ABSTRACT AND REFERENCES

CONTROL PROCESSES

AN EXPORT AND IMPORT SCHEME FOR CONTAINER DELIVERY BY FREIGHT FORWARDING COMPANIES (p. 4-10)

Olga Akimova

Container shipment has promoted the development of intermodal connections with the use of different vehicles. The activity of freight forwarding companies (FFC) is aimed at improving container transportation of export and import cargoes to the clients, which is possible due to improving motor transportation of goods in containers. The major limitation of FFC activity is their specializing in one direction only — export or import. In import, container delivery expenses of the client depend upon the time of container shipping from the port. The average penalty makes up $10 to $25 per TEU daily.

The paper suggests an export and import scheme of container deliveries by linear operators to FFC clients. The scheme allows shortening the term of container equipment exploitation and reducing linear operators' demurrage and detention expenses due to the suggested algorithm of FFC search of export freight for their returning auto transport.

The economic indicator of improving the export and import scheme of container shipment was received while arranging cargo delivery from Kyiv at a price of $ 650 to $ 750 per vehicle. Every day Odessa port ships 10 to 20 containers with import goods, and 5 to 10 of them can be shipped with export goods on their way back so that the average profit beyond the driver's wages could make up approximately $ 1500 to $ 2500 per day.

Keywords: freight forwarding companies, containers, demurrage, detention, linear operators, motor transport, seaports, PLS, schemes, freight/cargoes.

References

1. Pluzhnikov K. I., Chuntomova Y. A. (2006). Transportnoye ekspedirovaniye. TRANSLIT, 528.
2. Sweeney, E., Evangelista, P. (2005). 3PL definition and taxonomy. Technical Focus in Logistics Solutions, the Journal of the National Institute for Transport and Logistics, 7 (2), 9–10.
3. Ananev, E. (2005). Yest' u ekspeditorov zakon. Journal Ports of Ukraine, 4, 15–17.
4. Yazvinskaya, O. M. (2012). Zakhist prav spozhivachív píd chas nadannya transportno-yekspeditors'kikh poslug. Odesa, ONMU, 26, 615–622.
5. Chuev, A. (2013). O perspektive razvitiya transportno-ekspeditorskoy deyatel'nosti v Ukraine. Journal of Transport, 13, 64–67.
6. Skorobogatov, A. (2011). Sem' voprosov ob otvetstvennosti yekspeditora. Journal Transport, 15, 66–68.
7. Romanenko, E. M. (2009). Sovremennaya praktika organizatsii deyatel'nosti transportno-ekspeditorskikh kompaniy. Odesa, ONMU, 29, 164–175.
8. Koskina, Yu. A. (2008). Obshchaya kharakteristika vidov deyatel'nosti ekspeditorskoy kompanii na rynke morskikh perevozok, 13, 217–227.
9. Bontekoning, Y. M., Priemus, H. (2004). Breakthrough innovations in intermodal freight transport. Transportation Planning and Technology, 27 (5), 335–345. doi: 10.1080/0308106042000273031
10. Konings, R., Priemus, H., Nijkamp, P. (2008). The Future of Intermodal Freight Transport. Operations, Design and Policy. Transport economics, management and policy. Series Editor: Kenneth Button,University Professor, School of Public Policy, George Mason University, USA, 135–151.
11. Hanssen, T.-E. S., Mathisen, T. A., Jorgensen, F. (2012). Generalized Transport Costs in Intermodal Freight Transport. Proceedings of EWGT2012 - 15th Meeting of the EURO Working Group on Transportation, 189–200.
12. Naumov, V. S., Orda, O. O. (2009). Teoretichní ta praktichní pídkhodi pídvishchennya yefektivností transportno-yekspeditsíynogo obslugovuvannya. Eastern-European Journal of Enterprise Technologies, 5/3 (41), 38–41. Available at: http://journals.uran.ua/eejet/article/view/22576/20200
13. Naumov, V. S. (2013). Analiz rynka transportno-ekspeditorskogo obsluzhivaniya v khar'kovskom regione. Vestnik Khar'kov KHNADU, 32, 77–84.
14. Klassy PL-operatorov (provayderov logisticheskikh i skladskikh uslug) (2013). Available at: www: http:// likos.com.ua/world-pl-operators-classification.
15. Mal'tseva, M. V. (2007). Upravleniye kachestvom transportno-ekspeditsionnogo obsluzhivaniya vneshnetorgovykh perevozok. Avtoref. dis. Gosudarstvennyy universitet upravleniya, 134.
16. Shcherbina, O. V., Akímova, O. V. (2009). Sposoby nachisleniya «demeredzha» i «dispacha» v lineynom sudokhodstve. Sbornik nauchnykh trudov po materialam mezhdunarodnoy nauchno-prakticheskoy konferentsii. Odessa, 32–34.

AUTOMATED SYNTHESIS OF LANDSCAPE SURFACE MODEL BASED ON SATELLITE IMAGES (p. 10-15)

Petr Kachanov, Andrey Zuev

A method for automated construction of a realistic model of the landscape surface using satellite images and height fields as source data is proposed in the paper. A practical example of the landscape model synthesis is considered, performance characteristics of the method are evaluated.

Solving the problem of synthesis and imaging of realistic landscape surface in training complexes is integrated and computationally challenging because of the high level of detail of existing landscapes and the need to model their extended regions.

The method allows to obtain various types of landscapes in all climatic conditions and provides a basis for developing the vegetative cover synthesis methods. Feature of this method is minimization of the number of textures, used for the model imaging and correspondence of visual and physical landscape models.

Automation allows to significantly reduce the amount of manual work, as well as improve the quality of the synthesized landscape model. Computational resources, required for the landscape surface synthesis are minimized, which allows to use cheaper hardware for the imaging system construction and leads to lower price of training complex.

Keywords: height field, landscape texturing, training complexes, imaging system, cluster analysis.

References

1. Ujval, J. K., Rixner, S., Dally, J.W., Khailany, B., Ahn, J.H., Mattson, H., Owens, J. D. (2003). Programmable Stream Processors. IEEE Computer, 54–62. doi: 10.1109/MC.2003.1220582
2. Pheshenko, A. (2006). Potencial and perspektivi otechestvennogo voennogo trenagorostroeniya. Defence Express, 4, 39–45.
3. Lindstrom, P., Pascucci, V. (2001). Visualization of Large Terrains Made Easy. Proceedings of IEEE Visualization 2001, 10, 363–370. doi: 10.1109/VISUAL.2001.964533
4. Lindstrom, P., Koller, D., Ribarsky, W., Hodges, L., Faust, N., Turner, G. (1996). Real-time, continuous level of detail rendering of height fields. Proceedings of the 23rd annual conference on Computer graphics and interactive techniques - SIGGRAPH '96, 109–118. doi: 10.1145/237170.237217
5. Duchaineau, M., Wolinsky, M., Sigeti, D., Miller, M., Aldrich, C., Mineev-Weinstein, M. (1997). Roaming terrain: Real-time optimally adapting meshes. Proceedings. Visualization '97, 81–88. doi: 10.1109/visual.1997.663860
6. Thatcher, U. (2002). Rendering Massive Terrains using Chunked Level of Detail Control. In Course Notes of ACM SIGGRAPH 2002, 35.
7. Balog, A. (2003). Real-time visualization of detailed terrain. Budapest: Konzulens, Rajacsics Tamas.

