ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

DOI: 10.15587/1729-4061.2017.119493

DEVELOPMENT OF A METRIC AND THE METHODS FOR QUANTITATIVE ESTIMATION OF THE SEGMENTATION OF BIOMEDICAL IMAGES (p. 4–11)

Oleh Berezsky
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0001-9931-4154

Mykhailo Zarichnyi
Ivan Franko National University of Lviv, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-6494-2289

Oleh Pitsun
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0003-0280-8786

We analyzed modern digital microscopy. In order to categorize digital microscopy, the following criteria are introduced: level of automation, software level, the level of application of network technologies. To quantitatively estimate the quality of image segmentation, we devised the technique based on a metric approach using the Fréchet and Hausdorff metrics. Modern algorithms for calculating the Hausdorff and Fréchet distances were analyzed.

We have introduced the Fréchet distance between trees. It was proven that the Fréchet distance between trees is a metric. We devised a method for estimating a distance between trees of the non-convex regions, based on finding skeletons of regions and determining the distance between them. The algorithm for finding the Hausdorff distance between the non-convex regions is described. We constructed the algorithm for finding a distance between the non-convex regions based on the Fréchet metric between trees.

The developed algorithms are included into a hybrid intelligent system for automated microscopy, which is designed to process histological and cytological images.

The algorithms were tested using the results of segmentation of histologic and cytologic images from a database as an example.

Keywords: Fréchet metric, Hausdorff metric, non-convex regions, biomedical images, segmentation error.

References

1. Medoviy, V. S. (2009). Robotizirovannaya mikroskopiya vnedryaet standarty kachestva laboratornyh analizov. Standartizatsiya, 3, 33–37.
2. Medoviy, V. S., Sokolinskiy, B. Z., Markellov, V. V., Fedorova, D. S., Fedorov, I. V. (2011). Razrabotka i ispytanie avtomatizirovannogo kompleksa mikroskopii. Opticheskiy zhurnal, 78 (1), 66–73.
3. Medoviy, V. S., Pyatnitskiy, A. M., Sokolinskiy, B. Z. et. al. (2012). Sovremenniy vozmozhnosti robotizirovannoy mikroskopii v avtomatizatsii analizov i laboratornoy telemeditsine (analiticheskiy obzor). Klinicheskaya laboratornaya diagnostika, 10, 32–43.
4. Life Science Source. Available at: https://www.biovision.com
5. Tsenovoy list. Programmno-apparatnyy kompleks dlya mikroskopii. OOO «Nauchno-proizvodistvennaya kompaniya «Zenit». Available at: http://www.zenit-npk.ru/fprice/info/11
6. Skaniruyushchie mikroskopy-analizatory MEKOS-TS2. Skaniruyushchie mikroskopy-analizatory. Available at: http://msk.all-gorod.ru/product/4863699-skaniruyuschie-mikroskopy-analizatory-mekos-c2
7. Szeliski, R. (2010). Computer Vision: Algorithms and Applications. Springer, 812. doi: 10.1007/978-1-84882-935-0
8. Blum, H. A. Dunn, W. W. (1967). Transformation for extracting new descriptors of shape. Models for the Perception of Speech and Visual Form, 5, 362–380.
9. Koltsov, P. P., Osipov, A. S., Kutsaev, A. S., Kravchenko, A. A., Kotovich, N. V., Zaharov, A. V. (2015). On the formation of structures in nonequilibrium media in the resonant three-wave interaction. Computer Optics, 39 (4), 542–556. doi: 10.18287/0134-2452-2015-39-4-542-556
10. Berezskiy, O. N., Berezskaya, E. N. (2015). Kolichestvennaya otsenka kachestva segmentatsii izobrazheniy na osnove metric. Upravlyayushchie sistemy i mashiny, 6, 59–65.
11. Lopez, M. A., Reisner, S. (2005). Hausdorff approximation of convex polygons. Computational Geometry, 32 (2), 139–158. doi: 10.1016/j.comgeo.2005.02.002
12. Alt, H., Scharf, L. (2008). Computing the hausdorff distance between curved objects. International Journal of Computational Geometry & Applications, 18 (04), 307–320. doi: 10.1142/s0218195908002647
13. Chew, L. P., Kedem, K. (1998). Getting around a lower bound for the minimum Hausdorff distance. Computational Geometry, 10 (3), 197–202. doi: 10.1016/s0925-7721(97)00032-1
14. Knauer, C., Scherfenberg, M. (2011). Approximate nearest neighbor search under translation invariant hausdorff distance. International Journal of Computational Geometry & Applications, 21 (03), 369–381. doi: 10.1142/s0218195911003706
15. Alvarez, V., Seidel, R. (2010). Approximating the minimum weight spanning tree of a set of points in the Hausdorff metric. Computational Geometry, 43 (2), 94–98. doi: 10.1016/j.comgeo.2009.04.005
16. Mosig, A., Clausen, M. (2005). Approximately matching polygonal curves with respect to the Fréchet distance. Computational Geometry, 30 (2), 113–127. doi: 10.1016/j.comgeo.2004.05.004
17. Buchin, K., Buchin, M., Wenk, C. (2008). Computing the Fréchet distance between simple polygons. Computational Geometry, 41 (1-2), 2–20. doi: 10.1016/j.comgeo.2007.08.003
18. Rote, G. (2007). Computing the Fréchet distance between piecewise smooth curves. Computational Geometry, 37 (3), 162–174. doi: 10.1016/j.comgeo.2005.01.004
19. Schlesinger, M. I., Vodolazskiy, E. V., Yakovenko, V. M. (2016). Fréchet Similarity of Closed Polygonal Curves. International Journal of Computational Geometry & Applications, 26 (01), 53–66. doi: 10.1142/s0218195916500035
20. Ahn, H.-K., Knauer, C., Scherfenberg, M., Schlipf, L., Vigneron, A. (2012). Computing the discrete fréchet distance with imprecise input. International Journal of Computational Geometry & Applications, 22 (01), 27–44. doi: 10.1142/s0218195912600023

