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EFFICIENCY IMPROVEMENT OF USING AN UNMANNED AERIAL VEHICLES BY DISTRIBUTION OF TASKS BETWEEN THE CORES OF THE COMPUTING PROCESSOR

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The object of research is the computer system of unmanned aerial vehicles (UAVs). Most modern UAVs are based on 2- or 4-core single-chip processors, between which the OS automated scheduler tries to evenly distribute computational tasks. One of the most problematic places in the described process is that the first core can instantly become extremely congested in the event of an urgent task from the UAV control system. Therefore, the subject of research is complex indicators of the state of the processor cores for various algorithms of task distribution proposed between the cores of a multicore single-chip processor.

In the course of the research, methods for simulating the dispatching of tasks processed by the UAV computer system based on a quad-core single-chip processor are used. The expediency of using the energy of the measuring signal from piezoelectric sensors for partial compensation of the power consumption by the UAV computer system is investigated and justified. To evaluate the effectiveness of measures taken to improve the efficiency of the use of computer system components, the HWMonitor utility is used.

According to the research results from the developed certain optimal algorithm, which differs from the others by reserving the resources of the 1st core of a multi-core single-chip computing processor for calculations of primary importance. The use of such calculation algorithm provides an increase in flight time by 3.1 minutes and increases the range of professional tasks by 1.3 min (for UAV DJI Phantom 4).

In comparison with similar known solutions, the proposed algorithm improves the UAV stable behavior in critical applications (loss of ground control, the occurrence of obstacles, the impossibility of obtaining GPS coordinates in the areas of radio electronic warfare, etc.).

Keywords: computing systems of unmanned aerial vehicles (UAV), 4-core processor, simulation modeling.

References

1. Tencent and ZEROTECH Unveil Commercial Drone Based on Qualcomm Snapdragon Flight Platform. (2016, January 5). *Qualcomm Technologies, Inc*. Available at: https://www.qualcomm.com/news/releases/2016/01/05/tencent-and-zerotech-unveil-commercial-drone-based-qualcomm-snapdragon
2. *Cortex™-A9. Revision: r4p1. Technical Reference Manual.* (2012). ARM. Available at: http://infocenter.arm.com/help/topic/com.arm.doc.ddi0388i/DDI0388I_cortex_a9_r4p1_trm.pdf
3. Development of multi-threaded applications using optimization method for platforms. (2011, February 3). *Intel Software Developer Zone*. Available at: https://software.intel.com/ru-ru/articles/61695
4. Task Scheduler How To... *Microsoft TechNet*. Available at: https://technet.microsoft.com/en-gb/library/cc766428(v=ws.11).aspx
5. Prostaia model' planirovshchika OS. (2012, October 12). *Habrahabr*. Available at: https://habrahabr.ru/post/154609/
6. Troubleshooting Task Scheduler. *Microsoft TechNet*. Available at: https://technet.microsoft.com/en-gb/library/cc721846(v=ws.11).aspx
7. Tanenbaum, A. S., Bos, H. (2015). *Modern Operating Systems. Ed. 4*. Amsterdam, The Netherlands: Pearson Prentice-Hall, 1072.
8. Arhitektura: gibkaia, effektivnaia. (2013). *CHIP, 9*, 52–53.
9. Krainyk, Y., Perov, V., Musiyenko, M., Davydenko, Y. (2017). Hardware-oriented turbo-product codes decoder architecture. *Proceedings of the 2017 IEEE 9th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS 2017), Bucharest, Romania, September 21–23, 2017, 1*, 151–154. doi:10.1109/idaacs.2017.8095067
10. Burlachenko, I., Zhuravska, I., Musiyenko, M. (2017). Devising a method for the active coordination of video cameras in optical navigation based on the multi-agent approach. *Eastern-European Journal of Enterprise Technologies, 1 (9 (85))*, 17–25. doi:10.15587/1729-4061.2017.90863
11. Nikiforov, V. V. (2014). Basic Requirements to the SPIIRAS Transactions Paper Format Feasibility of Real-Time Applications on Multicore Processors. *SPIIRAS Proceedings, 8*, 255–284. doi:10.15622/sp.8.12
12. Zhuravska, I. M., Koretska, O. O., Musiyenko, M. P., Surtel, W., Assembay, A., Kovalev, V., Tleshova, A. (2017, August 7). Self-powered information measuring wireless networks using the distribution of tasks within multicore processors. *Photonics Applications in Astronomy, Communications, Industry, and High Energy Physics Experiments, Wilga, Poland, 2017*, 1–13. doi:10.1117/12.2280965
13. Sharapov, V., Sarwar, I., Chudaeva, I., Musienko, M. (1998). The electromechanical feed-back in piezoceramic sensors and transducers. *Proceedings of the IEEE Ultrasonics Symposium, Sendai, Japan, October 5–8, 1998, 1*, 543–544. doi:10.1109/ultsym.1998.762208
14. Trasvina-Moreno, C., Blasco, R., Marco, A., Casas, R., Trasvina-Castro, A. (2017). Unmanned Aerial Vehicle Based Wireless Sensor Network for Marine-Coastal Environment Monitoring. *Sensors, 17 (3)*, 460. doi:10.3390/s17030460
15. CPU Stability Test. (2017). *BenchmarkHQ*. Available at: http://www.benchmarkhq.ru/russian.html?/b.html
16. Chakos, B. (2013). *Here's how.* PCWorld, 89.
17. Property Process.ProcessorAffinity. (2016, October). *Microsoft Developer Network*. Available at: https://msdn.microsoft.com/ru-ru/library/system.diagnostics.process.processoraffinity(v=vs.110).aspx
18. Intel® Math Kernel Library – Documentation. (2017, September 13). *Intel Software Developer Zone*. Available at: https://software.intel.com/en-us/articles/intel-math-kernel-library-documentation
19. Grama, A., Karypis, G., Kumar, V., Gupta, A. (2003). *Introduction to Parallel Computing. Ed. 2*. Boston, MA, US: Addison-Wesley, 656.
20. Richter, J. (2012). *CLR via C#. Ed. 4*. Redmond, WA, US: Microsoft prePress, 813.
21. Phantom 4 Pro: specifications. (2017). *DJI*. Available at: https://www.dji.com/ru/phantom-4-pro/info

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ANALYSIS AND DEVELOPMENT OF COMPROMISE SOLUTIONS IN MULTICRITERIA TRANSPORT TASKS

page 13–18

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The object of research is the multicriteria transport problem of linear programming. Simultaneous consideration of several criteria is a problematic problem, since the optimal solutions for different criteria do not coincide. The possible solution of the problem is investigated – finding a way to obtain a compromise solution. Based on the results of the analysis of known methods for solving multicriteria problems (Pareto-set formation, scalarization of the vector criterion, concessions method), the last is justified. To implement the method, an iterative procedure is suggested, in which the initial plan is optimal according to the main criterion. At subsequent iterations, an assignment is made to the main criterion in order to improve the values of the additional criteria. The solution of the problem is continued until a compromise solution is obtained, ensuring the best value for the main criterion, provided that the values for the remaining criteria are no worse than those given. Important advantages of the proposed method: the simplicity of the computational procedure, the grounded technology of forming a new solution at each iteration, realizing the concept of assignment, quality control of the solution obtained at each step. The application of the proposed method opens the prospect of its generalization to the case when the initial data for the solution of the problem contain uncertainty.

