ABSTRACT AND REFERENCES

INFORMATION TECHNOLOGY

DEVELOPMENT OF AN INTELLIGENT AGENT FOR ANALYSIS OF NONFUNCTIONAL CHARACTERISTICS IN SPECIFICATIONS OF SOFTWARE REQUIREMENTS (p. 6-17)

Tetiana Hovorushchenko
Khmelnytskyi National University, Khmelnytskyi, Ukraine
ORCID: http://orcid.org/0000-0002-7942-1857

Olga Pavlova
Khmelnytskyi National University, Khmelnytskyi, Ukraine
ORCID: http://orcid.org/0000-0003-2905-0215

Mykyta Bodnar
Khmelnytskyi National University, Khmelnytskyi, Ukraine
ORCID: http://orcid.org/0000-0002-8614-0682

One of the urgent present-day tasks consists in ensuring an automated analysis of specifications of software requirements for sufficiency of information on nonfunctional component characteristics of software quality. Analysis of known intelligent agents based on the ontological approach has shown that these agents do not solve the problem of quantifying sufficiency of information in the specification of software requirements for determining nonfunctional characteristics of software.

The objective of this study was to implement the intelligent agent based on the ontological approach for analyzing information on nonfunctional characteristics in specifications of software requirements.

A model of intelligent agent activity has been developed based on the ontological approach for evaluating specifications of software requirements. It reflects features of assessing information sufficiency for determining nonfunctional component characteristics of software quality. The developed model is a theoretical basis for implementing the intelligent agent based on the ontological approach for evaluating specifications of software requirements.

The intelligent agent based on the ontological approach has been implemented for evaluating information on nonfunctional characteristics in the specifications of software requirements. The implemented agent forms conclusions on sufficiency or insufficiency of information about nonfunctional component characteristics of software quality in the specification of requirements to actual software. In addition, it quantifies the level of information sufficiency in the specification of requirements to actual software for determining each of nonfunctional characteristics of software and determining all nonfunctional component characteristics of software quality in aggregate. The agent provides a list of attributes that should supplement the specification of requirements for increasing the level of sufficiency of its information as well as visualization of gaps in knowledge of all nonfunctional component characteristics of software quality.

The results of functioning of the implemented agent have shown an increase in the level of information sufficiency in the specification of software requirements. The developed intelligent agent makes it possible to partially eliminate human participation in information processing, avoid loss of essential information and minimize occurrence of errors at the early stages of the software life cycle.

Keywords: specification of software requirements, nonfunctional characteristics of software, intelligent agent based on the ontological approach.

References

1. Hastie, S., Wojewoda, S. Standish Group 2015 Chaos Report – Q&A with Jennifer Lynch. Available at: http://www.infoq.com/articles/standish-chaos-2015

2. McConnell, S. (2013). Code complete. Redmond, 896.

3. Levenson, N. G. (2012). Engineering a safer world: systems thinking applied to safety. Cambridge, 560.

4. Cruickshank, K. J. (2009). A validation metrics framework for safety-critical software-intensive systems. Monterey, 144.

5. Hovorushchenko, T., Pomorova, O. (2018). Information technology of evaluating the sufficiency of information on quality in the software requirements specifications. CEUR-WS, 2104, 555–570. Available at: http://ceur-ws.org/Vol-2104/paper_228.pdf

6. ISO/IEC 25010:2011. Systems and Software Engineering. Systems and Software Quality Requirements and Evaluation (SQuaRE). System and Software Quality Models (2011). Geneva, 34.

7. Gruber, T. R. (1993). A translation approach to portable ontology specifications. Knowledge Acquisition, 5 (2), 199–220. doi: https://doi.org/10.1006/knac.1993.1008

8. Burov, E. (2014). Complex ontology management using task models. International Journal of Knowledge-Based and Intelligent Engineering Systems, 18 (2), 111–120. doi: https://doi.org/10.3233/KES-140291

9. Burov, E., Pasitchnyk, V., Gritsyk, V. (2014). Modeling software testing processes with task ontologies. British Journal of Education and Science, 2 (6), 256–263.

10. Assawamekin, N., Sunetnanta, T., Pluempitiwiriyawej, C. (2009). Ontology-based multiperspective requirements traceability framework. Knowledge and Information Systems, 25 (3), 493–522. doi: https://doi.org/10.1007/s10115-009-0259-2

11. Kof, L., Gacitua, R., Rouncefield, M., Sawyer, P. (2010). Ontology and Model Alignment as a Means for Requirements Validation. 2010 IEEE Fourth International Conference on Semantic Computing. doi: https://doi.org/10.1109/icsc.2010.95

12. Bajnaid, N. O., Benlamri, R., Pakstas, A., Salekzamankhani, Sh. (2016). An ontological approach to model software quality assurance knowledge domain. Lecture Notes on Software Engineering, 4 (3), 193–198.

13. Hovorushchenko, T., Pomorova, O. (2016). Ontological approach to the assessment of information sufficiency for software quality determination. CEUR-WS, 1614, 332–348.

14. Wooldridge, M., Jennings, N. R. (1995). Intelligent agents: theory and practice. The Knowledge Engineering Review, 10 (2), 115–152. doi: https://doi.org/10.1017/s0269888900008122

15. Freitas, A., Bordini, R. H., Vieira, R. (2017). Model-driven engineering of multi-agent systems based on ontologies. Applied Ontology, 12 (2), 157–188. doi: https://doi.org/10.3233/ao-170182

16. Ossowska, K., Szewc, L., Weichbroth, P., Garnik, I., Sikorski, M. (2016). Exploring an Ontological Approach for User Requirements Elicitation in the Design of Online Virtual Agents. Lecture Notes in Business Information Processing, 40–55. doi: https://doi.org/10.1007/978-3-319-46642-2_3

17. Lezcano-Rodriguez, L. A., Guzman-Luna, J. A. (2016). Ontological characterization of basics of KAOS chart from natural language. ITECKNE, 13 (2), 157–168. doi: https://doi.org/10.15332/iteckne.v13i2.1482

18. García-Magariño, I., Gómez-Sanz, J. J. (2013). An Ontological and Agent-Oriented Modeling Approach for the Specification of Intelligent Ambient Assisted Living Systems for Parkinson Patients. Lecture Notes in Computer Science, 11–20. doi: https://doi.org/10.1007/978-3-642-40846-5_2

19. Rakib, A., Faruqui, R. U. (2013). A Formal Approach to Modelling and Verifying Resource-Bounded Context-Aware Agents. Lecture Notes of the Institute for Computer Sciences, Social Infor-

matics and Telecommunications Engineering, 86–96. doi: https://doi.org/10.1007/978-3-642-36642-0_9