21. Cook, A. F., Driemel, A., Sherette, J., Wenk, C. (2015). Computing the Fréchet distance between folded polygons. Computational Geometry, 50, 1–16. doi: 10.1016/j.comgeo.2015.08.002
22. Gudmundsson, J., Smid, M. (2015). Fast algorithms for approximate Fréchet matching queries in geometric trees. Computational Geometry, 48 (6), 479–494. doi: 10.1016/j.comgeo.2015.02.003
23. Alt, H., Godau, M. (1995). Computing the fréchet distance between two polygonal curves. International Journal of Computational Geometry & Applications, 05 (01n02), 75–91. doi: 10.1142/s0218195995000064
24. Chambers, E. W., Colin de Verdière, É., Erickson, J., Lazard, S., Lazarus, F., Thite, S. (2010). Homotopic Fréchet distance between curves or, walking your dog in the woods in polynomial time. Computational Geometry, 43 (3), 295–311. doi: 10.1016/j.comgeo.2009.02.008
25. Berezsky, O. (2016). Frechet Metric for Trees. 2016 IEEE First International Conference on Data Stream Mining & Processing (DSMP). Lviv, 213–217. doi: 10.1109/dsmp.2016.7583543
26. Berezsky, O., Pitsun, O. (2017). Computation of the minimum distance between non-convex polygons for segmentation quality evaluation. 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT). Lviv, 183–186. doi: 10.1109/stc-csit.2017.8098764
27. Atallah, M. J., Ribeiro, C. C., Lifschitz, S. (1990). Computing Some Distance Functions Between Polygons. Computer Science Technical Reports, 9.
28. Cormen, T. H., Leiserson, C. E., Rivest, R. L., Stein, C. (2009). Introduction to Algorithms. MIT Press, 1312.
29. Berezky, O. M., Pitsun, O. Yo., Verbovyi, S. O., Datsko, T. V. (2017). Relational database of intelligent automated microscopy system. Scientific Bulletin of UNFU, 27 (5), 125–129. doi: 10.15421/40270525

DOI: 10.15587/1729-4061.2017.119264

DEVELOPMENT OF THE METHOD FOR DYNAMIC REGULARIZATION OF SELECTED ESTIMATES IN THE CORRELATION MATRICES OF OBSERVATIONS (p. 11–18)

Valeriy Skachkov
Military Academy, Odessa, Ukraine
ORCID: http://orcid.org/0000-0003-2432-4176

Victor Chepkyi
Military Academy, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-0637-9432

Hennadii Bratchenko
Odessa State Academy of Technical Regulation and Quality, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-0314-8188

Helena Tkachuk
Military Academy, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-3434-2709

Nadiia Kazakova
Odessa State Academy of Technical Regulation and Quality, Odessa, Ukraine
ORCID: http://orcid.org/0000-0003-3968-4094

The problem of formation of sample estimates of correlation matrices of observations by the «computational stability – consistency» criterion is considered. The problem of zero eigenvalues inherent in the problem of static regularization of sample estimates of correlation matrices is revealed. The solution of this problem by the static regularization method leads to the fact that the sample estimate of the regularized matrix is similar, but not identical to the original one in terms of consistency. Therefore, the problem of investigating the regularization of the sample estimate of the correlation matrix with respect to the solution of inverse problems under a priori uncertainty is actualized. In such a situation, the regularizing parameter of the inverse problem should be updated in real time as the input data arrive. To solve the revealed problem, an alternative method of dynamic regularization is proposed. In the study, the computational stability, convergence and consistency of sample estimates of correlation matrices of observations under a priori uncertainty are analyzed. The optimum function of dynamic regularization of sample estimates of correlation matrices of observations is obtained, the evaluation of which does not require prediction data and additional computing resources to search for the optimum value of the regularization parameter. The numerical results confirming the main findings are presented. The developed method of dynamic regularization of sample estimates of correlation matrices is an alternative to static regularization and allows resolving the «computational stability – consistency» contradiction when forming sample estimates of correlation matrices. Unlike static regularization, the procedure of dynamic regularization unambiguously connects the optimum dynamic regularization function with the matrix dimension and the size of the observed sample, which allows eliminating the problem of choosing the regularization parameter under a priori uncertainty with respect to the input data of the computational problem. In addition, the dynamic regularization method is characterized by simplicity of computational operations in real time in the absence of a priori information.

Application of the method of dynamic regularization of sample estimates of correlation matrices extends the capabilities of a wide class of information systems that are designed to solve ill-posed inverse problems under a priori uncertainty.

Keywords: static regularization, dynamic regularization, stability, convergence, consistency of estimates, correlation matrix.

References

1. Greshilov, A. A. (2009). Nekorrektnye zadachi tsifrovoy obrabotki informatsii i signalov. Moscow: Universitetskaya kniga, 360.
2. Vasin, V. V., Ageev, A. L. (1993). Nekorrektnye zadachi s apriornoy informatsiey. Ekaterinburg: Nauka, 264.
3. Terebizh, V. Yu. (2005). Vvedenie v statisticheskuyu teoriyu obratnyh zadach. Moscow: FIZMATLIT, 376.
4. Balanis, C. A., Ioannides, P. I. (2007). Introduction to Smart Antennas. Synthesis Lectures on Antennas, 2 (1), 1–175. doi: 10.2200/s00079ed1v01y200612ant005
5. Wirth, W.-D. (2013). Radar Techniques Using Array Antennas. London: The Institution of Engineering and Technology, 460. doi: 10.1049/pbra026e
6. Lekhovitskiy, D. I., Atamanskiy, D. V., Rachkov, D. S., Semenyaka, A. V. (2015). Otsenka energeticheskih spektrov otrazheniy v impul'snyh doplerovskih meteoradiolokatorah. Ch. 1. Raznovidnosti algoritmov spektral'nogo otsenivaniya. Izvestiya vuzov. Radioelektronika, 58 (12), 3–30.