Keywords: multicriteria transport problem, iterative solution, method of consecutive concessions for obtaining a compromise solution.

References

1. Yudin, D. B., Golshtein, E. G. (1969). *Zadachi lineinogo programmirovaniia transportnogo tipa*. Moscow: Nauka, 384.
2. Sira, O. V. (2010). *Mnogomernye modeli logistiki v usloviiah neopredelennosti*. Kharkiv: FOP Stetsenko I. I., 512.
3. Raskin, L. G., Kirichenko, O. I. (1982). *Mnogoindeksnye zadachi lineinogo programmirovaniia*. Moscow: Radio i sviaz, 240.
4. Steuer, R. (1986). *Multiple Criteria Optimization: Theory, Computation and Application*. New York: John Wiley, 546.
5. Savaragi, Y., Nakayama, H., Tanin, T. (1985). *Theory of Multiobjective Optimization*. Orlando: Academic Press Inc., 296.
6. Keeney, R. L., Raiffa, H. (1993). *Decisions with Multiple Objectives*. Cambridge University Press, 570. doi:10.1017/cbo9781139174084
7. Ehrgott, M. (2005). *Multicriteria Optimization*. Heidelberg: Springer, 323. doi:10.1007/3-540-27659-9
8. Craft, D. L., Halabi, T. F., Shih, H. A., Bortfeld, T. R. (2006). Approximating convex Pareto surfaces in multiobjective radiotherapy planning. *Medical Physics, 33 (9),* 3399–3407. doi:10.1118/1.2335486
9. Lotov, A. V., Pospelova, I. I. (2008). *Mnogokriterial'nye zadachi priniatiia reshenii*. Moscow: MAKS Press, 197.
10. Intrillitator, M. (2002). *Matematicheskie metody optimizatsii i ekonomicheskaia teoriia*. Moscow: Antris-press, 553.
11. Cohon, J. L. (2004). *Multiobjective Programming and Planning*. New York: Dover Publ, 352.
12. Luque, M., Ruiz, F., Miettinen, K. (2008). Global formulation for interactive multiobjective optimization. *OR Spectrum, 33 (1),* 27–48. doi:10.1007/s00291-008-0154-3
13. Panda, S. (2009). Multi-objective evolutionary algorithm for SSSC-based controller design. *Electric Power Systems Research, 79 (6),* 937–944. doi:10.1016/j.epsr.2008.12.004
14. Zadeh, L. A. (1965). Fuzzy sets. *Information and Control, 8 (3),* 338–353. doi:10.1016/s0019-9958(65)90241-x
15. Negoitse, K. (1981). *Primenenie teorii sistem k problemam upravleniia*. Moscow: MIR, 219.
16. Orlovskii, S. A. (1981). *Problemy priniatiia reshenii pri nechetkoi informatsii*. Moscow: Nauka, 264.
17. Diubua, D., Prad, A. (1990). *Teoriia vozmozhnostei. Prilozhenie k predstavleniiu znanii v informatike*. Moscow: Radio i sviaz, 286.
18. Raskin, L. G., Sira, O. V. (2008). *Nechetkaia matematika. Osnovy teorii. Prilozheniia*. Kharkiv: Parus, 352.
19. Raskin, L., Sira, O. (2016). Method of solving fuzzy problems of mathematical programming. *Eastern-European Journal of Enterprise Technologies, 5 (4 (83)),* 23–28. doi:10.15587/1729-4061.2016.81292
20. Pawlak, Z. (1982). Rough sets. *International Journal of Computer & Information Sciences, 11 (5),* 341–356. doi:10.1007/bf01001956
21. Raskin, L., Sira, O. (2016). Fuzzy models of rough mathematics. *Eastern-European Journal of Enterprise Technologies, 6 (4 (84)),* 53–60. doi:10.15587/1729-4061.2016.86739

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DEVELOPMENT OF A MODEL FOR OPTIMAL CONFIGURATION COMPONENTS SELECTION FOR ARCHITECTURE OF CRITICAL IT INFRASTRUCTURE AT ITS DESIGNING

page 19–27

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The object of research is a critical IT infrastructure. One of the most problematic places in the study of critical IT infrastructures is the complete lack of approaches, methodology and tools for designing, modeling and researching critical IT infrastructures that could be used in the form in which they are offered.

Based on the Markov decision-making process, a model is proposed that will allow to evaluate the implementation options for components, critical IT infrastructure systems by various criteria. The peculiarity of this model is the use of an extended set of criteria, which makes it possible to evaluate the implementation options for components and systems of critical IT infrastructure from different points of view.

In the course of the research, MatLab software package is used, which allowed to check the proposed model for operability.

The resulting model is fairly compact and fully reflects the necessary logic for evaluating the implementation options for components and critical IT infrastructure systems. It is shown that this is achieved due to the flexibility of the proposed mathematical apparatus, namely the possibility of using different evaluation criteria.

In the future, the proposed model and assessment models for all major systems and critical IT infrastructure components will provide a convenient tool for a wide range of researchers whose work is related to all aspects of researching critical IT infrastructures.

As a result of modeling, among the 84 possible configurations of the data processing center, the best overall winning (configuration 4) is chosen.

Keywords: critical IT infrastructure, Markov decision-making process, model of configuration choice.