20. Michalowski, W., O'Sullivan, D., Farion, K., Sayyad-Shirabad, J., Kuziemsky, C., Kukawka, B., Wilk, S. (2013). A Task-based Support Architecture for Developing Point-of-care Clinical Decision Support Systems for the Emergency Department. Methods of Information in Medicine, 52 (01), 18–32. doi: https://doi.org/10.3414/me11-01-0099

21. Michael, J. B., Man-Tak Shing, Cruickshank, K. J., Redmond, P. J. (2010). Hazard Analysis and Validation Metrics Framework for System of Systems Software Safety. IEEE Systems Journal, 4 (2), 186–197. doi: https://doi.org/10.1109/jsyst.2010.2050159

22. Baker, R., Habli, I. (2013). An Empirical Evaluation of Mutation Testing for Improving the Test Quality of Safety-Critical Software. IEEE Transactions on Software Engineering, 39 (6), 787–805. doi: https://doi.org/10.1109/tse.2012.56

23. ISO 25023:2016. Systems and Software Engineering. Systems and Software Quality Requirements and Evaluation (SQuaRE). Measurement of System and Software Product Quality (2016). Geneva, 45.

24. Hovorushchenko, T., Pavlova, O. (2019). Method of Activity of Ontology-Based Intelligent Agent for Evaluating Initial Stages of the Software Lifecycle. Recent Developments in Data Science and Intelligent Analysis of Information, 169–178. doi: https://doi.org/10.1007/978-3-319-97885-7_17

25. ISO/IEC/IEEE 29148:2011. Systems and Software Engineering. Life Cycle Processes. Requirements Engineering (2011). Geneva, 28.

DEVELOPMENT OF THE SYSTEM TO INTEGRATE AND GENERATE CONTENT CONSIDERING THE CRYPTOCURRENT NEEDS OF USERS (p. 18-39)

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

Volodymyr Kuchkovskiy
Programmer
ORCID: http://orcid.org/0000-0002-7941-6329

Igor Bobyk
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-0424-1720

Oksana Malanchuk
Danylo Halytsky Lviv National Medical University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-7518-7824

Yuriy Ryshkovets
LLC "SoftServe", Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-5831-4000

Irina Pelekh
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-3769-6844

Oksana Brodyak
Hetman Petro Sahaidachnyi National Army Academy, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-9886-3589

Vitaliy Bobrivetc
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0002-5133-6431

Valentyna Panasyuk
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0002-5133-6431

We have investigated processes of analysis, integration, and content generation, taking into consideration the needs of the user in cryptocurrency. By using the developed formal model and the performed critical analysis of methods and technologies for predicting the exchange rate of cryptocurrency, we have built a general architecture of the content processing system that acquires data from different cryptocurrency Internet stock exchanges. General functional requirements to the intelligent cryptocurrency system that target the Internet users have been stated. We have investigated methods, models, and tools to improve the effective support for developing structural elements in the model of a decision support system that manages content according to the user's needs. general architectures of the backend and frontend parts of an intelligent cryptocurrency system have been devised. We also developed software for the system of integration and generation of content considering the cryptocurrency needs of users. An analysis of results of experimental verification of the proposed method for content integration and generation taking into consideration the cryptocurrency needs of users has been performed. A special feature of the system is that it analyzes information from social media and builds a forecast of currency rates based on the acquired information. A given system makes it possible to guess the trend in an exchange rate fluctuation. Conferences of a particular cryptocurrency, new implementations, government decrees from different countries, affect a trend as well, so it too must be taken into consideration. In order to account for most cases, it is necessary to constantly accumulate information on the subject and to assign it to Tables in a database. A given process takes place using a specialized software bot that collects and indexes information. The system is characterized by the following features that favorably distinguish it from analogs: the speed of page generation; the presence of SSL certificate and TLS encryption; content of better quality as it is updated every minute; there are no inactive sections of the service; the mobile web-site layout does not copy content at subdomain; automated checks against e-mail spam messages on the exchange rate. The focus of the system is on the frequency of updates at the speed of data aggregation from the Internet stock exchanges and social networks.

Keywords: cryptocurrency, forecasting, Internet stock exchange, data mining, Internet marketing, Web Mining, Data-Mining, Machine Learning, bitcoin, token.

References

1. Nakamoto, S. Bitcoin: A Peer-to-Peer Electronic Cash System. Available at: https://bitcoin.org/bitcoin.pdf

2. 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

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

4. 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). 2018. doi: https://doi.org/10.1109/dsmp.2018.8478460

5. 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

6. 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

7. 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

8. 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

9. 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

10. 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

11. 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

12. Dosyn, D. G., Ivantyshyn, O. L., Koshovyy, V. V., Romanyshyn, I. M., Soroka, S. O. (2003). To a question on the mechanism of formation of ionospheric disturbances at groundbased artificial acoustic excitation. Proceedings of International Seminar/Workshop on Direct and Inverse Problems of Electromagnetic and Acoustic Wave Theory, DIPED, 211–214.

13. 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

14. Pukach, P. Ya., Kuzio, I. V. (2013). Nonlinear transverse vibrations of semiinfinite cable with consediration paid to resistance. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 3, 82–87.

15. Pukach, P. Ya., Kuzio, I. V. (2015). Resonance phenomena in quasizero stiffness vibration isolation systems. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 3, 62–67.

16. 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

17. 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

18. 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

19. 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

20. Fedushko, S. (2014). Development of a software for computer-linguistic verification of socio-demographic profile of web-community member. Webology, 11 (2). Available at: http://www.webology.org/2014/v11n2/a126.pdf

21. Korzh, R., Fedushko, S., Peleschyshyn, A. (2015). Methods for forming an informational image of a higher education institution. Webology, 12 (2). Available at: http://www.webology.org/2015/v12n2/a140.pdf

22. Korzh, R., Peleschyshyn, A., Syerov, Yu., Fedushko, S. (2014). The cataloging of virtual communities of educational thematic. Webology, 11 (1). Available at: http://www.webology.org/2014/v11n1/a117.pdf

23. 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.