8. Kachanov, P. A., Vasilchenkov, O. G., Zuev, A. A. (2004). Sintez realistichnih landshaftov dlya trenagernih kompleksov. Vistnyk NTU «KhPI», 17, 101–107.
9. Zuev, A. A. (2007). Metod upakovki poley visot. Vistnyk NTU «KhPI», 36, 44–48.
10. Hammes, J. (2001). Modeling of ecosystems as a data source for real-time terrain rendering. 1st International Symposium, DEM 2001, Manno, Switzerland, 9, 5–7.
11. Baldin, V. A. (1972). Teoriya i konstrukciya tankov. M., Voennaya akademiya bronetankovih voysk im. Malinovskogo, 781.
12. Duran, B., Odell, P. (1977). Klasterniy analiz. Moscow: "Statistika", 128.
13. Sedgvik, R. (2001). Fundamentalnie algoritmi na C++. Analiz / strukturi dannih / sortirovka / poisk. Kiev: "DiaSoft", 688.

THE FORMATION OF THE CONCEPT OF ROBOTIC MONITORING OF AN UNDERWATER ENVIRONMENT BASED ON THE USE OF REMOTELY OPERATED VEHICLES (p. 16-21)

Aleksandr Blinzov, Andrej Sirivchuk

To date, water resources monitoring in Ukraine is almost not performed. Major monitoring work is carried out without the use of specialized monitoring systems, though Ukraine has experience in applying remotely operated vehicles. For a more effective monitoring of an underwater environment, it is necessary to create the concept of remotely operated vehicle that could meet the underwater environment lighting requirements.

Existing monitoring tasks were classified into the four groups according to the scope of application. Each group has common, relative to the control system and specific tasks. Since the tasks to be performed by the control system, have common operation modes, there is the possibility to develop its generalized structure.

Generalized hierarchical structure of the automatic control system of remotely operated vehicle was developed to perform the underwater environment monitoring tasks. It contains three levels: strategic, tactical and executive. Implementing individual blocks of this structure is complex scientific and technical problem. The most promising is the use of artificial intelligence tools in the synthesis of elements of these blocks.

Intelligent components of the automatic control system ensure reduction of load on ROV operators and underwater environment monitoring efficiency improvement.

Keywords: remotely operated vehicle, water resources monitoring, intelligent control system, monitoring concept.

References

1. Poriadok zdijsnennia derzhavnoho monitorynhu vod. Kabinet Ministriv Ukrainy. Available at : http://zakon4.rada.gov.ua/laws/show/815-96-%D0%BF
2. Kontseptsiia tsil'ovoi kompleksnoi prohramy naukovykh doslidzhen' NAN Ukrainy «Kompleksna otsinka stanu i prohnozuvannia dynamiky mors'koho seredovyscha ta resursiv Azovo-Chornomors'koho basejnu». postanova Prezydii NAN Ukrainy vid 23.06.2010, № 201. Available at : http://www1.nas.gov.ua/infrastructures/Legaltexts/nas/2010/regulations/OpenDocs/100623_201_conception.pdf
3. Kontseptsiia tsil'ovoi kompleksnoi prohramy naukovykh doslidzhen' NAN Ukrainy «Kompleksnyj monitorynh, otsinka ta prohnozuvannia dynamiky stanu mors'koho seredovyscha ta resursnoi bazy Azovo-Chornomors'koho basejnu v umovakh zrostaiuchoho antropohennoho navantazhennia ta klimatychnykh zmin» na 2013-2015 rr. Prezydija NAN Ukrainy vid 22.02.2013, № 121. Available at : http://www1.nas.gov.ua/infrastructures/Legaltexts/nas/2013/ directions/OpenDocs/130222_121_koncept.pdf
4. Pro derzhavnyj kordon Ukrainy. zakon Ukrainy. Available at : http://zakon.nau.ua/doc/?uid=1085.56.9&nobreak=1
5. Konventsiia pro okhoronu pidvodnoi kul'turnoi spadschyny. Available at : http://zakon2.rada.gov.ua/laws/show/995_c52
6. Pro Zahal'noderzhavnu tsil'ovu prohramu zakhystu naselennia i terytorij vid nadzvychajnykh sytuatsij tekhnohennoho ta pryrodnoho kharakteru na 2013-2017 roky. zakon Ukrainy. Available at : http://zakon0.rada.gov.ua/laws/show/4909-17
7. Smolyn, V., Sokolov, H., Pavlov, B. (2003-2005). Hlubokovodnye vodolaznye spusky y ykh medytsynskoe obespechenye. Fyrma «Slovo».
8. Shamaryn, A. (2006). Monytorynh podvodnoj obstanovky v prybrezhnoj zone y puty eho usovershenstvovanyia. Hidroakustychnyj zhurnal (Problemy, metody ta zasoby doslidzhen' Svitovoho okeanu), 3, 75–77.
9. Blyntsov, V. (1998). Pryviaznye podvodnye systemy. Naukova dumka, 142.
10. Blintsov, O., Nadtochij A. (2013). The generalized underwater technics efficiency estimation methodology of deep sea archaeological projects. Eastern-European Journal of Enterprise Technologies, 1/3(67), 25–29. http://journals.uran.ua/eejet/article/view/21045/19318
11. Ryzhkov, S., Blintsov, V., Yehorov, H., Zhukov, Yu., Kvasnyts'kyj, V., Koshkin, K., Krivtsun, I., Niekrasov, V, Cevriukov, V., Solonichenko, Yu. (2011). Stvorennia universal'nykh transportnykh suden i zasobiv okeanotekhniky: Monohrafiia. Mykolaiv: Vydavnytstvo NUK, 340.
12. Govindarajan, R., Arulselvi, S., Thamarai, P. (2013). Underwater Robot Control Systems. International Journal of Scientific Engineering and Technology, 222–224.
13. Chan, Tam Dyk (2012). Struktura sistemy avtomaticheskogo upravlenija dvizheniem sistemy monitoringa morskoj akvatorii. Pidvodna tehnika i tehnologija: Materiali vseukrains'koï naukovo-tehnichnoi konferencii z mizhnarodnoju uchastju, 116–120.
14. Molchan, M. (2005). The Role of Micro-ROVs in Maritime Safety and Security. Mochlan Marine Sciences, 44.
15. Yakunyna, Y. V. (2009). Metody y prybory kontrolia okruzhaiuschej sredy. Ekolohycheskyj monytorynh. Tambov. Tambovskoho hosudarstvennoho tekhnycheskoho unyversyteta, 188.
16. Ageev, M. (2009). Avtonomnyj podvodnyj apparat – ideal'naja precizionnaja platforma dlja podvodnyh gravimetricheskih izmerenij. Podvodnye issledovanija i robototehnika, 1 (7), 4–8.
17. Blintsov, A. V. (2014) Intelligent fault detection system of underwater vehicle electrical devices "Innowacyjne Materialy i Technologie w Elektronice": Materialy konferencyjne "VIII Lubuska Konferencja Naukowo-Tecniczna". Zielona Gora: Uniwersytet Zielenogorski, 32–36.
18. Blyntsov, S. V. (2012). Onlain-ydentyfykatsyia parametrov podvodnoho apparata kak nestatsyonarnoho obekta v systeme upravlenyia na baze ynversnoi modely. Visnyk NUK, 3. Available at : http://ev.nuos.edu.ua/ru/material ?publicationId=18267