References

1. Ghemawat, P. (2007). Managing Differences: The Central Challenge of Global Strategy. *Harvard Business Review, 85 (3),* 58–68.
2. Simonsen, J. (2007). Involving top management in IT projects. *Communications of the ACM, 50 (8),* 52–58. doi:10.1145/1278201.127820
3. Wilkin, C. L., Chenhall, R. H. (2010). A Review of IT Governance: A Taxonomy to Inform Accounting Information Systems. *Journal of Information Systems, 24 (2),* 107–146. doi:10.2308/jis.2010.24.2.107
4. Grover, V., Henry, R. M., Thatcher, J. B. (2007). Fix IT-business relationships through better decision rights. *Communications of the ACM, 50 (12),* 80–86. doi:10.1145/1323688.1323699
5. Shpilberg, D., Berez, S., Puryear, R., Shah, S. (2007). Avoiding the Alignment Trp in Information Technology. *MIT Sloan Management Review, 49 (1),* 51–58.
6. Neirotti, P., Paolucci, E. (2007). Assessing the strategic value of Information Technology: An analysis on the insurance sector. *Information & Management, 44 (6),* 568–582. doi:10.1016/j.im.2007.05.005
7. Sen, A., Sinha, A. P. (2011). IT alignment strategies for customer relationship management. *Decision Support Systems, 51 (3),* 609–619. doi:10.1016/j.dss.2010.12.014
8. Casalicchio, E., Galli, E., Tucci, S. (2007). Federated Agent-based Modeling and Simulation Approach to Study Interdependencies in IT Critical Infrastructures. *Proceedings of the IEEE International Symposium on Distributed Simulation and Real-Time Applications (DS-RT'07)*. Chania, Crete, Greek. doi:10.1109/ds-rt.2007.11
9. Pederson, P., Dudenhoeffer, D., Hartley, S., Permann, M. (2006). Critical Infrastructure Interdependency Modeling: A Survey of U.S. and International Research. *Technical Report No. INL/EXT-06-11464*. Idaho: Idaho National Laboratory, 116. doi:10.2172/911792
10. Panzieri, S., Setola, R., Ulivi, G. (2005). An approach to model complex interdependent infrastructures. *IFAC Proceedings Volumes, 38 (1),* 404–409. doi:10.3182/20050703-6-cz-1902.00068

11. Dorogyy, Y. (2017). Development of the approach for designing, modelling and research of critical IT infrastructure. *Technology Audit and Production Reserves, 5 (2 (37))*, 34–41. doi:10.15587/2312-8372.2017.112495
12. *BS ISO/IEC 17789:2014. Information technology. Cloud computing. Reference architecture*. (2014). The British Standards Institution. doi:10.3403/30268907
13. *NIST SP 500-291. NIST Cloud Computing Standards Roadmap*. (2013). National Institute of Standards and Technology. doi:10.6028/nist.sp.500-291r2
14. Marcus, B. (2015, October 5). Interfacing NIST IoT, Big Data, and Cloud Models. Available at: https://bigdatawg.nist.gov/_uploadfiles/M0450_v1_3857254727.pdf
15. *BS ISO/IEC 27017:2015. Information technology. Security techniques. Code of practice for information security controls based on ISO/IEC 27002 for cloud services*. (2015). The British Standards Institution. doi:10.3403/30259620
16. *BS ISO/IEC 27018:2014. Information technology. Security techniques. Code of practice for protection of personally identifiable information (PII) in public clouds acting as PII processors*. (2014). The British Standards Institution. doi:10.3403/30266768
17. *BS ISO/IEC 27036-4:2016. Information technology. Security techniques. Information security for supplier relationships. Guidelines for security of cloud services*. (2016). The British Standards Institution. doi:10.3403/30275201
18. *BS EN ISO/IEC 27040:2016. Information technology. Security techniques. Storage security*. (2015). The British Standards Institution, doi:10.3403/30249804
19. *IEEE P 2302™/D 0.2. Draft Standard for Intercloud Interoperability and Federation (SIIF)*. (2012, January). The Institute of Electrical and Electronics Engineers, Inc. Available at: https://www.oasis-open.org/committees/download.php/46205/p2302-12-0002-00-DRFT-intercloud-p2302-draft-0-2.pdf
20. *ANSI/TIA-942-2005. Telecommunications Infrastructure Standard for Data Centers*. (2005). Arlington: Electronic Components Industry Association (ECIA). Available at: http://www.ieee802.org/3/hssg/public/nov06/diminico_01_1106.pdf
21. *BS EN 50173-5:2007+A2:2012. Information technology. Generic cabling systems. Data centres*. (2007). The British Standards Institution. doi:10.3403/30141480
22. *ISO/IEC 24764:2010. Information technology – Generic cabling systems for data centres*. (2010). International Organization for Standardization. Available at: https://www.iso.org/standard/43520.html
23. Shelimanova, Zh. V., Yanovska, O. V., Furmanov, A. A. (2015). Taxonomic scheme of cloud computing. *Radioelektronni i kompiuterni systemy, 74 (4)*, 51–55.
24. *Data Center Networking – Connectivity and Topology Design Guide*. Available at: https://www.cdigroup.co.uk/wp-content/pdf-documents/data-centers/Enterasys-Data-Center-Design-Guide.pdf
25. SLA for App Service. (2016, July). *Microsoft Azure*. Available at: https://azure.microsoft.com/en-us/support/legal/sla/app-service/v1_4/
26. Murray, P., Melander, B., Fusenig, V., Meulle, M., Vaquero, L. (2011). Cloud Networking Architecture Description. *Scalable and Adaptable Internet Solutions*, 14–69.

SYSTEMS AND CONTROL PROCESSES

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MODELING OF POLYGONS OF MAXIMUM PASSENGER ROUTE TRANSPORT ACCESSIBILITY BY THE EXAMPLE OF THE TRANSPORT SYSTEM OF UKRAINE

page 28–33

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The state (regional) transport system is analyzed on the example of Ukraine. The road network of railways and highways of Ukraine is considered, which consists of more than 30 thousand arcs and knots. The models of the network studied are constructed using ArcMap geoinformation technologies. This provides a description of the network elements with geographical accuracy. One of the most problematic areas of engineering and in particular transport networks is the determination of their maximum potential performance indicators. Formalization of certain parameters determines the planning of technical indicators of flows in the network.

Based on the results of the simulation of polygons of maximum passenger route transport accessibility for various modes of transport, it is determined that the characteristics of the model set of polygons are influenced by both the selected network model and the connection speed. It is proved that at the same speed of movement polygons constructed in different networks differ. This is due to the individual features of the networks,

It has been established that within 1.5 hours of driving, a railway track with a speed of 68 km/h does not reach any nodes (cities) in both networks, and an automotive polygon with the same speed contains one node (city). A polygon constructed on railway networks with a ride within the limits of 1.5 to 3 hours contains one transport node, and automobile under these conditions – two. When examining a landfill that meets the transport accessibility by rail networks within the range of 5 to 8 hours, there are eleven transport nodes, and the automotive network in these conditions is thirteen. Comparing rail and road transport networks, it can be argued that the road transport network has a larger service area than the railway.

The carried out researches can be used at the decision of questions of planning of time expenses and power resources in the course of transportation.

Keywords: transport system, road networks of railways and highways, intercity transportation.