7. Abramovich, Y. I., Spencer, N. K., Johnson, B. A. (2010). Band-Inverse TVAR Covariance Matrix Estimation for Adaptive Detection. IEEE Transactions on Aerospace and Electronic Systems, 46 (1), 375–396. doi: 10.1109/taes.2010.5417169
8. El-Zooghby, A. (2005). Smart antenna engineering. Artech House, 330.
9. Demmel, J. W. (1997). Applied Numerical Linear Algebra. University of California. Berkeley, California. doi: 10.1137/1.9781611971446
10. Abramovich, Yu. P. (1981). Regulyarizovannyy metod adaptivnoy optimizatsii fil'trov po kriteriyu maksimuma otnosheniya signal/pomekha. Radiotekhnika i elektronika, 26 (3), 543–551.
11. Cheremisin, O. P. (1982). Effektivnost' adaptivnogo algoritma s regulyarizatsiey vyborochnoy korrelyatsionnoy matritsy. Radiotekhnika i elektronika, 27 (10), 1933–1942.
12. Goodman, N. R. (1963). Statistical Analysis Based on a Certain Multivariate Complex Gaussian Distribution (An Introduction). The Annals of Mathematical Statistics, 34 (1), 152–177. doi: 10.1214/aoms/1177704250
13. Greshilov, A. A., Lebedev, A. L., Plohuta, P. A. (2008). Mnogosignal'naya pelengatsiya istochnikov radioizlucheniya na odnoy chastote kak nekorrektnaya zadacha. Uspekhi sovremennoy radioelektroniki, 42, 30–46.
14. Liu, C.-S. (2012). Optimally scaled vector regularization method to solve ill-posed linear problems. Applied Mathematics and Computation, 218 (21), 10602–10616. doi: 10.1016/j.amc.2012.04.022
15. Fuhry, M., Reichel, L. (2011). A new Tikhonov regularization method. Numerical Algorithms, 59 (3), 433–445. doi: 10.1007/s11075-011-9498-x
16. Geman, D., Chengda Yang. (1995). Nonlinear image recovery with half-quadratic regularization. IEEE Transactions on Image Processing, 4 (7), 932–946. doi: 10.1109/83.392335
17. Shou, G., Xia, L., Jiang, M., Wei, Q., Liu, F., Crozier, S. (2008). Truncated Total Least Squares: A New Regularization Method for the Solution of ECG Inverse Problems. IEEE Transactions on Biomedical Engineering, 55 (4), 1327–1335. doi: 10.1109/tbme.2007.912404
18. Brezinski, C., Rodriguez, G., Seatzu, S. (2008). Error estimates for linear systems with applications to regularization. Numerical Algorithms, 49 (1-4), 85–104. doi: 10.1007/s11075-008-9163-1
19. Cetin, M., Karl, W. C. (2001). Feature-enhanced synthetic aperture radar image formation based on nonquadratic regularization. IEEE Transactions on Image Processing, 10 (4), 623–631. doi: 10.1109/83.913596
20. Voskoboynikov, Yu. E., Muhina, I. N. (1999). Regulyariziruyushchiy algoritm vosstanovleniya signalov i izobrazheniy s utochneniem lokal'nyh otnosheniy shum/signal. Avtometriya, 4, 71–83.
21. Van Tris, G. (1972). Teoriya obnaruzheniya, otsenok i modulyatsii. Vol. 1. Teoriya obnaruzheniya, otsenok i lineynoy modulyatsii. Moscow: Sov. radio, 744.
22. Repin, V. G., Tartakovskiy, G. P. (1977). Statisticheskiy sintez pri apriornoy neopredelennosti i adaptatsiya informatsionnyh sistem. Moscow: Sov. radio, 432.
23. Voskoboynikov, Yu. E., Mitsel', A. A. (2015). Sovremennye problemy prikladnoy matematiki. Ch. 1. Lektsionniy kurs. Tomsk: Tomskiy gos. un-t sistem upravleniya i radioelektroniki (TUSUR), 136.
24. Girko, V. L. (1988). Spektral'niy teoriya sluchaynyh matrits. Moscow: Nauka, 376.
25. Tihonov, A. N., Goncharskiy, A. V., Stepanov, V. V. (1990). Chislennye metody resheniya nekorrektnyh zadach. Moscow: Nauka, 232.
26. Osipov, Yu. S., Vasil'ev, F. P., Potapov, M. M. (1999). Osnovy metoda dinamicheskoy regulyarizatsii. Moscow: Izd-vo MGU, 236.

DOI: 10.15587/1729-4061.2017.116839

FORECASTING THE EMERGENCY EXPLOSIVE ENVIRONMENT WITH THE USE OF FUZZY DATA (p. 19–27)

Oleh Zemlianskiy
Cherkasy Institute of Fire Safety named after Chornobyl Heroes of National University of Civil Defense of Ukraine, Cherkasy, Ukraine
ORCID: http://orcid.org/0000-0002-2728-6972

Ihor Maladyka
Cherkasy Institute of Fire Safety named after Chornobyl Heroes of National University of Civil Defense of Ukraine, Cherkasy, Ukraine
ORCID: http://orcid.org/0000-0001-8784-2814

Oleg Miroshnik
Cherkasy Institute of Fire Safety named after Chornobyl Heroes of National University of Civil Defense of Ukraine, Cherkasy, Ukraine
ORCID: http://orcid.org/0000-0001-8951-9498

Ihor Shkarabura
Cherkasy Institute of Fire Safety named after Chornobyl Heroes of National University of Civil Defense of Ukraine, Cherkasy, Ukraine
ORCID: http://orcid.org/0000-0002-3882-7623

Galina Kaplenko
Dnipropetrovsk State Agrarian and Economic University, Dnipro, Ukraine
ORCID: http://orcid.org/0000-0002-9545-8414

We resolved the scientific and technical problem to improve the efficiency of a decision-making processes carried out by a head of emergencies elimination of accidents at potentially dangerous objects by forecasting an emergency explosive environment under conditions of uncertainty.