SEMIGRAPHICAL MODEL OF RAILWAY STATIONS OPERATION (p. 21-26)

Anatoly Verlan

Semigraphical model of railway stations operation for technical and operational evaluation of their technology is presented in the paper. The paper is aimed at improving the model structure to simplify the mechanical engineer's interaction with a computer at the stage of a formal description of the model. In the simulation, railway station is considered as a complex system, in which maintenance of facilities by technical means and executors is carried out by performing manufacturing operations with them in accordance with the process. The developed semigraphical model includes the model of the station technical support, the model of the station operation, a list of serviced facilities, list of facility service technologies. Construction of these models is performed using the methods of graph theory and object-oriented analysis. The proposed model enhances the rate of human-machine interaction through automated insertion of the full range of operations that meet the facility service technology, automated modification of groups of operations and automated calculation of the station operation indicators in the schedule. The model is implemented as a supplement to the AutoCAD package. Using the proposed semigraphical model allows to reduce the load on mechanical engineers in developing operation technologies of stations and complex analysis of their operation by reducing routine operations.

Keywords: railway station; manufacturing process; station operation schedule; mathematical model.

References

1. Practical recommendations for the compilation of the technological process of the sorting station (2010). Publisher «PNP Polygrafservys», 230.
2. Bobrovsky, V. I., Vernigora, R. V. (2000). Functional modeling of railway stations in simulators operational dispatch personnel. Mathematical modeling, 2 (5), 68–71.
3. Giua, A. (2008). Modeling and supervisory control of railway networks using Petri nets. IEEE Transactions on Automation Science and Engineering. 3, 431–445. doi: 10.1109/tase.2008.916925
4. Milinkovic, S., Markovic, M., Veskovic, S., Ivic, M., Pavlovic, N. (2013). A fuzzy Petri net model to estimate train delays. Simulation Modelling Practice and Theory, 33, 144–157. doi: 10.1016/j.simpat.2012.12.005
5. Szucs, G. (2001). Railway Simulation with the CASSANDRA Simulation System. Journal of Computing and Information Technology, 2, 133–142. doi: 10.2498/cit.2001.02.04
6. Bobrovsky, V. I., Kozachenko, D. M., Vernigora, R. V. (2004). Ergatic models railway stations. Collected Works KUETT «Transportation Systems and Technologies», 5, 80–86.
7. Kozachenko, D. M., Vernigora, R. V., Korobyova, R. G. (2008). Software system for simulation of the railway stations on the basis of the daily plan – schedule. Railway Transport of Ukraine, 4, 18–20.
8. Bobrovskiy, V., Kozachenko, D., Vernigora, R. (2014). Functional simulation of railway stations on the basis of finite-state automate. Transport Problems, 9 (3), 57–65.
9. Kozachenko, D. M. (2013). Object-oriented model of the railway stations. Journal of DNURT, 46, 47–55.
10. Kozachenko, D. M., Vernigora, R. V., Berezovy, M. I. (2011). Comprehensive analysis of railway infrastructure metallurgical plant-based modeling graphoanalytical, 4, 55–60.
11. Kozachenko, D. M. (2013). A mathematical model for evaluating the technical and technological parameters of the railway stations. Journal of DNURT, 45, 22–28.

MODELING OPERATIONS OF WARNING RAILROAD WORKERS BY STATION DUTY OFFICERS (p. 26-29)

Sergey Zmiy, Vladimir Moroz, Roman Turchinov

Existing safety technologies of works on the railroad tracks oblige the station duty officer to warn railroad workers about all movements of rolling stock through the working space. However, the information load on the human operator is sometimes such that the station duty officer can not timely transfer this type of messages.

Therefore, the aim of the paper is to obtain quantitative values of probability of timely fulfillment of the operation of warning railroad workers and passengers.

To achieve this goal, the problem of constructing a model of operation of notifying railroad workers and passengers by the station duty officer, as well as obtaining the relationships among the probability of timely fulfillment of the operation, psychophysiological state of the operator and the number of crews on the tracks were solved. For this purpose, a functional-semantic network was developed and modeling of the operation of warning railroad workers and passengers by the station duty officer was performed.

As a result of the modeling, it was found that the probability of timely fulfillment of the operation does not meet the standards in the case of both the deterioration of the psychophysiological state of the station duty officer, and increase in the number of concurrently working crews.

The studies can be used for decision-making on the allocation of warning functions between the station duty officer and control system.

Keywords: warning, station duty officer, railroad workers, functional-semantic network, modeling, mathematical expectation, warning probability.