References

1. Spichkova, M., Simic, M., Schmidt, H. (2015). Formal Model for Intelligent Route Planning. *Procedia Computer Science, 60*, 1299–1308. doi:10.1016/j.procs.2015.08.196
2. Deri, A., Kalpakci, A. (2014). Efficient Usage of Transfer based System in Intracity Bus Transit Operation: Sample of Izmir. *Procedia – Social and Behavioral Sciences, 111*, 311–319. doi:10.1016/j.sbspro.2014.01.064
3. Dib, O., Manier, M.-A., Moalic, L., Caminada, A. (2017). A multimodal transport network model and efficient algorithms for building advanced traveler information systems. *Transportation Research Procedia, 22*, 134–143. doi:10.1016/j.trpro.2017.03.020
4. Vissat, L. L., Clark, A., Gilmore, S. (2015). Finding Optimal Timetables for Edinburgh Bus Routes. *Electronic Notes in Theoretical Computer Science, 310*, 179–199. doi:10.1016/j.entcs.2014.12.018
5. Arhin, S., Noel, E., Anderson, M. F., Williams, L., Ribisso, A., Stinson, R. (2016). Optimization of transit total bus stop time models. *Journal of Traffic and Transportation Engineering (English Edition), 3 (2)*, 146–153. doi:10.1016/j.jtte.2015.07.001
6. Bohari, Z. A., Bachok, S., Osman, M. M. (2014). Improving the Quality of Public Transportation System: Application of Simulation

Model for Passenger Movement. *Procedia – Social and Behavioral Sciences, 153,* 542–552. doi:10.1016/j.sbspro.2014.10.087
7. Haar, S., Theissing, S. (2015). A Hybrid-Dynamical Model for Passenger-flow in Transportation Systems**This research work has been carried out under the leadership of the Technological Research Institute SystemX, and therefore granted with public funds within the scope of the French Program «Investissements d'Avenir». *IFAC-PapersOnLine, 48 (27),* 236–241. doi:10.1016/j.ifacol.2015.11.181
8. Sun, D., Xu, Y., Peng, Z.-R. (2015). Timetable optimization for single bus line based on hybrid vehicle size model. *Journal of Traffic and Transportation Engineering (English Edition), 2 (3),* 179–186. doi:10.1016/j.jtte.2015.03.006
9. Vrtic, M., Frohlich, P., Schussler, N., Axhausen, K. W., Lohse, D., Schiller, C., Teichert, H. (2007). Two-dimensionally constrained disaggregate trip generation, distribution and mode choice model: Theory and application for a Swiss national model. *Transportation Research Part A: Policy and Practice, 41 (9),* 857–873. doi:10.1016/j.tra.2006.10.003
10. Rwakarehe, E. E., Zhong, M., Christie, J. (2014). Development of a Freight Demand Model for the Province of Alberta Using Public Sources of Data. *Procedia – Social and Behavioral Sciences, 138,* 695–705. doi:10.1016/j.sbspro.2014.07.263
11. Fornalchyk, Ye., Bilous, A., Demchuk, I. (2015). The Model of Correspondence of Passenger Transportation on the Basis of Fuzzy Logic. *ECONTECHMOD: An International Quarterly Journal on Economics of Technology and Modelling Processes, 4 (2),* 59–64.
12. Grosche, T., Rothlauf, F., Heinzl, A. (2007). Gravity models for airline passenger volume estimation. *Journal of Air Transport Management, 13 (4),* 175–183. doi:10.1016/j.jairtraman.2007.02.001
13. Wu, C., Han, J., Hayashi, Y. (2011). The impact of route network expansion on airport attractiveness: a case study of Chubu international airport in Japan. *Proceedings of the 2011 World Conference of Air Transport Research Society,* 1–14.
14. Hu, Y., Zhang, Q., Wang, W. (2012). A Model Layout Region Optimization for Feeder Buses of Rail Transit. *Procedia – Social and Behavioral Sciences, 43,* 773–780. doi:10.1016/j.sbspro.2012.04.151
15. Fonzone, A., Schmocker, J.-D., Liu, R. (2015). A Model of Bus Bunching under Reliability-based Passenger Arrival Patterns. *Transportation Research Procedia, 7,* 276–299. doi:10.1016/j.trpro.2015.06.015
16. Zhang, C., Teng, J. (2013). Bus Dwell Time Estimation and Prediction: A Study Case in Shanghai-China. *Procedia – Social and Behavioral Sciences, 96,* 1329–1340. doi:10.1016/j.sbspro.2013.08.151
17. Dave, S. M., Raykundaliya, D. P., Shah, S. N. (2013). Modeling Trip Attributes and Feasibility Study of co-ordinated Bus for School Trips of Children. *Procedia – Social and Behavioral Sciences, 104,* 650–659. doi:10.1016/j.sbspro.2013.11.159
18. Richter, C., Keuchel, S. (2012). Modelling Mode Choice in Passenger Transport with Integrated Hierarchical Information Integration. *Journal of Choice Modelling, 5 (1),* 1–21. doi:10.1016/s1755-5345(13)70045-9
19. Kabashkin, I. (2015). Modelling of Regional Transit Multimodal Transport Accessibility with Petri Net Simulation. *Procedia Computer Science, 77,* 151–157. doi:10.1016/j.procs.2015.12.373
20. Essadeq, I., Dubail, E., Jeanniere, E. (2016). Modelling Passenger Congestion in Transit System – Benchmark and Three Case Studies. *Transportation Research Procedia, 14,* 1792–1801. doi:10.1016/j.trpro.2016.05.145
21. Brands, T., de Romph, E., Veitch, T., Cook, J. (2014). Modelling Public Transport Route Choice, with Multiple Access and Egress Modes. *Transportation Research Procedia, 1 (1),* 12–23. doi:10.1016/j.trpro.2014.07.003
22. Dolya, C. (2017). Modeling of passenger transport correspondence between regional centers in Ukraine. *Technology Audit and Production Reserves, 1(2 (33)),* 44–48. doi:10.15587/2312-8372.2017.93458
23. Dolya, C. (2017). Modeling of intercity passenger transportation system. *Technology Audit and Production Reserves, 2(2 (34)),* 37–43. doi:10.15587/2312-8372.2017.100465
24. Grigorova, T., Davidich, Yu., Dolya, V. (2015). Development of distribution model of passenger transportation volumes among suburban transport modes. *Eastern-European Journal of Enterprise Technologies, 3(3 (75)),* 10–14. doi:10.15587/1729-4061.2015.43381
25. Grigorova, T., Davidich, Yu., Dolya, V. (2015). Development of the model of the change in the passenger transport fatigue when approaching stopping points of suburban bus routes. *Eastern-European Journal of Enterprise Technologies, 2(3 (74)),* 4–9. doi:10.15587/1729-4061.2015.38583
26. Mao, L., Wu, X., Huang, Z., Tatem, A. J. (2015). Modeling monthly flows of global air travel passengers: An open-access data resource. *Journal of Transport Geography, 48,* 52–60. doi:10.1016/j.jtrangeo.2015.08.017
27. Dolya, C., Botsman, A., Kozhyna, V. (2017). Investigation of approaches to modeling of intercity passenger transportation system. *Technology Audit and Production Reserves, 4(2 (36)),* 24–28. doi:10.15587/2312-8372.2017.108889

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DEVELOPMENT OF A SYMBOLIC IMAGE OF BUILDING STRUCTURE IN CAD

page 34–40

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The object of research are the processes of automated design of construction or reconstruction of complex building structures under the conditions of individual restrictions on each structure – technical heredity caused by internal and external environment surrounding construction. One of the problematic areas of automated construction design is due to the fact that it constantly needs to restore the model of the structure. This model should reflect not only the primary technical design for the building (drawings, etc.), but also found when designing the changes and developments in the turbulent internal and external environment surrounding the future construction environment.