We completed a formalized statement of the problem of identification of the concentration of an explosive gas-air mixture, which makes possible to use fuzzy input and output data. We determined the aspects of solution of the problem of forecasting with a use of expert conclusions in the case of absence or unreliability of input data.

We developed the technology of forecasting of parameters of an emergency explosive environment based on the obtained results. The proposed technology can be used in the post-emergency period to clarify fields of an explosive environment. A neuro-fuzzy network can be re-trained in the shortest possible time and used to solve a forecasting problem at all possible points in the zone of explosive environment on the base of the results of measurements of explosive concentration of devices. In addition, this technology can be used to clarify initial values of parameters of an accident, which will improve and objectify a decision making carried out by the head of emergencies elimination.

Keywords: gas-steam-air explosive environment, models and methods of forecasting, fuzzy data, emergency.

References

1. Brushlinsky, N., Ahrens, M., Sokolov, S., Wagner, P. (2016). World Fire Statistics. CTIF, No. 21. Available at: http://www.ctif.org/sites/default/files/ctif_report21_world_fire_statistics_2016.pdf
2. Biloshytskyi, M. V. (2009). Rozbizhnist u vyznachenni pozhezhnoi nebezpeky vyrobnychykh protsesiv ta prymishchen za pokaznykamy nyzhnoi kontsentratsiynoi mezhi zaimannia i rozrakhunkovym znachenniam nadlyshkovoho tysku vybukhu. Naukovyi visnyk UkrNDIPB, 2 (20), 91–98.
3. Basmanov, A. E., Govalenkov, S. S. (2010). Opredelenie zon vzryvoopasnyh kontsentratsiy opasnogo himicheskogo veshchestva v vozduhe. Materialy III Mizhn. nauk.-prakt. konf. «Aktualni problemy tekhnichnykh ta pryrodnychykh nauk u zabezpechenni tsyvilnoho zazystu». Cherkasy, APB im. Heroiv Chornobylia, 66–69.
4. Levchenko, A. D., Levchenko, D. Ye., Kryshtal, V. M., Zemlianskyi, O. M. (2010). Okremi aspekty kompleksnykh system rannoho vyiavlennia nadzvychainykh sytuatsiy. Pozhezhna bezpeka: teoriya i praktyka, 5, 76–80.
5. Tlyasheva, R. R., Solodovnikov, A. V. (2006). Prognozirovanie veroyatnyh zon zastoya na naruzhnoy ustanovke neftepererabatyvayushchego predpriyatiya. Neftegazovoe delo. Available at: http://www.ogbus.ru/authors/Tlyasheva/Tlyasheva_2.pdf
6. Johnson, D. M., Puttock, J. S., Richardson, S. A., Betteridge, S. (2011). Investigation of Deflagration and Detonation as an Explanation for the Buncefield Vapour Cloud Explosion. Proceedings of the Sixth International Seminar on Fire and Explosion Hazards. doi: 10.3850/978-981-08-7724-8_01-04
7. Raj, P. K. (2007). LNG fires: A review of experimental results, models and hazard prediction challenges. Journal of Hazardous Materials, 140 (3), 444–464. doi: 10.1016/j.jhazmat.2006.10.029
8. Atkinson, G., Cowpe, E., Halliday, J., Painter, D. (2017). A review of very large vapour cloud explosions: Cloud formation and explosion severity. Journal of Loss Prevention in the Process Industries, 48, 367–375. doi: 10.1016/j.jlp.2017.03.021
9. Vapour Cloud Development in Over-filling Incidents. Technical Note 12 [Electronic resource]. – FABIG. – 2013. Available at: http://fabig.com/video-publications/TechnicalGuidance#
10. Snytyuk, V. E., Zemlianskyi, O. N. (2013). The method of parametric optimization of the model reflecting the level of concentrated hazardous chemicals in post-accident period. Nauka i Studia, 42 (110), 26–311. Zemlianskyi, O., Snytyuk, V. (2013). Parametric identification for model of a chemical hazardous substance concentration using soft computing. International Journal Information Technologies & Knowledge, 7 (4), 337–346.
12. Zgurovskiy, M. Z., Pankratova, N. D. (2005). Sistemnyy analiz. Problemy, metodologiya, prilozheniya. Kyiv: Naukova dumka, 743.
13. Jang, J.-S. R. (1993). ANFIS: adaptive-network-based fuzzy inference system. IEEE Transactions on Systems, Man, and Cybernetics, 23 (3), 665–685. doi: 10.1109/21.256541
14. Zaichenko, Yu. P. (2004). Osnovy proektuvannia intelektualnykh system. Kyiv: Vydavnychyi Dim «Slovo», 352.
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. Snytiuk, V. Ye. (2012). Spriamovana optymizatsiya i osoblyvosti evoliutsiynoi heneratsiy potentsiynykh rozviazkiv. Materialy V Mizhn. shkoly-seminaru «Teoriya pryiniattia rishen». Uzhhorod, 182–183.
17. Rechenberg, I. (1994). Evolutionsstrategie '94. Stuttgart: Frommann-Holzboog, 434.
18. Borisov, A. N., Krumberg, O. A., Fedorov, I. P. (1990). Prinyatie resheniy na osnove nechetkih modeley: primery ispol'zovaniya. Riga: Zinatne, 184.
19. Saati, T. (1993). Prinyatie resheniy. Metod analiza ierarhiy. Moscow: Radio i svyaz', 278.