References

1. Teslenko, I. M. (2005). Povyshenie bezopasnosti truda na zheleznodorozhnom transporte. GOU VPO DVGUPS, 20.
2. Kuznecov, K. B. (2008). Bezopasnost tehnologicheskih processov i proizvodstv. Moscow: Uchebno-metodicheskiy centr po obrazovaniyu na zheleznodorozhnom transporte, 204.
3. Boynik, A. B., Koshevoy, S. V., Panchenko, S. V., Sotnik, V. A. (2005). Sistemyi intervalnogo regulirovaniya dvizheniya poezdov na peregonah. Kharkiv: UkrGAZhT, 256.
4. Boynik, A. B. (2003). Bezopasnost zheleznodorozhnyih pereezdov. Kharkiv: Transport Ukrainyi, 184.
5. Buzanov, S. P., Kharlamov, V. F. (1986). Okhrana truda na zheleznodorozhnykh stantsiyakh. Moscow: Transport, 284.
6. Moroz, V. P. Filenko, I. O. (2010). Psykhodiahnostyka intehralnoho zavantazhennia operatyvno-dyspetcherskoho personalu na zaliznychnomu transporti. Aktualni problemy psykholohii. Vol. 1: Orhanizatsiina psykholohiia. Ekonomichna psykholohiia. Sotsialna psykholohiia, 25, 209.
7. Gubinskiy, A. I., Kobzev, V. V. (1975). Otsenka nadezhnosti deyatel’nosti cheloveka-operatora v sistemakh upravleniya. Moscow: Mashinostroenie, 52.
8. Asherov, A. T., Sabadash, V. V. (2008). Sudebno-ergonomicheskaya ekspertiza neschastnykh sluchaev v sisteme «chelovek-tekhnika-sreda». Kharkiv: UIPA, 145.
9. Adamenko, A. N., Asherov, A. T., Berdnikov, I. L., Lavrov, E. A. (1993). Informatsionno-upravlyayushchie cheloveko-mashinnye sistemy: Issledovanie, proektirovanie, ispytaniya. Moscow: Mashinostroenie, 528.
10. Moroz, V. P. (2010). Pro spivvidnoshennia naiavnoho ta potribnoho vydiv chasu v liudyno-mashynnykh systemakh keruvannia rukhom poizdiv. Informatsiino-keruiuchi systemy na zaliznychnomu transporti, 4, 2–3.
11. Moroz, V. P., Skolota, S. V. (2010). Vrakhuvannia umov pratsi pry proektuvanni ARM operatyvno-dyspetcherskoho personalu. Informatsiino-keruiuchi systemy na zaliznychnomu transporti, 4, 2.
12. Sapozhnikov, Vl. V., Elkin, B. N., Kokurin, I. M. (1997). Stantsionnye sistemy avtomatiki i telemekhaniki. Moscow: Transport, 432.

MODELING OF DIFFERENTIAL DIAGNOSIS CLASSIFIERS OF PATHOLOGICAL STATES OF THE CARDIOVASCULAR SYSTEM (p. 30-34)

Ievgen Nastenko, Volodimir Pavlov, Olena Nosovets

The results of creating differential diagnosis classifiers of pathological states of the cardiovascular system are given in the paper. This task allows to solve the problem of creating non-invasive diagnosis method that allows to use repeated measurements, obtained in a state of unrest. A feature of this formulation is the classification of complex objects, each of which can overlap with other objects.

It is proposed to use the convolution of objects, obtained through the application of the modified combinatorial group method of data handling. Classification problem is solved by the “one-against-all” approach, i.e. a set of models, opposing each state to all other is modeled. The main purpose of the work was selecting the optimal modeling method, which allows to get the maximum accuracy on the training and test samples. As a result of the analysis, it was proved that the group method of data handling, which has shown the classification accuracy of over 90 % at the separation of all diagnoses is optimum for such problems.

Keywords: modeling, classifiers, logistic regression, discriminant analysis, group method of data handling.

References

1. Anishchenko, O. V. (2012). Medyko-demohrafichna sytuatsiya ta orhanizatsiya medychnoyi dopomohy naselennyu u 2011 rotsi. Ministerstvo okhorony zdorov`ya Ukrayiny, 103.
2. Zabara, S. S., Filimonova, N. B., Zelenskiy, K. H. (2009). Metod vidilennya invariantnih oznak signaliv. Dopovidi Natsionalnoi akademii nauk Ukraini, 2, 49–55.
3. Red’ko, I. N. (1996). Otsenka oblasty hlobal’noy ustoychyvosty uravnenyya mayatnykovoho typa metodamy teoryy klassyfykatsyy. 4 konferentsyya «Nelyneynie kolebanyya v mekhanycheskykh systemakh», 45–46.
4. Red’ko, I. N., Shalfeev, V. D. (1992). Primenenie metodov teorii klassifikacii ob`ektov dlja ocenok oblastej sushhestvovanija

установivshihsja dvizhenij. Vestnik NNGU, ser. Radiofizika, 68–72.
5. Cowley, A. W., Physiol, W. (1992). Long-term control of arterial blood pressure. Circular Researchers, 72 (1), 231–300.
6. Euler, U. S., Liljestrand, G. (1996). Observations on the pulmonary arterial blood pressure. Acta Physiologica Scandinavica, 12 (4), 301–320. doi: 10.1111/j.1748-1716.1946.tb00389.x
7. Arthur, C., Guyton, M. D., Thomas, G. (1992). Arterial pressure regulation. The American Journal of Medicine, 52 (5), 584–594.
8. O'Rourke, M. (1990). Arterial stiffness, systolic blood pressure, and logical treatment of arterial hypertension. Hypertension, 15 (4), 339–347. doi: 10.1161/01.hyp.15.4.339
9. McKenna, M., Wolfson, S., Kuller, L. (1991). The ratio of ankle and arm arterial pressure as an independent predictor of mortality. Atherosclerosis, 87 (2), 119–128. doi: 10.1016/0021-9150(91)90014-t
10. McVeigh, G. E., Bratteli, C. W., Morgan, D. J. (1999). Age-Related Abnormalities in Arterial Compliance Identified by Pressure Pulse Contour Analysis. Hypertension, 33 (6), 139–142. doi: 10.1161/01.hyp.33.6.1392
11. Stepashko, V. S. (1981). Kombinatornyj algoritm MGUA s optimal'noj shemoj perebora modelej. Avtomatika, 3, 31–36.
12. Nastenko, Ie. A., Knishov, G. V., Nosovets, O. K., Pavlov, V. A., Kondrashova, N. V. (2014). Combinatorial agorithm for constructing a parametric feature space for the classification of multidimensional models. Cybernetics and Systems Analysis, 50 (4), 627–633. doi: 10.1007/s10559-014-9651-3

RESCUE EQUIPMENT COMPLETING PROBLEM AND TECHNOLOGIES FOR ITS SOLUTION (p. 35-41)

Vasyl Kryshtal, Vitaliy Snytyuk

The paper deals with the rescue equipment completing problem and aspects of its solution. In recent years, this problem has become of particular importance and the necessity of its solution is underlined by resource-fiscal deficit. The analysis has shown a certain similarity of the considered problem with the bin packing problem. However, in contrast, we deal with the multicriterion discrete optimization problem.

A set of the structure, functioning and development models, accompanying the obtained solution at its lifecycle stages was elaborated. These models allow to construct the area of potential solutions and, most importantly, provide the ability to change the equipment range over time, ensuring its adaptive properties.

Four main completing assessment criteria: functionality, performance, power and price were indicated. The objective function was built based on the additive convolution to determine the optimal variant of rescue equipment completing. Since this problem is discrete optimization problem and the number of possible completing variants is significant, it was proposed to solve it using the composition of evolutionary methods, the analytic hierarchy process and fuzzy set theory, for which data pre-preparation procedures were developed. The structure of the knowledge base, which is the information basis of the decision support processes was developed.

Keywords: rescue equipment, completing, optimization, criterion, information base.