24. 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

25. 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

26. Vysotska, V., Fernandes, V. B., Emmerich, M. (2018). Web content support method in electronic business systems // Proceedings of the 2nd International Conference on Computational Linguistics and Intelligent Systems. Vol. I: Main Conference. Lviv, 20–41. Available at: http://ceur-ws.org/Vol-2136/10000020.pdf

27. Kanishcheva, O., Vysotska, V., Chyrun, L., Gozhyj, A. (2017). Method of Integration and Content Management of the Information Resources Network. Advances in Intelligent Systems and Computing, 204–216. doi: https://doi.org/10.1007/978-3-319-70581-1_14

28. Vysotska, V., Lytvyn, V., Burov, Y., Gozhyj, A., Makara, S. (2018). The consolidated information web-resource about pharmacy networks in city. CEUR Workshop Proceedings (Computational linguistics and intelligent systems), 2255, 239–255. Available at: http://ceur-ws.org/Vol-2255/paper22.pdf

29. Lytvyn, V., Vysotska, V., Veres, O., Rishnyak, I., Rishnyak, H. (2017). The risk management modelling in multi project environment. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098730

30. Korobchinsky, M., Chyrun, L., Chyrun, L., Vysotska, V. (2017). Peculiarities of content forming and analysis in internet newspaper covering music news. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098735

31. Naum, O., Chyrun, L., Vysotska, V., Kanishcheva, O. (2017). Intellectual system design for content formation. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098753

32. Lytvyn, V., Vysotska, V., Burov, Y., Veres, O., Rishnyak, I. (2017). The Contextual Search Method Based on Domain Thesaurus. Advances in Intelligent Systems and Computing, 310–319. doi: https://doi.org/10.1007/978-3-319-70581-1_22

33. Veres, O., Rusyn, B., Sachenko, A., Rishnyak, I. (2018). Choosing the method of finding similar images in the reverse search system. Workshop Proceedings (Computational linguistics and intelligent systems), 2136, 99–107.

34. Tkachenko, R., Izonin, I. (2018). Model and Principles for the Implementation of Neural-Like Structures Based on Geometric Data Transformations. Advances in Computer Science for Engineering

and Education, 578–587. doi: https://doi.org/10.1007/978-3-319-91008-6_58

35. Bodyanskiy, Y., Perova, I., Vynokurova, O., Izonin, I. (2018). Adaptive wavelet diagnostic neuro-fuzzy network for biomedical tasks. 2018 14th International Conference on Advanced Trends in Radioelecrtronics, Telecommunications and Computer Engineering (TCSET). doi: https://doi.org/10.1109/tcset.2018.8336299

36. Peleshko, D., Peleshko, M., Kustra, N., Izonin, I. (2011). Analysis of invariant moments in tasks image processing. 2011 11th International Conference The Experience of Designing and Application of CAD Systems in Microelectronics (CADSM), 263–264.

37. Peleshko, D., Ivanov, Y., Sharov, B., Izonin, I., Borzov, Y. (2016). Design and implementation of visitors queue density analysis and registration method for retail videosurveillance purposes. 2016 IEEE First International Conference on Data Stream Mining & Processing (DSMP). doi: https://doi.org/10.1109/dsmp.2016.7583531

38. Vitynskyi, P., Tkachenko, R., Izonin, I., Kutucu, H. (2018). Hybridization of the SGTM Neural-Like Structure Through Inputs Polynomial Extension. 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP). doi: https://doi.org/10.1109/dsmp.2018.8478456

39. Izonin, I., Trostianchyn, A., Duriagina, Z., Tkachenko, R., Tepla, T., Lotoshynska, N. (2018). The Combined Use of the Wiener Polynomial and SVM for Material Classification Task in Medical Implants Production. International Journal of Intelligent Systems and Applications, 10 (9), 40–47. doi: https://doi.org/10.5815/ijisa.2018.09.05

40. Rashkevych, Y., Peleshko, D., Vynokurova, O., Izonin, I., Lotoshynska, N. (2017). Single-frame image super-resolution based on singular square matrix operator. 2017 IEEE First Ukraine Conference on Electrical and Computer Engineering (UKRCON). doi: https://doi.org/10.1109/ukrcon.2017.8100390

41. Tkachenko, R., Tkachenko, P., Izonin, I., Tsymbal, Y. (2017). Learning-Based Image Scaling Using Neural-Like Structure of Geometric Transformation Paradigm. Studies in Computational Intelligence, 537–565. doi: https://doi.org/10.1007/978-3-319-63754-9_25

42. Lytvyn, V., Vysotska, V., Pukach, P., Bobyk, I., Pakholok, B. (2016). A method for constructing recruitment rules based on the analysis of a specialist's competences. Eastern-European Journal of Enterprise Technologies, 6 (2 (84)), 4–14. doi: https://doi.org/10.15587/1729-4061.2016.85454

43. Zhezhnych, P., Markiv, O. (2018). Recognition of tourism documentation fragments from web-page posts. 2018 14th International Conference on Advanced Trends in Radioelecrtronics, Telecommunications and Computer Engineering (TCSET). doi: https://doi.org/10.1109/tcset.2018.8336350

44. Gozhyj, A., Chyrun, L., Kowalska-Styczen, A., Lozynska, O. (2018). Uniform Method of Operative Content Management in Web Systems. CEUR Workshop Proceedings (Computational linguistics and intelligent systems), 2136, 62–77. Available at: http://ceur-ws.org/Vol-2136/10000062.pdf

45. Vysotska, V., Hasko, R., Kuchkovskiy, V. (2015). Process analysis in electronic content commerce system. 2015 Xth International Scientific and Technical Conference "Computer Sciences and Information Technologies" (CSIT). doi: https://doi.org/10.1109/stc-csit.2015.7325447

46. 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

47. Vysotska, V., Chyrun, L., Chyrun, L. (2016). The commercial content digest formation and distributional process. 2016 XIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2016.7589902

48. Lytvyn, V., Vysotska, V., Veres, O., Rishnyak, I., Rishnyak, H. (2016). Content linguistic analysis methods for textual documents classification. 2016 XIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2016.7589903

49. Lytvyn, V., Vysotska, V. (2015). Designing architecture of electronic content commerce system. 2015 Xth International Scientific and Technical Conference "Computer Sciences and Information Technologies" (CSIT). doi: https://doi.org/10.1109/stc-csit.2015.7325446

50. Vysotska, V., Chyrun, L. (2015). Analysis features of information resources processing. 2015 Xth International Scientific and Technical Conference "Computer Sciences and Information Technologies" (CSIT). doi: https://doi.org/10.1109/stc-csit.2015.7325448

51. Vasyl, L., Victoria, V., Dmytro, D., Roman, H., Zoriana, R. (2017). Application of sentence parsing for determining keywords in Ukrainian texts. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2017.8098797

52. Maksymiv, O., Rak, T., Peleshko, D. (2017). Video-based Flame Detection using LBP-based Descriptor: Influences of Classifiers Variety on Detection Efficiency. International Journal of Intelligent Systems and Applications, 9 (2), 42–48. doi: https://doi.org/10.5815/ijisa.2017.02.06

53. Peleshko, D., Rak, T., Izonin, I. (2016). Image Superresolution via Divergence Matrix and Automatic Detection of Crossover. International Journal of Intelligent Systems and Applications, 8 (12), 1–8. doi: https://doi.org/10.5815/ijisa.2016.12.01

54. Bazylyk, O., Taradaha, P., Nadobko, O., Chyrun, L., Shestakevych, T. (2012). The results of software complex OPTAN use for modeling and optimization of standard engineering processes of printed circuit boards manufacturing. 2012 11th International Conference on «Modern Problems of Radio Engineering, Telecommunications and Computer Science» (TCSET), 107–108.