DOI: 10.15587/1729-4061.2017.118167

ANALYSIS OF LOGICAL-DYNAMIC ARGUMENT CONVERSION PROCESSES IN ARITHMETIC DEVICES OF DIGITAL CONTROL SYSTEMS (p. 28–34)

Mahmoud M. S. Al-Suod
Tafila Technical University, Tafila, Jordan
ORCID: http://orcid.org/0000-0002-2025-9816

Oleksandr Ushkarenko
Admiral Makarov National University of Shipbuilding, Mykolaiv, Ukraine
ORCID: http://orcid.org/0000-0002-3159-330X

Lev Petrenko
Admiral Makarov National University of Shipbuilding, Mykolaiv, Ukraine

The procedure for analysis of logical-dynamic processes of argument conversion in arithmetic devices of digital control systems was developed. Disadvantages and limitations of the formal methods used to describe processes in control systems were described and a graph-analytical method for describing the processes of argument conversion was proposed. Analysis of the logical-dynamic processes of conversion of data arguments in adders and multipliers used in digital control systems was performed. Sign-positional notation makes it possible to significantly increase speed of adders and multipliers in digital control systems. In this case, a necessity of formation of scientifically substantiated analytical rules for conversion of logical arguments and functional structures through which they are implemented appears. The analytical description of the processes of conversion of information arguments in digital control systems allows one to form their mathematical models with increased technological and informational qualities as well as solve optimization problems. The summation process in arithmetic devices is realized in accordance with the logic of argument conversion of the ternary notation. The axioms of the ternary notation can serve as a theoretical basis of the process of summation of arguments implemented in the binary notation format. The proposed approach enables evaluation of speed of the performed arithmetic operations with the use of various digital codes and opens up the possibility of improving the methods and algorithms of data processing in digital control systems.

Keywords: logical-dynamic process, argument conversion, partial product, graph-analytical model.

References

1. Le-Huy, H. (2001). Modeling and simulation of electrical drives using MATLAB/Simulink and Power System Block-

set. IECON'01. 27th Annual Conference of the IEEE Industrial Electronics Society (Cat. No.37243). doi: 10.1109/iecon.2001.975530
2. Liu, Y., Ling, X., Shi, Z., Lv, M., Fang, J., Zhang, L. (2011). A Survey on Particle Swarm Optimization Algorithms for Multimodal Function Optimization. Journal of Software, 6 (12). doi: 10.4304/jsw.6.12.2449-2455
3. Zhang, Y., Wang, S., Ji, G. (2015). A Comprehensive Survey on Particle Swarm Optimization Algorithm and Its Applications. Mathematical Problems in Engineering, 2015, 1–38. doi: 10.1155/2015/931256
4. Rajasekhar, K., Sowjanya, P., Umakiranmai, V., Harish, R., Krishna, M. (2014). Design and Analysis of Comparator Using Different Logic Style of Full Adder. Int. Journal of Engineering Research and Applications, 4 (4), 389–393.
5. Asaduzzaman, A., Lee, H. Y. (2014). GPU Computing to Improve Game Engine Performance. Journal of Engineering and Technological Sciences, 46 (2), 226–243. doi: 10.5614/j.eng.technol.sci.2014.46.2.8
6. Igić, T. S., Veljković, N. Ž. (2011). Design of a System for Monitoring Reliability of Structures and Constructions in Civil Engineering. International Journal of Engineering Pedagogy (iJEP), 1 (2). doi: 10.3991/ijep.v1i2.1634
7. Murthy, G. R., Senthilpari, C., Velrajkumar, P., Sze, L. T. (2013). A Novel Design of Multiplexer Based Full-Adder Cell for Power and Propagation Delay Optimizations. Journal of Engineering Science and Technology, 8 (6), 764–777.
8. Aminof, B., Mogavero, F., Murano, A. (2011). Synthesis of hierarchical systems. Formal Aspects of Component Software, 42–60. doi: 10.1007/978-3-642-35743-5_4
9. Wang, Y. (2015). Concept Algebra: A Denotational Mathematics for Formal Knowledge Representation and Cognitive Robot Learning. Journal of Advanced Mathematics and Applications, 4 (1), 61–86. doi: 10.1166/jama.2015.1074
10. Ryabenkiy, V. M., Ushkarenko, A. O. (2011). Metod sin$_T$ tezu matematychnih modelei logiko-dynamichnyh protsesiv kontrolyu i keruvanya. Tehnichna elektrodynamika, 2 (1), 121–125.
11. Ryabenkiy, V. M., Ushkarenko, A. O. (2014). Formalnoye opisanie elementov avtomatizirovannogo rabochego mesta operatora electroenergeticheskoi sistemy. Naukivyi vistnyk Khersonskiy derzhavniy morskiy akademiyi, 1 (1), 43–50.
12. Mahmoud, M. A. S., Ushkarenko, O. O. (2016). Analytical Representation of Control Processes of Induction Motor and Synchronous Generator in Power Plants. Jordan Journal of Electrical Engineering, 2 (4), 278–288.

DOI: 10.15587/1729-4061.2017.119299

DEVELOPMENT OF ALGORITHMS FOR BIOMEDICAL IMAGE SEGMENTATION BASED ON PRELIMINARY MARKUP AND TEXTURE ATTRIBUTES (p. 35–44)

Yuriy Batko
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0002-6732-4865

Natalia Batryn
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0001-5449-6302

Grygoriy Melnyk
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0003-0646-7448

Serhiy Verbovyy
Ternopil National Economic University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0001-8009-7508

Tamara Datsko
I. Horbachevsky Ternopil State Medical University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0001-9283-2629

Petro Selskyy
I. Horbachevsky Ternopil State Medical University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0001-9778-2499

Biomedical images are used for diagnosis and treatment of malignant neoplasms. Images of normal and pathological cells and tissues are derived using light microscopes. These images are the objects of study in histology and cytology. One of the most important stages in the automation of measuring optical and geometrical parameters of images is the segmentation of micro objects. Analysis of biomedical images is complicated due to the highly variable parameters and weak contrast in most micro objects.