References

1. Snytyuk, V., Kucher, P. (2014). Problem and mathematical models for rescue technics acquisition. International Journal "Information Theories and Applications", 21 (1), 60–64.
2. Zadeh, L. A. (1994). Fuzzy logic, neural network and soft computing. Communications of the ACM, 37 (3), 77–84.
3. Snytyuk, V., Dghulay, O. (2007). Evolutionary technique of shorter route determination of fire brigade following to fire place with the optimized space of search. Information Technologies and Knowledge, 1 (4), 325–332.
4. Snytyuk, V. E., Dghulay, A. N., Bychenko, A. A. (2008). Evolyuzionnie tekhnologii prinyatiya resheniy pri pozharotushenii. Kiev: Maklaut, 268.
5. Zemlyanskiy, O. M. (2012). Modeli ta evolyuziyni metodi optimizatsii struktiri system pozhezhnogo monitoringu budivel I sporud. Kiev, KNUBA, 22.
6. Zemlyanskiy, O. M. (2014). Informaziyna tekhnologiya prognosuvannya konzentrazii nebezpechnoi rechovini pri avariynomu vikidi v umovakh neviznachenosti. Cherkasy, CHDTU, 20.
7. Snytyuk, V. E., Myroshnyk, O. N. (2014). Modelirovanie i prognozirovanie prozessov na rynke nedvizhimosti. Cherkasy: "Chabanenko", 416.
8. Lodi, A., Martello, S., Vigo, D. (2002). Recent advances on two-dimensional bin packing problems. Discrete Applied Mathematics, 123 (1-3), 379–396. doi: 10.1016/s0166-218x(01)00347-x
9. Silvano, M., Toth, P. (1990). Knapsack problems. Chichester, UK: John Wiley and Sons, 221.
10. Kucher, P., Snytyuk, V. (2009). Formalizaziya zadachi komplektuvannya I evolyuziyni aspekti ee resheniya. Isskustvenniy intellekt, 4, 268–273.
11. Volkovitch, V. L., Voloshyn, A. F. (1993). Modeli i metodi optimizazii nadezhnosti slognikh system. K.: Nauk. dumka, 312.
12. Chernoruzkiy, I. G. (2005) Medodi prinyatiya resheniy. SPb.: BHV, 416.
13. Voloshyn, O. F., Maschenko, S. O. (2006). Teoriya prinyatiya resheniy. Kiev: Kievskiy universitet, 304.
14. Michalevitch, V. C., Volkovitch, V. L. (1982). Vichislitelnie metodi issledovaniya i proektirovaniya slognikh system. Moscow: Nauka, 286.
15. Holland, J. H. (1994). Adaptation in natural and artificial systems. An introductory analysis with application to biology, control and artificial intelligence. London: Bradford book edition, 211.
16. Michalewitcz, Z. (1996). Genetic Algorithms+Data Structures=Evolution Programs. Springer Verlag, Berlin, Heidelberg, New-York, 387. doi: 10.1007/978-3-662-03315-9
17. Rechenberg, I. (1994). Evolutionsstrategie "94". Stuttgart-Bad GannStatt: Frommann Halzboog, 434.
18. Timchenko, A. A., Rodionov, A. A. (1991). Osnovi informatiki sistemnogo proektirovaniya objektov novoy techniki. Kiev: Naukova dumka, 231.
19. Larichev, O. I. (2003). Teoriya i metodi prinyatiya resheniy. Moscow: Logos, 392.
20. Saati, T., Kerns, K. (1991). Analiticheskoe planirovanie organizazii sistem. Moscow: Radio i svyaz, 224.

SELECTION OF METROLOGICAL SUPPORT OF MANAGEMENT OF COMPLEX FOUNDRY OBJECTS WITH HARDLY MEASURABLE PARAMETERS (p. 41-47)

Gennady Oborskyi, Alexandr Stanovskyi, Igor Prokopovich, Marianna Dukhanina

It is shown that the parameters of foundry objects are usually hardly measurable, which creates serious metrological problems in the organization of the ACS for such processes. The system of selection of the metrological support, including obtaining the time-space mapping from the object and its convolution to the measurement result based on the classification of the measurement methods using Kohonen neural networks with an open set of classes is proposed.

On the example of sand casting process, the operation of the system of selection of measurement methods for various manufacturing process stages with six-tuple of discrete characteristics of the measurement object at the system input and one of the known methods at the output is shown.

The system provides for the expansion of the known list of measurement methods, thereby determining the direction of the scientific search for researchers-metrologists.

Keywords: complex systems, metrological support, hardly measurable parameters, Kohonen map.

References

1. Tonkonogiy, V. M. (2004). Upravlenie ob'edinennyimi tehnologicheskimi processami. Trudy Odesskogo politehnicheskogo universiteta, 1(21), 96–101.
2. Tonkonogiy, V. M. (2004). Trehkonturnaya ASU naneseniem ionno-plazmennogo pokryitiya na rezhuschiy instrument. Avtomatika. Avtomatizatsiya. Elektrotehnicheskie kompleksy i sistemy, 1 (13), 185–189.
3. Lysenko, T. V. (2004). Upravlenie kachestvom otlivok. Trudy Odesskogo politehnicheskogo universiteta, 1 (21), 20–22.