55. Bondariev, A., Kiselychnyk, M., Nadobko, O., Nedostup, L., Chyrun, L., Shestakevych, T. (2012). The software complex development for modeling and optimizing of processes of radio-engineering equipment quality providing at the stage of manufacture. TCSET'2012, 159.

56. Riznyk, V. (2016). Multi-modular Optimum Coding Systems Based on Remarkable Geometric Properties of Space. Advances in Intelligent Systems and Computing, 129–148. doi: https://doi.org/10.1007/978-3-319-45991-2_9

57. Teslyuk, V., Beregovskyi, V., Denysyuk, P., Teslyuk, T., Lozynskyi, A. (2018). Development and Implementation of the Technical Accident Prevention Subsystem for the Smart Home System. International Journal of Intelligent Systems and Applications, 10 (1), 1–8. doi: https://doi.org/10.5815/ijisa.2018.01.01

58. 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

59. 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

60. 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

61. Chernukha, O., Bilushchak, Y. (2016). Mathematical modeling of random concentration field and its second moments in a semispace with erlangian disrtibution of layered inclusions. Task Quarterly, 20 (3), 295–334.

62. 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

63. 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

64. 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

65. 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

66. 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

67. 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

68. 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

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

70. 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

71. 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

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

DEVELOPMENT OF A TECHNOLOGY FOR ELIMINATING COLOR RENDERING IMPERFECTIONS IN DIGITAL PHOTOGRAPHIC IMAGES (p. 40-47)

Bohdan Kovalskyi
Ukrainian Academy of Printing, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-5519-0759

Myroslava Dubnevych
Ukrainian Academy of Printing, Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-7089-0190

Tetyana Holubnyk
Ukrainian Academy of Printing, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-8325-9813

Nadiia Pysanchyn
Ukrainian Academy of Printing, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-6138-3899

Bohdana Havrysh
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0003-3213-9747

Complexity of integrating color control systems into a workflow for obtaining digital half-tone images results in appearance of color rendering imperfections in photographic images as exposure conditions constantly vary in power and spectral composition of radiation. A wide range of corrective means in graphic editors does not ensure full elimination of color rendering imperfections in photographic images because of imperfect technical approaches to realization of the corrective effect.

The process of correcting color rendering imperfections is complicated by the lack of methods for objective quantitative assessment of qualitative characteristics of digital color halftone images.

The developed method of quantitative assessment of color characteristics of digital images by conversion of actinicity in values of effective densities provides optimal and comprehensive analysis of color rendering accuracy. The procedure consists in representation of color separation characteristics in a form of dependence of effective densities of the photographic image on grey-equivalent densities of the recorded object. It becomes possible to numerically evaluate imperfections of color rendering in a digital color photographic image.

The developed assessment procedure has become the basis for implementation of a new method for correcting color rendering imperfections with the help of compensatory corrective images ensuring elimination of the imperfection of insufficient color. The correction effect is provided by the physical content of compensatory images which contain effective densities for the separated colors which are absent in digital photographic images because of non-isoactinism of isochrome colors.

The new technology for correcting color rendering is implemented in the developed Image Redactor specialized software. Effectiveness of the described method was proved on the basis of analysis of images processed in the created software product according to the method of graphical representation of color separation characteristics described in the paper. Color separation matrices indicate a significant increase in useful contrasts of separated colors in comparison with similar characteristics of color rendering in images before their processing. This provides for the possibility of applying the developed method of correcting color rendering imperfections in the digital work flow of processing photographic images.

Keywords: digital photography, photosensitivity, Bayer array, color rendering assessment, specific effective density.

References

1. Mehta, S., Patel, A., Mehta, J. (2015). CCD or CMOS Image sensor for photography. 2015 International Conference on Communications and Signal Processing (ICCSP). doi: https://doi.org/10.1109/iccsp.2015.7322890

2. Mahmoud, K., Park, S., Park, S.-N., Lee, D.-H. (2013). Measurement of normalized spectral responsivity of digital imaging devices by using a LED-based tunable uniform source. Applied Optics, 52 (6), 1263–1271. doi: https://doi.org/10.1364/ao.52.001263

3. Verhoeven, G. J., Schmitt, K. D. (2010). An attempt to push back frontiers – digital near-ultraviolet aerial archaeology. Journal of Archaeological Science, 37 (4), 833–845. doi: https://doi.org/10.1016/j.jas.2009.11.013

4. Duran, J., Buades, A. (2015). A Demosaicking Algorithm with Adaptive Inter-Channel Correlation. Image Processing On Line, 5, 311–327. doi: https://doi.org/10.5201/ipol.2015.145

5. Sahani, M., Rout, S. K., Panigrahi, A. K., Acharya, A. S. (2015). Modified color histogram equalization with variable enhancement degree for restoration of skin color. 2015 International Conference on Communications and Signal Processing (ICCSP). doi: https://doi.org/10.1109/iccsp.2015.7322561

6. Boher, P., Leroux, T., Collomb Patton, V., Bignon, T. (2012). Color accuracy of imaging using color filters. Journal of Information Dis-

play, 13 (1), 7–16. doi: https://doi.org/10.1080/15980316.2012.652204

7. Bianco, S., Bruna, A., Naccari, F., Schettini, R. (2012). Color space transformations for digital photography exploiting information about the illuminant estimation process. Journal of the Optical Society of America A, 29 (3), 374–384. doi: https://doi.org/10.1364/josaa.29.000374

8. Lin, M., Zhou, S., Chu, F. (2009). Quality Analysis in Digital Printing Based on Color Management System. International Journal of Engineering and Technology, 1 (2), 135–138. doi: https://doi.org/10.7763/ijet.2009.v1.24

9. Dubnevych, M. (2014). Porivniannia zasobiv vypravlennia nedolikiv koloropodilu tonovykh zobrazhen u hrafichnykh redaktorakh. Tezy dopovidei XIX mizhnarodnoi naukovo-praktychnoi konferentsiyi z problem vydavnycho-polihrafichnoi haluzi. Kyiv: UkrNDISVD, 25–27.

10. Hunko, S., Dubnevych, M. (2014). Koloropodilni nedoliky tsyfrovykh pivtonovykh zobrazhen ta tekhnolohiya yikh vypravlennia koryhuiuchymy zobrazhenniamy. Tekhnolohichni kompleksy, 2, 56–64.