The use of point connections for segmenting the images has several advantages: processing images of any type, splitting micro objects that are in contact, insensitivity to noise. A method of image segmentation based on preliminary markup implies splitting a color image into homogeneous regions, calculating the coefficient of relation between adjacent points, and merging points into homogeneous regions. The algorithm allows for the automated segmentation.

A texture segmentation method involves computing values of spatial moments for each point of the image. A feature space, obtained in this way, is segmented by the algorithm. The algorithm calculates thresholds based on mathematical expectation. This makes it possible to identify such complex micro objects as the layers of cells, cross-sections of blood vessels and ducts.

The quality of segmentation was estimated using a metric approach. The developed segmentation algorithms made it possible to improve quality of the biomedical image segmentation by 18–21 % on average.

Keywords: histological and cytological images, segmentation, preliminary markup, spatial moments, segmentation estimation.

References

1. Argyris, G., Kapageridis, I., Triantafyllou, A. (2008). 3D Terrain Modelling of the Amyntaio – Ptolemais Basin. 2nd International Workshop in «Geoenvironment and Geotechnics». Milos island.
2. Berezsky, O. M., Batko, Y. M., Melnyk, G. M. (2009). Method of image segmentation based on previous layouts images. Proceedings of the 4th International Scientific-Technical Conference «Computer Science and Information Technology 2009». Lviv: «Tower and Co», 48–52.
3. Berezsky, O. M., Berezska, K. M., Batko, Y. M., Melnyk, G. M. (2011). Vision-based medical expert system. 6th International Scientific and Technical Conference «Computer Sciences and Information Technologies». Lviv, 49–50.
4. Bieri, M., Wethmar, A., Wey, N. (2009). Quantitative analysis of Alzheimer plaques in mice using virtual microscopy. First European Workshop on Tissue Imaging and Analysis, 31–38.

5. Muralidhar, G. S., Bovik, A. C., Giese, J. D., Sampat, M. P., Whitman, G. J., Haygood, T. M. et. al. (2010). Snakules: A Model-Based Active Contour Algorithm for the Annotation of Spicules on Mammography. IEEE Transactions on Medical Imaging, 29 (10), 1768–1780. doi: 10.1109/tmi.2010.2052064
6. Berezsky, O. M., Batko, Y. M., Melnyk, G. M. (2009). Texture segmentation of biomedical images based on spatial moments. Proceedings of the 4th International Scientific-Technical Conference «Computer Science and Information Technology 2009». Lviv: «Tower and Co», 42–45.
7. Berezsky, O., Batko, Y., Melnyk, G., Verbovyy, S., Haida, L. (2015). Segmentation of cytological and histological images of breast cancer cells. 2015 IEEE 8th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS). doi: 10.1109/idaacs.2015.7340745
8. Fu, K. S., Mui, J. K. (1981). A survey on image segmentation. Pattern Recognition, 13 (1), 3–16. doi: 10.1016/0031-3203(81)90028-5
9. Pal, N. R., Pal, S. K. (1993). A review on image segmentation techniques. Pattern Recognition, 26 (9), 1277–1294. doi: 10.1016/0031-3203(93)90135-j
10. Skarbek, W., Koschan, A. (1994). Color Image Segmentation – A Survey. Berlin, 81.
11. Lucchese, L., Mitra, S. (2001). Color Image Segmentation: A State-of-the-Art Survey, Image Processing, Vision, and Pattern Recognition. Proceedingss of the Indian National Science Academy (INSA-A). New Delhi, India, 207–221.
12. Jipkate, B. R., Gohokar, V. V. (2012). A Comparative Analysis of Fuzzy C-means Clustering and K-means Clustering Algorithms. International Journal of computational Engineering Research, 2 (3), 737–739.
13. Thilagamani, S., Shanthi, N. (2011). A Survey on image segmentation through clustering. International journal of research and Information sciences, 1 (1).
14. Sharma, N., Mishra, M., Shrivastava, M. (2012). Colour image segmentation techniques and issues: an approach. International Journal of Scientific & Technology Research, 1 (4), 9–12.
15. Saini, S., Arora, K. (2014). A Study Analysis on the Different Image Segmentation Techniques. International Journal of Information & Computation Technology, 4 (14), 1445–1452.
16. Belaid, L. J., Mourou, W. (2011). Image segmentation: a watershed transformation algorithm. Image Analysis & Stereology, 28 (2), 93. doi: 10.5566/ias.v28.p93-102
17. Abirami, M. S., Sheela, T. (2014). Analysis of Image Segmentation Techniques for Medical Images. Proceedings of International Conference on Emerging Research in Computing, Information, Communication and Applications (ERCICA-14).
18. Li, C., Huang, R., Ding, Z., Gatenby, J. C., Metaxas, D. N., Gore, J. C. (2011). A Level Set Method for Image Segmentation in the Presence of Intensity Inhomogeneities With Application to MRI. IEEE Transactions on Image Processing, 20 (7), 2007–2016. doi: 10.1109/tip.2011.2146190
19. Berezsky, O. M., Berezska, K. M., Batko, Y. M., Melnyk, G. M. (2009). Design of computer systems for biomedical image analysis. Proceedings of the X-th International Conference «The Experience of Designing and Application of CAD Systems in Microelectronics» CADSM'2009. Lviv-Polyana, 186–192.
20. Arbeláez, P., Maire, M., Fowlkes, C., Malik, J. (2011). Contour Detection and Hierarchical Image Segmentation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 33 (5), 898–916. doi: 10.1109/tpami.2010.161
21. Joshi, V. S., Shire, A. N. (2013). A Review of an Enhanced Algorithm for Color Image Segmentation. Journal of Advanced Research in Computer Science and Software Engineering, 3 (3), 435–441.
22. Berezsky, O. N., Berezskaya, E. N. (2015). Quantitative evaluation of the quality of the segmentation of images based on metrics. Upravlyayushchie Sistemy i Mashiny, 6, 59–65.
23. Atallah, M. J., Ribeiro, C. C., Lifschitz, S. (1991). A linear time algorithm for the computation of some distance functions between convex polygons. RAIRO – Operations Research, 25 (4), 413–424. doi: 10.1051/ro/1991250404131
24. Berezsky, O., Pitsun, O. (2016). Automated Processing of Cytological and Histological Images. 2016 XII International Conference on Perspective Technologies and Methods in MEMS Design (MEMSTECH). Lviv-Polyana, 51–53. doi: 10.1109/memstech.2016.7507518
25. Berezky, O. M., Pitsun, O. Y., Verbovyi, S. O., Datsko, T. V. (2017). Relational database of intelligent automated microscopy system. Scientific Bulletin of UNFU, 27 (5), 125–129. doi: 10.15421/40270525