4. Tonkonogiy, V. M., Perperi, L. M. (2004). Kompozitsionnyiy gisterezis pri postroenii modeley tehnologicheskih protsessov. Materialy XI seminara «Modelirovanie v prikladnyh nauchnyh issledovaniyah», 11–12.
5. Oborskiy, G. A., Ryazantsev, V. M., Shihireva, Yu. V. (2013). Izmerenie parametrov vnutrennih teplovyih protsessov po infrakrasnyim videopotokam ot poverhnosti detali. Suchasni tehnologii v mashinobuduvanni: zbirnik naukovih prats, 8, 124–132.
6. Stanovskiy, P. A., Bovnegra, L. V., Shihireva, Yu. V. (2012). Avtomatizirovannyiy monitoring protekaniya tehnologicheskih protsessov s pomoschyu nizkochastotnyih videopotokov. Zbirnik naukovih prats Kirovogradskogo natsionalnogo tehnichnogo universitetu, 25 (Part II), 70–74.
7. Bovnegra, L. V., Shihireva, Yu. V., Nosenko, T. I. (2012). Metod otsenki iznosa rezhuschego instrumenta s pomoschyu parabolicheskogo preobrazovaniya videopotoka so shodyaschey struzhki. Zbirnik naukovih prats institutu problem modelyuvannya v energetitsi im. G.S.Puhova, 65, 60–67.
8. Mescheryakov, V. I. (1990). Ustroystvo obrabotki izobrazheniy vyisokotemperaturnyih teplofizicheskih poley. Trudy otraslevogo soveschaniya «Opticheskie metody i sposoby obrabotki dannyh teplofizicheskih i neyronnofizicheskih protsessov v elementah energoelektroniki», 12–13.
9. Shihireva, Yu. V., Bovnegra, L. V. (2012). Intellektualnoe informatsionnoe obespechenie teplovyih izmereniy. Materialy XX nauchno-tehnicheskogo seminara «Modelirovanie v prikladnyih nauchnyih issledovaniyah», 32–34.
10. Bovnegra, L. V., Stanovskiy, P. A., Shihireva, Yu. V. (2012). Parabolicheskoe preobrazovanie tsvetnogo videopotoka. Materialy XX nauchno-tehnicheskogo seminara «Modelirovanie v prikladnyih nauchnyih issledovaniyah», 28–32.
11. Stanovskiy, A. L., Prokopovich, I. V., Duhanina, M. A. (2013). Nerazrushayuschiy metod izmereniya plotnosti fragmentov peschanyih liteynyih form. Zbirnik naukovih prats: «Informatsiyni tehnologii v osviti, nautsi ta virobnitstvi», 4 (5), 104–110.
12. Stanovskiy, A. L., Prokopovich, I. V., Duhanina, M. A. (2012). Fizicheskiy metod otsenki plotnosti otlivok. Materialy XIII Mizhnarodnoi naukovo-tehnichnoi konferentsii «Nemetalevi vkraplennya i gazi u livarnih splavah», 33–34.
13. Stanovskiy, A. L., Prokopovich, I. V., Duhanina, M. A. (2013). Primenenie strukturnyih identifikatorov sostoyaniya v liteynom proizvodstve. Materialy mezhdunarodnoy nauchno-prakticheskoy konferentsii «Lit'e. Metallurgiya. 2013», 193–194.
14. Stanovskiy, P. A., Bovnegra, L. V., Shihireva, Yu. V. (2012). Parabolicheskoe preobrazovanie polnotsvetnogo videopotoka ot teplovizora. Pratsi Odeskogo politehnichnogo universitetu, 2 (39), 67–71.
15. Kallan, R. (2001). Osnovnyie kontseptsii neyronnyih setey. Moscow: Viljams, 288.
16. Medvedev, V. S., Potemkin, V. G. (2002). Neyronnyie seti. Moscow: Dialog-MIFI, 496.
17. Naleva, G. V. (2005). Diagnostika latentnyih narusheniy protsessa polucheniya kompozitnyih instrumentalnyih materialov. Teoriya i praktika protse-siv. Podribnennya, rozdilennya, zmishuvannya i uschilnennya: Zbirnik naukovih prats, 11, 71–78.
18. Naleva, G. V. (2004). Ekspertnaya diagnostika skryityih povrezhdeniy. Trudy XII seminara «Modelirovanie v prikladnyih nauchnyih issledovaniyah», 61–62.
19. Stanovskiy, A. L., Saveleva, O. S., Prokopovich, I. V., Toropenko, A. V., Duhanina, M. A. (2014). Development of heat-mass exchange optimization methods using fractal convolutions of computer tomograms. Eastern-European Journal of Enterprise Technologies, 5/5(71), 4–9. doi: 10.15587/1729-4061.2014.27978
20. Oborskiy, G. A., Stanovskiy, A. L., Prokopovich, I. V. (2013). Upravlenie slozhnyimi ob'ektami liteynogo proizvodstva s pomoschyu prostranstvenno-vremennyih otobrazheniy. Materialy XXI nauchno-tehnicheskogo seminara «Modelirovanie v prikladnyih nauchnyih issledovaniyah», 2, 100–102.

PREDICATE ALGEBRA APPLICATION FOR AIR OBJECTS RECOGNITION BY THE RADAR SPECTRAL IMAGE (p. 48-53)

Volodymyr Zhyrnov, Svetlana Solonskaya

The possibility of predicate algebra application for air objects recognition by the radar spectral image is analyzed in the paper. The author examines the human-operator's decision-making algorithms to analyze the features of clutter and air objects signals spectra. The spectral pattern is described by the predicate on the set of spectral channels, which have exceeded a certain threshold value. Features-predicates, by a combination of which the instantaneous spectrum uniquely correlates with one of the spectrum types, are introduced to identify the spectral types. Air objects recognition is held by solving the developed equations of predicate operations. Based on the obtained equations, functional diagram of the automatic determination of the spectral types is constructed.

As a result it is shown that the application of mathematical tools of predicate algebra allows automatic and real-time performance of all operations on the identification of features and radar recognition of air objects by the spectral image of the received signals.

Keywords: predicate algebra, air objects recognition, spectral image, clutter, human-operator.

References

1. Russel, S., Norvig, P. (2006). Artificial intelligence. A modern approach. Second Edition. Williams, 1410.
2. Luger, G. F. (2005). Artificial intelligence: structures and strategies for complex problem-solving. 4 edition. Williams, 864.
3. Robinson, J. (1965). A machine-oriented logic based on the resolution principle. Journal of the ACM (JACM), 12 (1), 23–41.
4. Bondarenko, M. F., Shabanov-Kushnarenko, Yu. P. (2007). Teoriya intellekta. Uchebnik. Harkov: izd-vo SMIT, 576.
5. Bondarenko, M. F., Chikina, V. A. (1998). O metode matematicheskogo opisaniya morfologicheskih otnosheniy i ih shemnoy realizatsii. Problemy bioniki, 48, 3–11.
6. Bondarenko, M. F., Shabanov-Kushnarenko, Yu. P. (1987). Ob abstraktnom opredelenii algebry konechnyih predikatov. Problemy bioniki, 39, 3–12.
7. Shabanov-Kushnarenko, S. Yu. (1994). Komparatornaya identifikatsiya protsessov mnogomernoy kolichestvennoy otsenki. Hark. tehn. un-t radioelektroniki, 230.
8. Bondarenko, M. F., Shabanov-Kushnarenko, S. Yu. (1989). O lineynyh predikatah. Problemy bioniki, 43, 3–7.
9. Bondarenko, M. F. (1983). Issledovanie sistemy aksiom algebry konechnyih predikatov. ASU i pribory avtomatiki, 66, 120–129.
10. Borodaenko, D. N. (2001). Raspoznavanie obrazov. Raspoznavanie obrazov i iskusstvennyiy intellekt. Available at: http://www.ocrai.narod.ru (Last accessed: 26.12.2007).
11. Gorelik, A. L., Skripkin, V. A. (2004). Metody raspoznavaniya. Mosow: Vyssh. shk, 261.
12. Slagle, J. R., Gardiner, O. A., Kyungsook, N. (1990). Knowledge specification on an expert system. IEEE Expert, 5 (4), 29–38. doi: 10.1109/64.58019
13. Schank, R. (1972). Conceptual Dependency: a Theory of Natural Language Understanding Cognitive. Cognitive Psychology, 3 (4), 552–631. doi: 10.1016/0010-0285(72)90022-9
14. Manning, C. D., Raghavan, P., Schütze, H. (2008). Introduction to Information Retrieval. Cambridge University Press, 496.
15. Zhuravlev, Yu. I. (2005). Ob algebraicheskom podhode k resheniyu zadach raspoznavaniya ili klassifikatsii. Problemy kibernetiki. Moscow: Nauka, 33, 5–68.
16. Solonskaya, S. V. (2004). O vozmozhnosti ispolzovaniya algebry predikatov dlya klassifikatsii vozdushnyh ob'ektov po radiolokatsionnomu spektralnomu izobrazheniyu. Radiotehnika, 139, 73–76.
17. Zhyrnov, V. V., Solonskaya, S. V. (2005). Intellektualnaya sistema radioloka-tsionnogo obnaruzheniya malozametnyh vozdushnyh ob'ektov. Radioelektronika i informatika: Nauchno-tehnicheskiy zhurnal, 3, 134–138.
18. Zhyrnov, V. V., Solonskaya, S. V. (2006). Raspoznavanie radiolokatsionnyh otmetok po spektralnomu izobrazheniyu s adaptivnymi vesovymi koeffitsientami. Radioelektronika i informatika: Nauchno-tehnicheskiy zhurnal, 1, 121–124.
19. Teyz, A., Gribomon, P. (1990). Logicheskiy podhod k iskusstvennomu intellektu: ot klassicheskoy logiki k logicheskomu programmirovaniyu. Moscow: Mir, 432.

