anderson, C., Cadena, Á. (2020). Risk-averse stochastic dual dynamic programming approach for the operation of a hydro-dominated power system in the presence of wind uncertainty. International Journal of Electrical Power & Energy Systems, 115, 105469. doi: https://doi.org/10.1016/j.ijepes.2019.105469

15. Funktsional'naya bezopasnost' sistem elektricheskih, elektronnyh, programmiruemyh elektronnyh, svyazannyh s bezopasnost'yu. Ch. 1. Obshchie trebovaniya: natsional'nyy standart Rossiyskoy Federatsii GOST R MEK 61508-1-2007 (2008). Federal'noe agentstvo po tehnicheskomu regulirovaniyu i metrologii. Moscow: Standartinform, V, 44.

16. Funktsional'naya bezopasnost' sistem elektricheskih, elektronnyh, programmiruemyh elektronnyh, svyazannyh s bezopasnost'yu. Ch. 2. Trebovaniya k sistemam: natsional'nyy standart Rossiyskoy Federatsii GOST R MEK 61508-2-2007 (2008). Federal'noe agentstvo po tehnicheskomu regulirovaniyu i metrologii. Moscow: Standartinform, V, 58.

17. Funktsional'naya bezopasnost' sistem elektricheskih, elektronnyh, programmiruemyh elektronnyh, svyazannyh s bezopasnost'yu. Ch. 3. Trebovaniya k programmnomu obespecheniyu: natsional'nyy standart Rossiyskoy Federatsii GOST R MEK 61508-3-2012 (2014). Federal'noe agentstvo po tehnicheskomu regulirovaniyu i metrologii. Moscow: Standartinform, V, 97.

18. Funktsional'naya bezopasnost' sistem elektricheskih, elektronnyh, programmiruemyh elektronnyh, svyazannyh s bezopasnost'yu CH. 6. Rukovodstvo po primeneniyu GOST R MEK 61508-2-2007 i GOST R MEK 61508-3-2007: natsional'nyy standart Rossiyskoy Federatsii GOST R MEK 61508-6-2007 (2008). Federal'noe agentstvo po tehnicheskomu regulirovaniyu i metrologii. Moscow: Standartinform, V, 62.

19. Funktsional'naya bezopasnost' v nepreryvnyh proizvodstvah. Rukovodstvo po bezopasnosti protsessov. Natsional'nyy standart Rossiyskoy Federatsii GOST R MEK 61511-1-2011 (2013). Federal'noe agentstvo po tehnicheskomu regulirovaniyu i metrologii. Moscow: Standartinform, V, 66.

20. Functional safety guidelines for safety related systems and other applications with SIL2, SIL3 level in accordance with IEC 61508 and IEC 61511. GM International Technology for safety (2013). Villasanta, 77.

21. 610.12-1990 - IEEE Standard glossary of software engineering terminology. doi: https://doi.org/10.1109/ieeestd.1990.101064

22. 1012-2004 - IEEE Standard for Software Verification and Validation. doi: https://doi.org/10.1109/ieeestd.2005.96278

23. ISO/IEC 12207:2008 Systems and software engineering – Software life cycle processes.

24. Lyfar', V. A., Safonova, S. A., Ivanov, V. G. (2015). Development of optimization method of the repair work taking into account the risk indicators. Technology audit and production reserves, 2 (2 (22)), 11–17. doi: https://doi.org/10.15587/2312-8372.2015.40768

25. Nair, S., Jetley, R., Nair, A., Hauck-Stattelmann, S. (2015). A static code analysis tool for control system software. 2015 IEEE 22nd International Conference on Software Analysis, Evolution, and Reengineering (SANER). doi: https://doi.org/10.1109/saner.2015.7081856

26. Fagan, M. E. (1976). Design and code inspections to reduce errors in program development. IBM Systems Journal, 15 (3), 182–211. doi: https://doi.org/10.1147/sj.153.0182

27. Henli, E. Dzh., Kumamoto, H. (1984). Nadezhnost' tehnicheskih sistem i otsenka riska. Moscow: Mashinostroenie, 528.