DOI: 10.15587/1729-4061.2017.118798

DEVELOPMENT OF A MATHEMATICAL MODEL OF EEVALUATION OF ROAD-AND-TRANSPORT ASSETS AS A COMPONENT OF INFORMATION-AND-MANAGEMENT SYSTEM (p. 45–57)

Olena Slavinska
National Transport University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-9709-0078

Vyacheslav Savenko
National Transport University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-8174-7728

Anna Kharchenko
National Transport University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-8166-6389

Andrey Bubela
National Transport University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-5619-003X

The mathematical model of evaluation of road-and-transport assets based on the level of real qualitative state was developed. The study was performed in connection with the lack of evaluation methods that take into account specifics of the assets of the road-and-transport complex. This problem is caused by absence of scientifically substantiated criteria for property evaluation of road assets.

As a result of this study, the conceptual model for evaluating the road-and-transport infrastructure assets was developed. Unlike the conventional approach, the constructed conceptual model of the evaluation procedure is based on application of a qualimetric model and a multilevel hierarchical system of indicators. This approach has enabled elucidation of the real physical wear converse to the level of qualitative state of the asset which is the basis for a fair evaluation.

The conceptual model of evaluation was laid in the basis of construction of a mathematical model that, in contrast to the conventional approach, takes into account the qualitative

state of linearly extensive objects. The disadvantages of application of the developed mathematical model include the necessity of estimation of errors and the level of expert competence. However, the calculations made in testing of this model gives the right to assert fairness of the asset evaluation which is an input parameter to the information-and-management system of the road-and-transport infrastructure.

The study results create a favorable environment for making managerial decisions on the assets as the objects of management in the road-and-transport complex and can be used by enterprises and organizations of the complex.

Keywords: asset value, evaluation, information-and-management system, level of qualitative state, qualimetry.