AN ALGORITHM FOR OPERATING AND OPTIMIZING INFORMATION FLOWS IN WIRELESS SENSOR NETWORKS (p. 53-63)

Pavel Galkin

The paper suggests a principle for splitting a wireless sensor network into piconetworks. The approach allows using advantages of clusterization. A criteria matrix is suggested as a determiner of factors that would impact the intensity of information flows. The devised algorithm facilitates managing the information flow through network nodes. The ant algorithm would be modified in two ways. The first approach is based on an algorithm of managing data transmission through the node of a wireless sensor network and additional exploiting of the node buffer. The second approach to modification suggests introduction of a semaphore principle. The two modifications may be considered as separate modified ant algorithms. The suggested ant algorithm with the use of semaphores can be applied for optimizing routes and traffic as well as for other tasks within large dimensions of search areas. The semaphore method would be used to restrict access to some nodes: in the first case—through a fixed number of flows, while in the second case—through nodes receiving alarm signaling. The research findings can be applied in designing wireless sensor networks.

Keywords: algorithm for operating and optimizing, information flows, wireless sensor networks, piconetwork.

References

1. Voskov, L. S., Komarov, M. M. (2012). Improvement of service quality in stationary wireless sensor networks with Autonomous power sources. Quality. The innovation. Education, 1, 51–55.
2. Kucheryavyiy, A. E., Ermoshkina, D. D. (2011). Classification of wireless sensor networks for load types. T-Comm: Telecommunications and transport, 5 (7), 64–65.
3. Kudryashov, S. V. (2008). Optimal routing of data flows in wireless sensor networks. Journal of Computer and Systems Sciences International, 47 (2), 282–295. doi: 10.1134/s1064230708020159
4. Akimov, A. A., Bogatyirev, V. E., Finogeev, A. G. (2010). System decision support based on wireless sensor networks using data mining. Proceedings of the International Symposium on Reliability and quality, 1, 225–229.
5. Krutolapov, A. S. (2013). Ensuring quality of service in information exchange networks. Bulletin VI state fire service of EMERCOM of Russia, Voronezh, 1, 18–22.
6. Anitha, C. L., Sumathi, R. (2014). Comparative Analysis of Data Aggregation Algorithms Under Various Architectural Models in Wireless Sensor Networks. BIJIT-BVICAM's International Journal of Information Technology, 6 (2), 757–763.
7. Gritsyuk, V. I. (2013). Modified sustainable methods of model selection. Bulletin of NTU "KHPI", 8 (982), 25–28.
8. Borisenko, A. S. (2013). Modeling and calculation of antenna for Zigbee network. Bulletin of National technical University KHPI. Collection of scientific papers. Series: Mathematical modelling in engineering and technology, 37 (1010), 17–26.
9. Borisenko, A. S. (2013). Methods of optimization for mesh network in ZigBee. Eastern-European Journal of Enterprise Technologies, 1/9(61), 24–29. Available at: http://journals.uran.ua/eejet/article/view/9497/8265
10. Ageev, D. V. (2013). Overlay telecommunication networks synthesis taking into account data units and using multilayer graph. Eastern-European Journal of Enterprise Technologies, 4/9(64), 49-51. doi: http://journals.uran.ua/eejet/article/view/16393/13894
11. Chuang, P.-J., Jiang, Y.-J. (2014). Effective neural network-based node localisation scheme for wireless sensor networks. Wireless Sensor Systems, IET, 4 (2), 97–103. doi: 10.1049/iet-wss.2013.0055
12. Kumar, D. (2014). Performance analysis of energy efficient clustering protocols for maximising lifetime of wireless sensor networks. Wireless Sensor Systems, IET, 4 (1), 9–16. doi: 10.1049/iet-wss.2012.0150
13. Muhammad, A. K., Asfandyar, K., Said, K. S., Azween, A. (2013). An Energy Efficient Color Based Topology Control Algorithm for Wireless Sensor Networks. Wireless Sensor Networks, 5 (1), 1–7. doi: 10.4236/wsn.2013.51001
14. Khosravi, H. (2012). Optimal Node Scheduling for Desired Percentage of Coverage in Wireless Sensor Networks. Wireless Sensor Networks, 4 (5), 127–132. doi: 10.4236/wsn.2012.45018
15. Sudha, M. N., Valarmathi, M. L., Rajsekar, G., Mathew, M. K., Dineshraj, N., Rajbarath S. (2009). Minimization of Collision in Energy Constrained Wireless Sensor Network. Wireless Sensor Networks, 1 (4), 350–357. doi: 10.4236/wsn.2009.14043
16. Damaso, A., Rosa, N., Maciel, P. (2014). Reliability of Wireless Sensor Networks. Sensors, 14 (9), 15760–15785. doi: 10.3390/s140915760
17. Hong, S.-H., Kim, B.-K., Eom, D.-S. (2010). Localization algorithm in wireless sensor networks with network mobility. IEEE Transactions on Consumer Electronics, 55 (4), 1921–1928. doi: 10.1109/TCE.2009.5373751
18. Ha, I., Djuraev, M., Ahn, B. (2014). An Energy-Efficient Data Collection Method for Wireless Multimedia Sensor Network. International Journal of Distributed Sensor Networks, 2014, 1–8. doi: 10.1155/2014/698452
19. Zhang, J., Jiang, H., Jiang, H., Chen, C. (2014). Energy-Efficient Policy Based on Cross-Layer Cooperation in Wireless Communication. International Journal of Distributed Sensor Networks, 2014, 1–11 doi: 10.1155/2014/831686
20. Zhong, X., Xu, C.-Z. (2007). Energy-Efficient Wireless Packet Scheduling with Quality of Service Control, 6 (10), 1158–1170. doi: 10.1109/TMC.2007.1012
21. Rehman, R. A., Kim, B.-S. (2014). L2ER: Low-Latency and Energy-Based Routing Protocol for Cognitive Radio Ad Hoc Networks. International Journal of Distributed Sensor Networks, 2014, 1–9. doi: 10.1155/2014/963202
22. Lemeshko, A. V., Kinan, A. (2014). Features of the mathematical description of the processes multicast routing flow models. Proceedings of the North-Caucasian branch of the Moscow technical University of communications and Informatics, 1, 94–98. Available at: http://skf-mtusi.ru/fileadmin/page_res/nr/sb2014-1.pdf
23. Lemeshko, A. V., Evseeva, O. Yu., Garkusha, S. V. (2013). The results of the study of tensor models for multipath routing with quality of service in telecommunication networks. Bulletin of the South Ural state University. Series: Computer technology, management, electronics, 13 (4), 38–54.
24. Lemeshko, A. V., Vavenko, T. V. (2012). Improvement threading model multipath routing based on load balancing. Problems of telecommunications, 1 (6), 12–29. Available at: http://pt.journal.kh.ua/2012/1/1/121_lemeshko_multipath.pdf
25. Shah-Mansouri, V., Mohsenian-Rad, A. H., Wong, V. W. S. (2009). Lexicographically Optimal Routing for Wireless Sensor Networks With Multiple Sinks. IEEE Transactions on Vehicular Technology, 58 (3), 1490–1500. doi: 10.1109/TVT.2008.928898
26. Kovalenko, I. G. (2014). Methods of increasing the duration of the operation of wireless sensor networks with excessive number of nodes. Telecommunication and Information Technology, 1, 44–54. Available at: http://www.dut.edu.ua/uploads/p_130_10609916.pdf#page=44
27. Rusakov, A. M. (2010). Model measurement information flow control sensors in wireless sensor networks. Industrial process control and Controllers, 4, 37–39.
28. Poyda, A. A., Zhizhin, M. N., Medvedev, D. P., Moskvitin, A. E., Andreev, A. V. (2011). Mechanics, management and informatics, 5, 162–182.
29. Muravev, S. V., Tarakanov, E. V. (2012). Data transmission in wireless sensor networks with the priorities based on preference aggregation. Bulletin of the Tomsk Polytechnic University, 5, 111–116.
30. Novoselov, S. P., Rak, E. V. (2013). The method of constructing routing tables for wireless sensor network. Technology Audit and Reserves Production, 1 (10), 42–44. Available at: http://journals.uran.ua/tarp/article/view/12958/10847
31. Zou, P., Liu, Y. (2014). Low energy WSN data aggregation algorithm based on improved aggregation tree model. International Journal of Sensor Networks, 15(3), 149-156. doi: 10.1504/ijsnet.2014.063895
32. Xiao, P., He, J., Chen, Y., Fu, Y. (2013). A new trusted roaming protocol in wireless mesh networks. International Journal of Sensor Networks, 14 (2), 109–119. doi: 10.1504/IJSNET.2013.056610
33. Fard, E. S., Nadimi, M. H. (2014). Routing Protocol of Wireless Sensor Network (ED-LEACH). International Journal of Sensors and Sensor Networks, 2 (3), 26–30.
34. Lim, S. Y., Choi, Y.-H. (2013). Malicious Node Detection Using a Dual Threshold in Wireless Sensor Networks. Journal of Sensor and Actuator Networks, 2 (1), 70–84. doi: 10.3390/jsan2010070