ANALYTICAL IDENTIFICATION OF THE UNMANNED AERIAL VEHICLES' SURFACES FOR THE IMPLEMENTATION AT A 3D PRINTER (p. 48-56)

Tatyana Sheyko
A. N. Podgorny Institute for Mechanical Engineering Problems of NAS of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-3295-5998

Kirill Maksymenko-Sheyko
A. N. Podgorny Institute for Mechanical Engineering Problems of NAS of Ukraine, Kharkiv, Ukraine
V. N. Karazin Kharkiv National University, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-7064-2442

Vladimir Sirenko
Yuzhnoye State Design Office, Dnipro, Ukraine

Anna Morozova
Kharkiv National University of Radio Electronics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-7082-4115

Roksana Petrova
Kharkiv National University of Radio Electronics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-5886-8943

Based on the R-functions theory, new approaches to analytical identification of drone surfaces for realization of 3D printing technology have been developed.

The R-functions theory allows one to describe geometric objects of a complex shape with a single analytical expression, that is, obtain a mathematical model of the object in a form of an equation. To derive such equations, we used both the well-known standard primitive (sphere, ellipsoid, cylinder, cone, pyramid, etc.) procedure and a new approach, blending on a frame, which enables derivation of multiparameter equations with specified properties. Multiparameter equations of surfaces of drones of various types and purposes have been derived and visualized. Adequacy of the results to the designed objects was confirmed by visualization, both in conditions of operation of the RFPreview program and by realization on a 3D printer. The use of literal parameters when specifying geometric information in an analytical form makes it possible to promptly change size and shape of the designed objects which helps reduce time required to build computational models. The proposed method can reduce labor input in operation of CAD systems by months in cases when it is necessary to view a large number of design variants in a search for an optimal solution. Having the object equation, one can easily obtain equation of any of its sections which is useful for numerical calculations, namely, when building computational meshes.

This can have a great effect on reducing complexity in construction of computational models for determining aero-gas-dynamic and strength characteristics. Characterization is also often associated with the need to account for changes in the aircraft shape. This leads to the fact that establishment of aerodynamic characteristics just because of the need to build a large number of computational models to account for this factor increases work duration by months. When specifying parameters, change of the rated operating conditions is made almost instantly.

Keywords: drone, R-functions, 3D printer, standard primitive, blending on a frame.

References

1. Fedorov, S. I., Haustov, A. V., Kramarenko, T. M., Dolgih, V. S. (2016). UAV Classification and Intelligent Management Systems. Otkrytye informacionnye i komp'yuternye integrirovannye tekhnologii, 74, 12–21.

2. Austin, R. (2010). Unmanned Aircraft Systems: UAVS Design, Development and Deployment. John Wiley and Sons, 332. doi: https://doi.org/10.1002/9780470664797

3. Arjomandi, M. (2006). Classification of Unmanned Aerial Vehicles. MECH ENG 3016. Aeronautical Engineering. The University of Adelaide Australia, 49.

4. Unmanned Aircraft System Operation in UK. Airspace – Guidance: CAP 722 (2010). Civil Aviation Authority, 96.

5. Sulsa – perviy v mire samolet, napechatanniy na printere. Available at: http://www.novate.ru/blogs/030811/18344/

6. Napechatannyy na 3D-printere samolet prinyat na sluzhbu v Antarktide. Available at: https://3dnews.ru/931573

7. AIRBUS predstavlyaet THOR – napechatannyy na 3D-printere bespilotnik. Available at: http://www.3dpulse.ru/news/promyshlennost/airbus-predstavlyaet-thor-napechatannyi-na-3d-printere-bespilotnik/

8. Napechatanniy na 3D-printere rossiyskiy bespilotnik pokazali na "Innoprome". Available at: http://www.interfax.ru/russia/517842

9. Prisacariu, V. (2016). CFD Analysis of UAV Flying Wing. INCAS BULLETIN, 8 (3), 65–72. doi: https://doi.org/10.13111/2066-8201.2016.8.3.6

10. Xie, C., An, C., Liu, Y., Yang, C. (2017). Static aeroelastic analysis including geometric nonlinearities based on reduced order model. Chinese Journal of Aeronautics, 30 (2), 638–650. doi: https://doi.org/10.1016/j.cja.2016.12.031

11. Pogrebnaya, T. V., Shipilov, S. D. (2017). Method for numerical modeling of unsteady separated flow around airfoils moving close to flat screen. Nauchniy vestnik Moskovskogo gosudarstvennogo tekhnicheskogo universiteta grazhdanskoy aviacii, 20 (2), 46–56.

12. Bulat, P. V., Minin, O. P. (2018). On modern approach to airplane-type unmanned aerial vehicles design with short takeoff and landing. Part III. Numerical modeling of aircraft vortex aerodynamics by discrete vortex method. Scientific and Technical Journal of Information Technologies, Mechanics and Optics, 18 (2), 169–190. doi: https://doi.org/10.17586/2226-1494-2018-18-2-169-190

13. Wildmann, N., Hofsäß, M., Weimer, F., Joos, A., Bange, J. (2014). MASC – a small Remotely Piloted Aircraft (RPA) for wind energy research. Advances in Science and Research, 11 (1), 55–61. doi: https://doi.org/10.5194/asr-11-55-2014

14. Selecký, M., Váňa, P., Rollo, M., Meiser, T. (2013). Wind Corrections in Flight Path Planning. International Journal of Advanced Robotic Systems, 10 (5), 248. doi: https://doi.org/10.5772/56455

15. Abufanas, A. S., Lobatiy, A. A. (2015). Bespilotnyy aviacionnyy kompleks kak slozhnaya mul'tistrukturnaya sistema. Sistemniy analiz i prikladnaya informatika, 1, 4–9.

16. Rvachev, V. L., Sheiko, T. I. (1995). R-Functions in Boundary Value Problems in Mechanics. Applied Mechanics Reviews, 48 (4), 151–188. doi: https://doi.org/10.1115/1.3005099

17. Maksimenko-Sheyko, K. V. (2009). R-funkcii v matematicheskom modelirovanii geometricheskih ob'ektov i fizicheskih poley. Kharkiv: IPMash NAN Ukrainy, 306.

18. Lisin, D. A., Maksimenko-Sheyko, K. V., Tolok, A. V., Sheyko, T. I. (2011). R-functions in computer modeling of 3D car surface design. Prikladnaya informatika, 6 (36), 78–85.