As a result of the analysis of the role of the terms of reference and its place in the process of automated design of building structures, it is established that the initial task must be constantly adapted to the external and internal environment of the building. On the other hand, it must also adapt to the conditions that the particular building has inherited from its predecessors or neighbors.

It is proposed to use models known as the complex genetic algorithm in the form of branched chromosomes as symbolic models of building constructions, and the accumulation of «same-sex mutations» in them to simulate ossification (prohibition of change) in any transformation of the corresponding genes.

The results of the work in the form of CAD «TEHED» are involved in the reorganization of the facade of an industrial facility in order to increase its ventilation, energy-saving and lighting characteristics. The tests show that the use of CAD «TEHED» allows to reduce the terms of automated design of reconstruction by 23.4 %, as a result, the cost of reconstruction was 18.9 % lower than planned.

Keywords: construction design, model update, turbulent environment, symbolic image, technical heredity.

References

1. Baranov, V. V. Tehnologicheskii audit predpriiatiia v semi shagah. *Elitarium*. Available at: http://www.elitarium.ru/tekhnologicheskijj_audit_predprijatija/
2. Vasiliev, A. S. (2017). Tehnologicheskaia nasledstvennost' v mashinostroenii. Vestnik *Rybinskoi gosudarstvennoi aviatsionnoi tehnologicheskoi akademii im. P. A. Solovieva, 1 (40),* 198–202.
3. Yashcheritsyn, P. I. (2004). Tehnologicheskoe nasledovanie ekspluatatsionnyh parametrov detalei mashin. *Spravochnik, 9,* 20–22.

4. Lapidus, V. A., Serov, M. E. (2017). Sovmestimy li standartizatsiia i tvorchestvo? *Metody menedzhmenta kachestva, 5,* 60–61.
5. Tsytsyliano, O. (2007). Kreatyvnist ta standartyzatsiia yak osnova konkurentospromozhnosti orhanizatsii. Standartyzatsiia. Sertyfikatsiia. *Yakist, 1 (44),* 66–71
6. Novikov, S. (2007). Svoei koleei. *Standarty i kachestvo, 8,* 34–35.
7. *Istoriia razvitiia kolei.* Available at: http://rzd-expo.ru/history/Istoriya%20razvitiya%20kolei/
8. Jia, J., Zhu, F., Ma, X., Cao, Z. W., Li, Y. X., Chen, Y. Z. (2009). Mechanisms of drug combinations: interaction and network perspectives. *Nature Reviews Drug Discovery, 8 (2),* 111–128. doi:10.1038/nrd2683
9. Kolesnykova, K., Monova, D., Toropenko, A., Toropenko, O., Ali, A. Sh. (2016). The project management of the building structure reengineering by the limits in all functional areas. *Technology Audit and Production Reserves, 5 (2 (31)),* 18–23. doi:10.15587/2312-8372.2016.79982
10. Martin, J. N. T. (2007). Metaphors in Mind: Transformation Through Symbolic Modelling. *Metaphor and Symbol, 22 (2),* 201–211. doi:10.1080/10926480701235510
11. Rees, J., Manea, A. I. (2016). The Use of Clean Language and Metaphor in Helping Clients Overcoming Procrastination. *Journal of Experiential Psychotherapy, 19 (3),* 30–36.
12. Ferreira, C. (2001). Gene Expression Programming: A New Adaptive Algorithm for Solving Problems. *Complex Systems, 13 (2),* 87–129.
13. *Technical Drawing Specifications Resource. A guide to support VCE Visual Communication Design study design 2013–17.* Available at: https://www.slideshare.net/bhubanfomb/technical-drawing-specifications
14. Gogunskii, V. D., Stanovska, I. I., Guriev, I. N. (2013). Upravlenie seriinymi proektami v mashinostroenii. *Suchasni tekhnolohii v mashynobuduvanni, 8,* 254–262.
15. Gogunskii, V. D., Stanovska, I. I., Guriev, I. N. (2013). The complex optimization problems in the control of same objects creation program. *Informatsiini tekhnolohii v osviti, nautsi ta vyrobnytstvi, 1 (2),* 250–255.
16. Cui, W., Peinado, M., Chen, K., Wang, H. J., Irun-Briz, L. (2008). Tupni: Automatic reverse engineering of input formats. *ACM Proceedings of the 15th ACM Conference on Computer and Communications Security.* Virginia, 391–402. doi:10.1145/1455770.1455820
17. Chetverikov, G. G., Vechirskaia, I. D. (2008). Formal'noe opisanie logicheskogo prostranstva. *Shtuchnyi intelekt, 3,* 781–789.
18. Zhang, J., Chung, H. S.-H., Lo, W.-L. (2007). Clustering-Based Adaptive Crossover and Mutation Probabilities for Genetic Algorithms. *IEEE Transactions on Evolutionary Computation, 11 (3),* 326–335. doi:10.1109/tevc.2006.880727
19. Stanovskyi, O., Shvets, P., Toropenko, A., Bondarenko, V., Abu, Sh. O., Krasnozhon, O., Stanovskyi, A. (2016). Connectivity optimization of the elements in the tasks of computer-aided system design. *Bulletin of The National Technical University «Kharkiv Polytechnic Institute»: Mechanical-Technological Systems And Complexes, 49,* 170–175. Available at: \www/URL: http://mtsc.khpi.edu.ua/article/view/59969

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ANALYSIS OF APPROACHES TO DEVELOP OF THE COMPETENTS SYSTEM OF THE PROJECT TEAM OF THE BUILDING COMPANY VIRTUAL LOGISTIC CENTER CREATION

page 40–46

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The object of research is the system of development of individual and organizational competence in the project of creating a virtual logistics center of a construction company. One of the most problematic places is the lack of systematic approach in construction organizations for development of personnel, the improvement of organizational competencies and the formation of technological maturity in the field of project management. To address these shortcomings, the project considers the filling of 28 competencies according to the model of the International Project Management Association. Based on the models of the International Project Management Association and Harold Kerzner, a combined model for development of organizational and individual competencies is proposed. In the model, the levels of technological maturity in the field of project management are aligned with the main elements of competencies inherent in the levels, as well as the main values. The tasks that the system for managing the development of the competence of the project team for creating a virtual logistics center for a construction company should be formulated. In the course of the study, the method of analyzing international standards and the synthesis method for constructing a combined model was used.