35. Chen, J., Xu, W., He, S., Sun, Y., Thulasiraman, P., Shen, X. (2010). Utility-based asynchronous flow control algorithm for wireless sensor networks. IEEE Journal on Selected Areas in Communications, 28 (7), 1116–1126. doi: 10.1109/jsac.2010.100916
36. Homayounnejad, S., Bagheri, A., Ghebleh, A. (2011). AAA: Asynchronous Adaptive Algorithm to solve Max-Flow Problem in wireless sensor networks. MIPRO, 2011 Proceedings of the 34th International Convention, 440–445.
37. Moon, S.-H., Han, S.-J., Park, S. (2013). Energy-efficient flow control and routing for clustered wireless sensor networks. The International Conference on Information Networking (ICOIN), 83–88. : 10.1109/icoin.2013.6496356
38. Galkin, P. V. (2014). Analysis of energy consumption nodes wireless sensor networks. ScienceRise, 2 (2), 55–61. doi: 10.15587/2313-8416.2014.27246
39. Galkin, P. V. (2014). Analysis of models and optimization of information collection in wireless sensor networks. Eastern-European Journal of Enterprise Technologies, 5/9(71), 24–30. doi: 10.15587/1729-4061.2014.28008
40. Kureychik, V. M., Kazharov, A. A. (2011). Using Swarm intelligence in solving NP-hard problems. News SFU. Technical science, 7, 30–36.
41. Diduk, V. A., Kovalenko, A. M., Trofimenko, E. G. (2011). Developing an algorithm directed routing for wireless sensor networks. Proceedings of the Odessa Polytechnic University, 1 (35), 151–154.
42. Mochalov, V. A. (2013). Hybrid synthesis algorithm biconical structure wireless sensor network. T-COMM: telecommunications and transport, 7 (10), 72–77.
43. Putrya, F. M., Medvedev I. A. (2010). Hardware methods to synchronize threads in a multi-core computing cluster. All-Russian scientific-technical conference “problems of development of perspective micro – and nanoelectronic systems (MES)”. Proceedings of , 1, 346–351.
44. Galkin, P. V. (2011). Improving the efficiency of information collection in wireless sensor networks. Economy, science production, proceedings of the, Moscow, Publishing house “Moscow state open University C. S. Chernomyrdin, 42–44.
45. Galkin, P. V. (2013). Model of wireless sensor networks based on hypergraph. 17th international youth forum “Radioelectronics and youth in the XXI century”, The proceedings of the forum, 4, 71–72.
46. Vyibornova, A. I. (2014). Investigation of the characteristics of traffic in wireless sensor networks. Dissertation, 183.
47. Dorigo, M., Stutzle, T. (2004). Ant Colony Optimization. Cambridge, MIT Press, Book, 321.
48. Shtovba, S. D. (2007). Design of fuzzy systems by means of MATLAB. Hotline, Telecom, Book, 288.
49. Recommendation, Y1541 Network performance objectives for IP-based services (2011). ITU-T, 1–66.