19. Rusanow, A. V., Lampart, P., Pashchenko, N. V., Rusanov, R. A. (2016). Modelling 3D Steam Turbine Flow Using Thermodynamic Properties of Steam Iapws-95. Polish Maritime Research, 23 (1), 61–67. doi: https://doi.org/10.1515/pomr-2016-0009

DETECTION OF REGULARITIES IN THE PARAMETERS OF THE ATEBGABOR METHOD FOR BIOMETRIC IMAGE FILTRATION (p. 57-65)

Mariya Nazarkevych
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-6528-9867

Oleg Riznyk
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-3815-043X

Volodymyr Samotyy
Cracow University of Technology, Cracow, Poland
Lviv State University of Life Safety, Lviv, Ukraine
ORCID: http://orcid.org/0000-0003-2344-2576

Ulyana Dzelendzyak
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0003-0529-8582

The study has developed a new image filtering method based on Ateb-Gabor. The method involves the well-known Gabor filter that helps convert images with clear contours. Therefore, this method is applicable to biometric images where the creation of clear contours is particularly relevant. During Gabor filtration, the image is transformed by multiplying the harmonic function by the Gaussian function. Ateb-functions are a generalization of elementary trigonometry and, accordingly, have greater functionality for known harmonic functions.

Ateb-Gabor filtering makes it possible to change the intensity of the whole image as well as intensity in certain ranges and thus gives more contrast to certain areas of an image. Ateb-functions are changed by two rational parameters, and this provides flexible control of the filtering. Research has been made on the properties of Ateb-functions as well as the possibility of changing the amplitude and the frequency of alternations when filtering by the Ateb-Gabor. The development of filtration is based on a two-dimensional Ateb-Gabor; its dependencies have been analyzed and appropriate experiments have been performed. The relationship between the frequency and the width of the Ateb-Gabor filter has been determined, which has made it possible to produce filters for finding edges of objects with different frequencies and sizes.

Appropriate software has been developed for python filtering without the use of third-party libraries that are associated with image processing. Fingerprints were filtered using the developed Ateb-Gabor filter. The effectiveness of its use is shown to consist in forming more combinations of processed images. The results of numerous experiments demonstrate a successful selection of edges in an image based on the parameters of the Ateb-Gabor filter.

Keywords: Gabor filter, Ateb functions, biometric system, image processing, deflection of the Gaussian kernel.

References

1. Biometrics Market and Industry Report 2009–2014 (2007). International Biometric Group.

2. Maltoni, D., Maio, D., Jain, A. K., Prabhakar, S. (2009). Handbook of Fingerprint Recognition. Springer, 494. doi: https://doi.org/10.1007/978-1-84882-254-2

3. Lee, T. S. (1996). Image representation using 2D Gabor wavelets. IEEE Transactions on Pattern Analysis and Machine Intelligence, 18 (10), 959–971. doi: https://doi.org/10.1109/34.541406

4. Sebe, N. (2001). Image retrieval using wavelet-based salient points. Journal of Electronic Imaging, 10 (4), 835. doi: https://doi.org/10.1117/1.1406945

5. Nazarkevych, M., Oliarnyk, R., Troyan, O., Nazarkevych, H. (2016). Data protection based on encryption using Ateb-functions. 2016 XIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT). doi: https://doi.org/10.1109/stc-csit.2016.7589861

6. Senik, P. M. (1970). Inversion of the incomplete beta function. Ukrainian Mathematical Journal, 21 (3), 271–278. doi: https://doi.org/10.1007/bf01085368

7. Sree Vidya, B., Chandra, E. (2018). Multimodal biometric hashkey cryptography based authentication and encryption for advanced security in cloud. Biomedical Research. doi: https://doi.org/10.4066/biomedicalresearch.29-17-1766

8. Russell, S. J., Norvig, P. (2016). Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited.

9. Meitram, R., Choudhary, P. (2018). Palm Vein Recognition Based on 2D Gabor Filter and Artificial Neural Network. Journal of Advances in Information Technology, 9 (3), 68–72. doi: https://doi.org/10.12720/jait.9.3.68-72

10. Akin, C., Kacar, U., Kirci, M. (2018). A Multi-Biometrics for Twins Identification Based Speech and Ear. arXiv. Available at: https://arxiv.org/ftp/arxiv/papers/1801/1801.09056.pdf

11. Arif, A., Li, T., Cheng, C.-H. (2017). Blurred fingerprint image enhancement: algorithm analysis and performance evaluation. Signal, Image and Video Processing, 12 (4), 767–774. doi: https://doi.org/10.1007/s11760-017-1218-0

12. Andrew, A. M. (2004). Handbook of fingerprint recognition, by Davide Maltoni, Dario Maio, Anil K. Jain and Salil Probhakar, Springer, New York, 2003, hardback, xii + 348 pp., with DVD-ROM, ISBN 0-387-95431-7 (£46.00). Robotica, 22 (5), 587–588. doi: https://doi.org/10.1017/s026357470422094x

13. Gottschlich, C. (2012). Curved-Region-Based Ridge Frequency Estimation and Curved Gabor Filters for Fingerprint Image Enhancement. IEEE Transactions on Image Processing, 21 (4), 2220–2227. doi: https://doi.org/10.1109/tip.2011.2170696

14. Gopi, K. (2012). Fingerprint Recognition Using Gabor Filter And Frequency Domain Filtering. IOSR Journal of Electronics and Communication Engineering, 2 (6), 17–21. doi: https://doi.org/10.9790/2834-0261721

15. Bartunek, J. S., Nilsson, M., Sallberg, B., Claesson, I. (2013). Adaptive Fingerprint Image Enhancement With Emphasis on Preprocessing of Data. IEEE Transactions on Image Processing, 22 (2), 644–656. doi: https://doi.org/10.1109/tip.2012.2220373

16. Mei, Y., Chen, S., Zhou, Y., Zhao, B. (2014). Orthogonal curved-line Gabor filter for fast fingerprint enhancement. Electronics Letters, 50 (3), 175–177. doi: https://doi.org/10.1049/el.2013.2619

17. Kassis, M., El-Sana, J. (2016). Scribble Based Interactive Page Layout Segmentation Using Gabor Filter. 2016 15th International Conference on Frontiers in Handwriting Recognition (ICFHR). doi: https://doi.org/10.1109/icfhr.2016.0016

18. Jones, J. P., Palmer, L. A. (1987). An evaluation of the two-dimensional Gabor filter model of simple receptive fields in cat striate

cortex. Journal of Neurophysiology, 58 (6), 1233–1258. doi: https://doi.org/10.1152/jn.1987.58.6.1233

19. Grigorescu, S. E., Petkov, N., Kruizinga, P. (2002). Comparison of texture features based on Gabor filters. IEEE Transactions on Image Processing, 11 (10), 1160–1167. doi: https://doi.org/10.1109/tip.2002.804262

20. Ali, M. A. M., Tahir, N. M. (2014). Half iris Gabor based iris recognition. 2014 IEEE 10th International Colloquium on Signal Processing and Its Applications. doi: https://doi.org/10.1109/cspa.2014.6805765

21. Bazen, A. M., Gerez, S. H. (2003). Fingerprint matching by thin-plate spline modelling of elastic deformations. Pattern Recognition, 36 (8), 1859–1867. doi: https://doi.org/10.1016/s0031-3203(03)00036-0

22. Petrovic, V. S., Xydeas, C. S. (2004). Gradient-Based Multiresolution Image Fusion. IEEE Transactions on Image Processing, 13 (2), 228–237. di: https://doi.org/10.1109/tip.2004.823821

23. Struble, R. A. (2018). Nonlinear differential equations. Courier Dover Publications, 288.

24. Senik, P. M., Vozniy, A. M. (1973). Chislennoe obrashchenie odnogo klassa nepolnoy Beta-funkcii. Matematicheskaya fizika, 14, 160–164.