An effective mechanism for the associated development of individual and organizational competencies in the construction organization is obtained. This is due to the fact that the proposed combined model has a number of features, in particular, system, the interconnectedness of individual and organizational elements of competence, the existence of a value dimension. Thanks to this, it is possible to increase the efficiency of organizational activities of construction organizations as a result of using the model by 10–15 %. In comparison with similar known models, this provides such advantages as: the interconnected development of individual and organizational competencies, the value measurement of competence and the possibility of constructing an integral value-competence strategy for the development of a construction organization.

Keywords: project management, construction logistics, project competence, organizational and individual competencies.

References

1. Kerzner, H. (2009). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling.* New Jersey: Wiley, 1120.
2. *IPMA Organisational Competence Baseline (IPMA OCB) for Developing Competence in Managing by Projects. Version 1.1.* (2016). Amsterdam: International Project Management Association, 105.
3. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide).* (2013). Project Management Institute, 589.
4. *Organizational Project Management Maturity Model (OPM3®). Ed. 3.* (2013). Project Management Institute, 246.
5. Individual Competence Baseline for Project, Programme & Portfolio Management. Version 4.0. (2015). Zurich: IPMA. Available at: http://products.ipma.world/ipma-product/icb/read-icb/
6. In: Bushuyev, S. D. (2009). *Rukovodstvo po upravleniiu innovatsionnymi proektami i programmami. Vol. 1, Version 1.2.* Kyiv: Naukovii svit, 173.
7. Adizes, I. (1983). *How to Solve the Mismanagement Crisis: Diagnosis and Treatment of Management Problems.* Carpinteria: Adizes Institute, 281.
8. Bushuyev, S., Bushueva, N., Yaroshenko, R. (2012). Harmonization models property development programmer in turbulence environment. *Management of Development of Complex Systems, 10,* 9–13.
9. Bushueva, N. S. (2007). *Modeli i metody proaktivnogo upravleniia programmami organizatsionnogo razvitiia.* Kyiv: Naukovii svit, 199.
10. Pokolenko, V. O. (2001). Formuvannia ratsionalnoho skladu uchasnykiv vtilennia investytsiinykh proektiv. *Naukovyi visnyk budivnytstva, 16,* 102–106.

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DEVELOPMENT OF THE STRUCTURE AND CONTENT OF SCRUM-TECHNOLOGIES OF CONTROL OF FAST-FLOWING MEDICAL PROJECTS WITH CRITICAL RISKS

page 46–53

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The object of research is a project (for example, a surgical operation), which, while preserving all the basic properties of the project (uniqueness, limited time, economic and material resources, carried out by the Project Team for a given purpose in cooperation with the turbulent environment), has a number of specific features. These features include fast flow and high responsibility for the result, which make it possible to distinguish project management in a special class of project activity.

A problematic place in the research object is the forced need for redistribution of the roles of the project participants. The project team should be small, mobile and multifunctional. The owner of the project product, who is also a patient, is simultaneously an interested person in the successful completion of the project and the most «detached» from making any decisions in choosing the structure and content of the project technologies.

A system for the proactive management of the structure and content of operations based on SCRUM-technologies is proposed. The peculiarity of the system is that it allows to estimate the probability of occurrence of internal and external significant risk events and to change the originally planned sequence of Sprints in SCRUM-technology under the influence of this assessment.

When managing the draft selection of treatment strategy and tactics within the SCRUM-technology of special treatment in patients with disseminated common abdominal tumors, the high positive statistical clinical effect of such tests has been officially confirmed. This is due to the fact that the proposed method of project management allows to anticipate and prevent the risks of the operation, both during its conduct and for the subsequent control (1 year) period of patients' life.

Thanks to this, the resectability of the primary tumor increased to 65 % in comparison with the control group, the quality of life improved by 43 % and the number of patients whose life expectancy exceeded 1 year after diagnosis and treatment started increased by 23 %.

Keywords: SCRUM-technologies, project participants, Sprint planning, fast-flowing medical projects, critical risks.