25. Gricik, V. V., Nazarkevich, M. A. (2007). Mathematical models algorythms and computation of Ateb-functions. Dopovidi NAN Ukraini Seriji A, 12, 37–43.

26. Nazarkevych, M., Hladets, A. (2009). Development of software package for the encryption of electronic documents means Ateb-functions. Bulletin of the Lviv Polytechnic National University, Computer Science and Information Technology, 638, 55–61.

27. Nazarkevych, M., Oliiarnyk, R., Nazarkevych, H., Kramarenko, O., Onyshshchenko, I. (2016). The method of encryption based on Ateb-functions. 2016 IEEE First International Conference on Data Stream Mining & Processing (DSMP). doi: https://doi.org/10.1109/dsmp.2016.7583523

28. Maltoni, D., Maio, D., Jain, A. K., Prabhakar, S. (2009). Handbook of fingerprint recognition. Springer. doi: https://doi.org/10.1007/978-1-84882-254-2

29. Maltoni, D., Maio, D., Jain, A. K., Prabhakar, S. (2003). Handbook of Fingerprint Recognition. Springer.

30. Fingerprint matching using minutiae and texture features (2002). Proceedings 2001 International Conference on Image Processing (Cat.No.01CH37205). doi: https://doi.org/10.1109/icip.2001.958106

31. Matsumoto, T., Matsumoto, H., Yamada, K., Hoshino, S. (2002). Impact of artificial «gummy» fingers on fingerprint systems. Optical Security and Counterfeit Deterrence Techniques IV. doi: https://doi.org/10.1117/12.462719

32. Riznik, O., Yurchak, I., Vdovenko, E., Korchagina, A. (2010). Model of stegosystem images on the basis of pseudonoise codes. In Perspective Technologies and Methods in MEMS Design (MEMSTECH), 2010 Proceedings of VIth International Conference.

33. Fries, M., Fischbach, R., Houdeau, D. (2002). U.S. Pat. No. 6.347.040. Washington, DC: U.S. Patent and Trademark Office.

DEVELOPMENT OF A METHOD FOR FRAUD DETECTION IN HETEROGENEOUS DATA DURING INSTALLATION OF MOBILE APPLICATIONS (p. 65-75)

Tetiana Polhul
Vinnytsia National Technical University, Vinnytsia, Ukraine
ORCID: http://orcid.org/0000-0002-0379-1392

Andrii Yarovy
Vinnytsia National Technical University, Vinnytsia, Ukraine
ORCID: http://orcid.org/0000-0002-6668-2425

A method for fraud detection when installing mobile applications was proposed. The developed method, in contrast to existing ones, uses all available data regardless of their types, dimensions, and discrepancies and converts such data into homogeneous coefficients based on the proposed scaling method. This approach allows one to improve accuracy of task solution and build an open to expansion knowledge base with characteristics of fraudsters and rules of detecting fraudulent users. A system of scales for converting heterogeneous data into homogeneous coefficients has been developed which has enabled construction of a mathematical model of the scaling process. The algorithm of scaling heterogeneous data sets based on the proposed scales and the mathematical model of the process of scaling large arrays of heterogeneous data has been developed which has made it possible to reduce the whole data set to two homogeneous groups. The algorithms of processing the resulting groups of homogeneous data and detection of fraudulent users were offered. The developed algorithms using coefficients of similarity between user characteristics form fingerprints of fraudsters, determine characteristics and dependences of fraudsters which allows one to increase efficiency and speed of the process of fraudster detection. A scheme of the fraud detection process which was used in the intelligent system of automatic detection of fraudsters for carrying out of experimental studies was proposed. According to the results of experimental study, accuracy of fraudster detection was 99.14 % for a given representative sample. The results of experimental studies have shown effectiveness of automatic detection of fraudsters and the possibility of expanding formats and characteristics of fraudsters based on intelligent analysis and knowledge bases.

Keywords: fraud detection, heterogeneous data, installation of mobile applications, data abnormalities, data scaling.

References

1. Chandola, V., Banerjee, A., Kumar, V. (2009). Anomaly detection. ACM Computing Surveys, 41(3), 1–58. doi: https://doi.org/10.1145/1541880.1541882

2. Song, X., Wu, M., Jermaine, C., Ranka, S. (2007). Conditional Anomaly Detection. IEEE Transactions on Knowledge and Data Engineering, 19 (5), 631–645. doi: https://doi.org/10.1109/tkde.2007.1009

3. Gricenko, A. V. (2012). Tipy anomaliy v videoizobrazheniyah. Tekhnicheskie nauki – ot teorii k praktike: sbornik statey po materialam VII mezhdunarodnoy nauchno-prakticheskoy konferencii. Chast’ I. Novosibirsk: SibAK. Available at: https://sibac.info/conf/tech/vii/26730

4. Prado-Romero, M. A., Gago-Alonso, A. (2016). Detecting contextual collective anomalies at a Glance. 2016 23rd International Conference on Pattern Recognition (ICPR). doi: https://doi.org/10.1109/icpr.2016.7900017

5. Géron, A. (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. Aurélien Géron, O’Reilly Media, 574.

6. Cielen, D., Meysman, A. D. B., Ali, M. (2016). Introducing Data Science: Big data, machine learning, and more, using Python tools. Manning, 320.

7. Guido, S., Müller, A. (2016). Introduction to Machine Learning with Python: A Guide for Data Scientists. O’Reilly Media, 400.

8. Chollet, F. (2017). Deep Learning with Python. Manning, 384.

9. Agrawal, R., Srikant, R. (1995). Mining sequential patterns. Proceedings of the Eleventh International Conference on Data Engineering. doi: https://doi.org/10.1109/icde.1995.380415

10. Agarwal, D. (2005). An Empirical Bayes Approach to Detect Anomalies in Dynamic Multidimensional Arrays. Fifth IEEE International Conference on Data Mining (ICDM’05). doi: https://doi.org/10.1109/icdm.2005.22

11. Siaterlis, C., Maglaris, B. (2004). Towards multisensor data fusion for DoS detection. Proceedings of the 2004 ACM symposium on Applied computing – SAC ‘04. doi: https://doi.org/10.1145/967900.967992

12. Agarwal, D. (2006). Detecting anomalies in cross-classified streams: a Bayesian approach. Knowledge and Information Systems, 11 (1), 29–44. doi: https://doi.org/10.1007/s10115-006-0036-4

13. MachineLearning.ru. Professional'nyy informacionno-analiticheskiy resurs, posvyashchennyy mashinnomu obucheniyu, raspoznavaniyu obrazov i intellektual'nomu analizu dannyah. Available at: http://www.machinelearning.ru

14. Polhul, T. D., Yarovyi, A. A. (2016). Vyznachennia shakhraiskykh operatsiy pry vstanovlenni mobilnykh dodatkiv z vykorystanniam intelektualnoho analizu danykh. Suchasni tendentsiyi rozvytku systemnoho prohramuvannia. Tezy dopovidei. Kyiv, 55–56. Available at: http://ccs.nau.edu.ua/wp-content/uploads/2017/12/%D0%A1%D0%A2%D0%A0%D0%A1%D0%9F_2016_07.pdf

15. Polhul, T. D., Yarovyi, A. A. (2017). Vyznachennia shakhraiskykh operatsiy pry instaliatsiyi mobilnykh dodatkiv z vykorystanniam intelektualnoho analizu danykh. Materialy XLVI naukovo-tekhnichnoi konferentsiyi pidrozdiliv VNTU. Vinnytsia. Available at: http://ir.lib.vntu.edu.ua/bitstream/handle/123456789/17200/2158.pdf?sequence=3

16. Yarovyi, A. A., Romanyuk, O. N., Arsenyuk, I. R., Polhul, T. D. (2017). Program applications install fraud detection using data mining. Naukovi pratsi Donetskoho natsionalnoho tekhnichnoho universytetu. Seriya: "Informatyka, kibernetyka ta obchysliuvalna tekhnika", 2 (25), 126–131. Available at: http://science.donntu.edu.ua/wp-content/uploads/2018/03/ikvt_2017_2_site-1.pdf

17. Yarovyi, A., Polhul, T., Krylyk, L. (2018). Rozrobka metodu vyiavlennia shakhraistva pry instaliuvanni mobilnykh dodatkiv z vykorystanniam intelektualnoho analizu danykh. Materialy konferentsiyi «XLVII Naukovo-tekhnichna konferentsiya pidrozdiliv Vinnytskoho natsionalnoho tekhnichnoho universytetu (2018)». Vinnytsia. Available at: http://ir.lib.vntu.edu.ua/bitstream/handle/123456789/22722/079.pdf?sequence=1

18. Kiulian, A. H., Polhul, T. D., Khazin, M. B. (2012). Matematychna model rekomendatsiynoho servisu na osnovi metodu kolaboratyvnoi filtratsiyi. Kompiuterni tekhnolohiyi ta Internet v informatsiynomu suspilstvi, 226–227. Available at: http://ir.lib.vntu.edu.ua/bitstream/handle/123456789/7911/226-227.pdf?sequence=1&isAllowed=y

19. Segaran, T. (2008). Programming Collective Intelligence. Building Smart Web 2.0 Applications. O'Reilly Media, 368.

20. Yeung, D.-Y., Chow, C. (2002). Parzen-window network intrusion detectors. Object recognition supported by user interaction for service robots. doi: https://doi.org/10.1109/icpr.2002.1047476

21. Hodge, V. J., Austin, J. (2004). A Survey of Outlier Detection Methodologies. Artificial Intelligence Review, 22 (2), 85–126. doi: https://doi.org/10.1007/s10462-004-4304-y

22. Agyemang, M., Barker, K., Alhajj, R. (2006). A comprehensive survey of numeric and symbolic outlier mining techniques. Intelligent Data Analysis, 10 (6), 521–538. doi: https://doi.org/10.3233/ida-2006-10604

23. Keogh, E., Lin, J., Fu, A. (2005). HOT SAX: Efficiently Finding the Most Unusual Time Series Subsequence. Fifth IEEE International Conference on Data Mining (ICDM'05). doi: https://doi.org/10.1109/icdm.2005.79

24. Keogh, E., Lin, J., Lee, S.-H., Herle, H. V. (2006). Finding the most unusual time series subsequence: algorithms and applications. Knowledge and Information Systems, 11 (1), 1–27. doi: https://doi.org/10.1007/s10115-006-0034-6

25. Donoho, S. (2004). Early detection of insider trading in option markets. Proceedings of the 2004 ACM SIGKDD International Conference on Knowledge Discovery and Data Mining – KDD '04. doi: https://doi.org/10.1145/1014052.1014100

26. Fu, A. W., Leung, O. T.-W., Keogh, E., Lin, J. (2006). Finding Time Series Discords Based on Haar Transform. Lecture Notes in Computer Science, 31–41. doi: https://doi.org/10.1007/11811305_3

27. Yarovyi, A. A., Polhul, T. D. (2015). Pidvyshchennia produktyvnosti obchysliuvalnykh protsesiv v paralelno-ierarkhichniy merezhi za dopomohoiu Framework Benchmark Akka. Zbirnyk tez dopovidi VII Mizhnarodnoi naukovo-tekhnichnoi konferentsiyi «Fotonika ODS-2015». Vinnytsia, 9.

28. Baudat, G., Anouar, F. (2000). Generalized Discriminant Analysis Using a Kernel Approach. Neural Computation, 12 (10), 2385–2404. doi: https://doi.org/10.1162/089976600300014980

29. Yarovyi, A. A., Polhul, T. D. (2018). Kompiuterna prohrama «Prohramnyi modul zboru danykh informatsiynoi tekhnolohiyi» vyiavlennia shakhraistva pry instaliuvanni prohramnykh dodatkiv. Cvidotstvo pro reiestratsiu avtorskoho prava na tvir No. 76348. Kyiv: Ministerstvo ekonomichnoho rozvytku i torhivli Ukrainy.

30. Yarovyi, A. A., Polhul, T. D. (2018). Kompiuterna prohrama «Prohramnyi modul vyznachennia skhozhosti korystuvachiv informatsiynoi tekhnolohiyi vyiavlennia shakhraistva pry instaliuvanni prohramnykh dodatkiv». Cvidotstvo pro reiestratsiu avtorskoho prava na tvir No. 76347. Kyiv: Ministerstvo ekonomichnoho rozvytku i torhivli Ukrainy.