References

1. Schwaber, K., Sutherland, J. (2016). *The Scrum Guide*, 17. Available at: https://www.scrumguides.org/docs/scrumguide/v2016/2016-Scrum-Guide-US.pdf
2. Pichler, R. (2010). *Agile Product Management with Scrum: Creating Products that Customers Love*. Upper Saddle River: Addison-Wesley, 133.
3. Johnson, H. L. (2011, January 13). ScrumMaster vs scrum master: What do you think? *Agile Learning Labs*. Available at: http://www.agilelearninglabs.com/2011/01/scrummaster-vs-scrum-master
4. Gogunskii, V. D., Bibik, T. V., Stanovska, I. I. (2012). Upravlenie kompleksnymi riskami proekta soprovozhdeniia sistem avariinoi zashchity obiektov otvetstvennogo naznacheniia. *Vestnik Natsional'nogo universiteta korablestroeniia, 2,* 104–108.
5. Bibik, T. V., Nosenko, T. I., Purich, D. A., Odukalets, L. A. (2010). Desinhronizatsiia posledstvii avarii na atomnyh elektrostantsiiah. *Zbirnyk naukovykh prats Instytutu problem modeliuvannia v enerhetytsi im. Pukhova NANU, 56,* 100–105.
6. Brajesh, K. (2013, December 26). The Product Owner's Role in Technical Matters. Scrum Alliance. *Scrum Alliance*. Available at: https://www.scrumalliance.org/community/articles/2013/december/product-owner-should-not-interfere-in-techincal-as
7. Liang, Y., Wang, S. (2015). The best anesthesia regimen for patients undergoing cytoreductive surgery and hyperthermic intraperitoneal chemotherapy. *International Journal of Surgery, 19,* 103. doi:10.1016/j.ijsu.2015.05.022
8. Kolesnykova, K., Monova, D., Toropenko, A., Toropenko, O., Ali, A. Sh. (2016). The project management of the building structure reengineering by the limits in all functional areas. *Technology Audit and Production Reserves, 5 (2 (31)),* 18–23. doi:10.15587/2312-8372.2016.79982
9. Vladelec producta. *The Improved Methods*. Available at: http://tim.com.ua/tag/vladelec-producta/
10. Pihler, R. Kto takoi vladelets produkta? *Upravlenie produktom v Scrum*. Available at: http://rutlib2.com/book/26423/p/3
11. Chernov, S. K. (2006). Uchet riskov i neopredelennostei v organizatsionnyh proektah. *Upravlinnia proektamy ta rozvytok vyrobnytstva, 1 (17),* 41–44.
12. Lotti, M., Capponi, M., Piazzalunga, D., Poiasina, E., Pisano, M., Manfredi, R., Ansaloni, L. (2016). Laparoscopic HIPEC: A bridge between open and closed-techniques. *Journal of Minimal Access Surgery, 12 (1),* 86–89. doi:10.4103/0972-9941.158965
13. Yang, Y., Yang, Y., Xie, X., Xu, X., Xia, X., Wang, H. et al. (2016). Dual stimulus of hyperthermia and intracellular redox environment triggered release of siRNA for tumor-specific therapy. *International Journal of Pharmaceutics, 506 (1-2),* 158–173. doi:10.1016/j.ijpharm.2016.04.035
14. Ramingwong, S., Ramingwong, L. (2009). The Paradoxical Relationships of Risks and Benefits in Offshore Outsourcing of Software Projects. *The Open Software Engineering Journal, 3 (1),* 35–38. doi:10.2174/1874107x00903010035
15. Schmidt, R., Lyytinen, K., Keil, M., Cule, P. (2001). Identifying Software Project Risks: An International Delphi Study. *Journal of Management Information Systems, 17 (4),* 5–36. doi:10.1080/07421222.2001.11045662
16. Bushuyev, S. D., Bushuyeva, N. S. (2005) Modern approaches to development of the project management methodology. *Project management and development of production, 1 (13),* 5–19.
17. Gogunskii, V., Stanovska, S., Guriev, I. (2013). Bushuyev law – the guarantee of incomplete transformation of serial projects in operating activities. *Eastern-European Journal of Enterprise Technologies, 4 (3 (64))*, 41–44. Available at: http://journals.uran.ua/eejet/article/view/16279/1379
18. Stanovska, I. I., Shchedrov, I. M., Berezovska, K. I. (2014). Prevention and management of risk latency. *NUS Journal. Electronic Editon, 3*. Available at: http://evn.nuos.edu.ua/article/view/44133/40375
19. Stanovskyi, O., Kolesnykova, K., Liebedieva, O., Heblov, I. (2015). Dynamic models in the method of project management. *Eastern-European Journal of Enterprise Technologies, 6 (3 (78))*, 46–52. doi:10.15587/1729-4061.2015.55665
20. Spriestersbach, A., Rohrig, B., du Prel, J.-B., Gerhold-Ay, A., Blettner, M. (2009). Descriptive Statistics: The Specification of Statistical Measures and Their Presentation in Tables and Graphs – Part 7 of a Series on Evaluation of Scientific Publications. *Deutsches Aerzteblatt Online, 106 (36),* 578–583. doi:10.3238/arztebl.2009.0578

MATHEMATICAL MODELING

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DEVELOPMENT OF THE ROBUST ALGORITHMS AND CONTROL SYSTEM OF TECHNICAL STATE OF CONSTRUCTION OBJECTS

page 54–60

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The object of the research is the technical state of the construction objects. The most problematic part of the task is the fact that with the use of existing traditional control systems based on known methods for calculating dispersion, correlation, spectral, static and dynamic characteristics, it becomes possible to detect only pronounced changes in the technical state of the controlled object. And

this, in turn, prevents the timely conduct of an operational set of measures to prevent premature wear, damage and the appearance of defects. In the course of the research, technologies are developed for robust noise analysis of noisy signals received at the output of sensors installed in certain nodes of a construction object, as well as spectral analysis of noise. Due to the use of mentioned technologies, it becomes possible to eliminate the influence of noise on the adequacy of the results of monitoring and to conduct continuous control of the technical state of the construction objects in order to detect the latent stage of the origin of the changes, which is currently impossible with the application of existing algorithms and technologies. On the basis of stated technologies, the basic principles for the development of a system for the continuous control of the latent period of the origin of changes in the technical state of construction objects are proposed. Identification of the latent period of the origin of changes allows reducing material and time costs due to timely carrying out preventive maintenance work.

Keywords: noisy signal, correlation function, spectral characteristics, construction object, technical state, control system.

References

1. Musaeva, N., Aliyev, E., Sattarova, U., Rzayeva, N. (2012). Correlation matrices in problems of identification of seismic stability and technical condition of high-rise buildings and building structures. *2012 IV International Conference «Problems of Cybernetics and Informatics» (PCI)*. IEEE, 157–173. doi:10.1109/icpci.2012.6486357
2. Kollakot, R. (1989). *Diagnostika povrezhdenii*. Moscow: Mir, 516.
3. Gaskin, V. V., Ivanov, I. A. (2005). *Seismostoikost' zdanii i transportnyh sooruzhenii*. Irkutsk: IrGUPS, 76.
4. Sushchev, S. P. (2005). Monitoring ustoichivosti i ostatochnogo resursa vysotnyh zdanii i sooruzhenii s primeneniem mobil'nogo diagnosticheskogo kompleksa «Strela». *Unikal'nye i spetsial'nye tehnologii v stroitel'stve (UST-Build 2005)*. Moscow: TsNTSMO, 68–71.
5. Lei, Y., Jiang, Y., Xu, Z. (2012). Structural damage detection with limited input and output measurement signals. *Mechanical Systems and Signal Processing, 28*, 229–243. doi:10.1016/j.ymssp.2011.07.026
6. Moon, B., Lee, C.-T., Kang, B.-S., Kim, B. S. (2005). Statistical random response analysis and reliability design of structure system with non-linearity. *Mechanical Systems and Signal Processing, 19 (5)*, 1135–1151. doi:10.1016/j.ymssp.2004.05.003
7. Aliev, T. (2007). *Digital Noise Monitoring of Defect Origin*. Boston, MA: Springer US, 224. doi:10.1007/978-0-387-71754-8
8. Aliev, T. (2003). *Robust Technology with Analysis of Interference in Signal Processing*. Boston, MA: Springer US, 200. doi:10.1007/978-1-4615-0093-3
9. Aliev, T. A., Abbasov, A. M., Guluyev, Q. A., Pashaev, F. H., Sattarova, U. E. (2013). System of robust noise monitoring of anomalous seismic processes. *Soil Dynamics and Earthquake Engineering, 53*, 11–25. doi:10.1016/j.soildyn.2012.12.013
10. Aliev, T. A., Alizada, T. A., Rzayeva, N. E. (2017). Noise technologies and systems for monitoring the beginning of the latent period of accidents on fixed platforms. *Mechanical Systems and Signal Processing, 87*, 111–123. doi:10.1016/j.ymssp.2016.10.014

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APPLICATION OF SUPER-STICKING ALGEBRAIC OPERATION OF VARIABLES FOR BOOLEAN FUNCTIONS MINIMIZATION BY COMBINATORIAL METHOD

page 60–76

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The simplification of the problem of Boolean function minimization by a combinatorial method is a new procedure for the algebra of logic – super-sticking of variables. This procedure is performed if there is a complete binary combinatorial system with repetition or an incomplete binary combinatorial system with repetition in the truth table structure.

The procedure for reducing the total perfect disjunctive normal form (PDNF) of the logical function gives unity. And since the complete PDNF uniquely determines the complete binary combinatorial system with repetition and vice versa, this gives grounds to delete all the blocks of the complete binary combinatorial system from the truth table, whose structure allows to carry out the rules of super-sticking of variables.

The efficiency of the algebraic operation of supers-sticking of variables greatly simplifies the algorithm for Boolean function minimization and allows manual minimization of functions with a number of variables up to 10.

The complexity of the algorithm for finding the minimal function by a combinatorial method is $O(n)$ and is linear for $n<7$. With an increase in the number of variables from $n=6$ to 8, the growth dynamics of the number of transformations is characterized by the law $O(n^2)$, followed by the growth of $O(f(n))$ with the increase in the Boolean function capacity according to the polynomial law.

The introduction of an algebraic operation of super-sticking of variables to the problem of Boolean function minimization is more advantageous in comparison with analogs in the following factors:

– lower cost of development and implementation, since a significant proportion of functions are minimized by functions with a number of variables of no more than 16, and therefore, in general, the need for automation of the process of minimizing the function decreases;

– increase in manual minimization of 4–10 bit functions, facilitates control and study of the algorithm for minimizing the logic function.

The combinatorial method of Boolean functions minimization can find practical application in the design of electronic computer systems, because:

– minimization of the DNF function is one of the multiextremal logic-combinatorial problems, the solution of which is, in particular, the combinatorial device of the block-design with repetition;

– extends the capabilities of the algorithm for Boolean functions minimization for their application in information technology;

– improves the algebraic method of Boolean function minimization due to the tabular organization of the method, the introduction of the shaped transformation apparatus and the rules of super-sticking of variables.

Keywords: Boolean function, minimization method, minimization of a logical function, block-design with repetition, minterm, super-sticking of variables.

References

1. Quine-McCluskey algorithm. (2017, August 1). *Wikipedia*. Available at: https://en.wikipedia.org/wiki/Quine%E2%80%93McCluskey_algorithm
2. Riznyk, V., Solomko, M. (2017). Minimization of Boolean functions by combinatorial method. *Technology Audit and Production Reserves, 4 (2 (36))*, 49–64. doi:10.15587/2312-8372.2017.108532
3. Solairaju, A., Periyasamy, R. (2011). Optimal Boolean Function Simplification through K-Map using Object-Oriented Algorithm. *International Journal of Computer Applications, 15 (7)*, 28–32. doi:10.5120/1959-2621
4. Kumar, R., Rawat, S. (2016). Cubical Representation and Minimization through Cubical Technique A Tabular Approach. *International Journal of Applied Engineering Research, 11 (7)*, 4822–4829. Available at: https://www.ripublication.com/ijaer16/ijaerv11n7_27.pdf
5. Stergiou, S., Daskalakis, K., Papakonstantinou, G. (2004). A Fast and Efficient Heuristic ESOP Minimization Algorithm. *Proceedins of the 14th ACM Great Lakes symposium on VLSI – GLSVLSI'04*. Boston. doi:10.1145/988952.988971
6. Dusa, A., Thiem, A. (2015). Enhancing the Minimization of Boolean and Multivalue Output Functions WitheQMC. *The Journal of Mathematical Sociology, 39 (2)*, 92–108. doi:10.1080/0022250x.2014.897949
7. Voudouris, D., Sampson, M., Papakonstantinou, G. (2005). *Exact ESCT minimization for functions of up to six input variables – PRELIMINARY VERSION*, 17. Available at: http://mule.cslab.ece.ntua.gr/xor/docs/xmin6.pdf

8. Valli, M., Periyasamy, R., Amudhavel, J. (2017). A State of Appraoches on Minimization of Boolean Functions. *Journal of Advanced Research in Dynamical and Control Systems, 12,* 1322–1341. Available at: http://www.jardcs.org/abstract.php?archiveid=1323#
9. Boyar, J., Peralta, R. (2010). A New Combinational Logic Minimization Technique with Applications to Cryptology. *Lecture Notes in Computer Science,* 178–189. doi:10.1007/978-3-642-13193-6_16
10. Eungi, K. (2013). Derivations of Single Hypothetical Don't-Care Minterms Using the Quasi Quine-McCluskey Method. *Journal of the Korea Industrial Information Systems Research, 18 (1),* 25–35. doi: 10.9723/jksiis.2013.18.1.025
11. Dubrova, E., Jiang, Y., Brayton, R. (2001). *Minimization of Multiple-Valued Functions in Post Algebra,* 5. Available at: https://pdfs.semanticscholar.org/e9fa/a422aad8b92c0448eb8d41425852717cb637.pdf
12. Anjuli, S. A. (2013). 2-Bit Magnitude Comparator Design Using Different Logic Styles. *International Journal of Engineering Science Invention, 2 (1),* 13–24. Available at: http://www.ijesi.org/papers/Vol(2)1%20(version%202)/C211324.pdf
13. Buniak, A. (2001). *Elektronika ta mikroskhemotekhnika*. Kyiv: Aston, 382.
14. Rytsar, B. Ye. (2013). Minimization of logic functions system by konjuncterms parallel splittingmethod. *Bulletin of the Lviv Polytechnic National University. Radio Electronics and Telecommunications, 766,* 18–27. Available at: http://nbuv.gov.ua/UJRN/VNULPPT_2013_766_6
15. Rytsar, B. Ye. (2015). New minimization method of logical functions in polynomial set-theoretical format. 1. Generalized rules of conjuncterms simplification. *Upravliaiushchie sistemy i mashiny, 2,* 39–57. Available at: http://dspace.nbuv.gov.ua/handle/123456789/87194
16. Samofalov, K. G., Romlinkevich, A. M., Valuiskii, V. N., Kanevskii, Yu. S., Pinevich, M. M. (1987). *Prikladnaia teoriia tsifrovyh avtomatov.* Kyiv: Vishcha shkola, 375.
17. Plehanov, A. (2016, March 8). Simmetrichnye karty kak sredstvo minimizatsii bulevyh funktsii. *Geektimes.* Available at: https://geektimes.ru/post/272294/
18. Plehanov, A. (2016, May 5). Eshche raz o minimizatsii bulevyh funktsii. *Habrahabr.* Available at: https://habrahabr.ru/post/283030/
19. Triohmernaia karta Karno. (2016, February 9). *Cyclowiki.* Available at: http://cyclowiki.org/wiki/Трёхмерная_карта_Карно
20. Karta Karno. (2017, September 30). *Wikipedia.* Available at: https://ru.wikipedia.org/wiki/Карта_Карно