References

1. McPherson, K., Bennett, C. R. (2005). Success Factors for Road Management Systems. Version 1.0. East Asia Pacific Transport Unit. The World Bank. Washington, D.C., 111.
2. Hordijk, A. C. (2012). Real Estate Appraisal and International Valuation Standards. XLI Incontro di Studio del Ce.S.E.T., 397–401. Available at: http://www.fupress.net/index.php/ceset/article/viewFile/13150/12437
3. Markus, Ya. I. (2013). Mify i realii otsenki imushchestva. Visnyk Prydniprovskoi derzhavnoi akademii budivnytstva ta arkhitektury, 7, 8–12.
4. Fedorovych, R., Seredynska, I. (2013). Neobkhidnist vykorystannia vartisnykh metodiv v upravlinskykh tekhnolohiyakh. Halytskyi ekonomichnyi visnyk, 3 (42), 60–72.
5. Dojutrek, M. S., Makwana, P. A., Labi, S. (2012). A Methodology for Highway Asset Valuation in Indiana. Joint Transportation Research Program. Indiana Department of Transportation and Purdue University, West Lafayette, Indiana. doi: 10.5703/1288284315035
6. McNeil, S. (2000). Asset Management and Asset Valuation: The Implication of the Government Accounting Standards Bureau (GASB) Standards for Reporting Capital Assets. Midcontinent Transportation Symposium. Minnesota, 34–37.
7. Switzer, A., McNeil, S. (2004). Developing a Road Map for Transportation Asset Management Research. Public Works Management & Policy, 8 (3), 162–175. doi: 10.1177/1087724x03259475
8. Sidenko, V. M., Rokac, S. Yu. (1981). Upravlenie kachestvom v dorozhnom stroitel'stve. Moscow: Transport, 252.
9. Kaveshnikov, N. T. (2000). Upravlenie kachestvom produktsii (na primere vypolneniya dorozhno-stroitel'nyh rabot). Moscow: Moskovskiy gosudarstvenniy universitet prirodoobustroystva, 105.
10. Azgaldov, G. G., Kostin, A. V., Omiste, A. E. P. (2015). The ABC of Qualimetry: The Toolkit for measuring immeasurable. Ridero, 167.
11. Trishch, H. M. (2013). System of dependencies for assessment of enterprises quality management processes. Eastern-European Journal of Enterprise Technologies, 4 (3 (64)), 60–63. Available at: http://journals.uran.ua/eejet/article/view/16283/13802
12. Katrych, O. O. (2015). Scientific approaches to quality assessment processes. ScienceRise, 4 (2 (9)), 69–72. doi: 10.15587/2313-8416.2015.41589
13. Lapidus, A., Makarov, A. (2016). Fuzzy sets on step of planning of experiment for organization and management of construction processes. MATEC Web of Conferences, 86, 05003. doi: 10.1051/matecconf/20168605003
14. Kanin, O. P., Kharchenko, A. M. (2012). Sutnist ta pryznachennia informatsiyno-analitychnykh system upravlinnia dorozhnim hospodarstvom Ukrainy. Upravlinnia proektamy, systemnyi analiz i lohistyka, 9, 71–78.
15. Kanin, O. P., Kharchenko, A. M. (2014). Upravlinnia dorozhnim hospodarstvom shliakhom zastosuvannia informatsiyno-analitychnoi systemy. Informatsiyni protsesy, tekhnolohiy ta systemy na transporti, 2, 98–102.
16. Slavinska, O. S. (2016). Metodolohya mainovoi otsinky avtomobilnoi dorohy, yak obiekta derzhavnoi vlasnosti. Avtomobilni dorohy i dorozhnie budivnytstvo, 97, 70–76.
17. Bubela, A. V. (2016). Vykorystannia dyferentsiynoho metodu v proektakh budivnytstva avtomobilnoi dorohy dlia obliku ta otsinky aktyviv dorozhnoho hospodarstva. Avtomobilni dorohy i dorozhnie budivnytstvo, 98, 22–29.
18. Slavinska, O. S. (2016). Application of transformation assessment tasks highways managment methodology of property evalution road on the basis of transformation. Roads and road construction, 96, 104–1119.
19. Bubela, A. V. (2016). Project management of estimates of the roads based on considerstion of the technical state. Roads and road construction, 97, 50–55.
20. Slavinska, O. S., Kharchenko, A. M. (2016). Zastosuvannia kvalimetrychnoi modeli do otsinky transportno-ekspluatatsiynoho stanu avtomobilnoi dorohy. Avtomobilni dorohy i dorozhnie budivnytstvo, 95, 111–120.
21. Savenko, V. Ya. (2016). Upravlinnia yakistiu tekhnichnoho stanu avtomobilnoi dorohy na osnovi zastosuvannia metodu defektiv pry mainovi otsintsi. Avtomobilni dorohy i dorozhnie budivnytstvo, 97, 63–70.
22. Parli, R. L. (2007). The education of a profession. The Appraisal Journal, LXXV (4), 326–338.
23. Falls, L. C., Haas, R., Hosang, J. (2001). Asset Valuation as a Key Element of Pavement Management. 5th International Conference on Managing Pavements. Seatle.
24. Falls, L. C., Tighe, R. H. (2005). A Framework for Selection of Asset Valuation Methods for Civil Infrastructure. Annual Conference of the Transportation Association of Canada.
25. Dewan, S. A., Smith, R. E. (2005). Valuing Pavement Network Assets and Use of Values as Decision Supports. Journal of Infrastructure Systems, 11 (4), 202–210. doi: 10.1061/(asce)1076-0342(2005)11:4(202)
26. Clarke, H., Prentice, D. (2009). A Conceptual Framework For The Reform Of Taxes Related To Roads And Transport. La Trobe University, for Australia Treasury Australia's Future Tax System, 104. Available at: https://taxreview.treasury.gov.au/content/html/commissioned_work/downloads/Clarke_and_Prentice.pdf
27. Dutzik, T., Davis, B., Baxandall, P. (2011). Do Roads Pay for Themselves? Setting the Record Straight on Transportation Funding. U.S. PIRG Education Fund, 45. Available at: https://uspirg.org/sites/pirg/files/reports/Do-Roads-Pay-for-Themselves.pdf
28. Litman, T. (2011). Environmental Reviews & Case Studies: Why and How to Reduce the Amount of Land Paved for Roads and Parking Facilities. Environmental Practice, 13 (1), 38–46. doi: 10.1017/s1466046610000530
29. Proekt pershoi redaktsiy MR D 1.2-37641918-884:2017. Available at: http://dorndi.org.ua/uk/2017/10/03/%D0%BF%D1%80%D0%BE%D0%B5%D0%BA%D1%82-%D0%BF%D0%B5%D1%80%D1%88%D0%BE%D1%97-%D1%80%D0%B5%D0%B4%D0%B0%D0%BA%D1%86%D1%96%D1%97-%D0%BC%D1%80-%D0%B4-1-2-37641918-8842017/

DOI: 10.15587/1729-4061.2017.119497

DEVELOPMENT OF ONTOLOGICAL SUPPORT OF CONSTRUCTIVE-SYNTHESIZING MODELING OF INFORMATION SYSTEMS (p. 58–69)

Vladislav Skalozub
Dnipropetrovsk National University of Railway Transport named after academician V. Lazaryan, Dnipro, Ukraine
ORCID: http://orcid.org/0000-0002-1941-4751

Valeriy Ilman
Dnipropetrovsk National University of Railway Transport named after academician V. Lazaryan, Dnipro, Ukraine
ORCID: http://orcid.org/0000-0003-0983-8611

Victor Shynkarenko
Dnipropetrovsk National University of Railway Transport named after academician V. Lazaryan, Dnipro, Ukraine
ORCID: http://orcid.org/0000-0001-8738-7225

The methodology and means of ontological support of the processes of constructive-synthesizing modeling of complex information technologies have been developed in the study. The requirements for the applied ontology of constructive-synthesizing modeling have been formulated along with developing and specifying the conceptualization methods, axiomatics, the output system and performers that provide effective modeling for a wide range of subject areas.

The theoretical basis of constructive-synthesizing modeling has been devised as the underlying principle of applied ontologies, with examples of the formation of concept models of subject domains.

In ontology, constructive-synthesizing models of subject domains have been formed and presented on the basis of a single constructive structure containing primary classes of ontology instances, active binders of operators of actions and performers. It ensures universality and opportunity to use the models for developing and setting them in subject domains of modeling.

The completed formalization of the ontology design allows improving the quality of automated processes of creating intelligent information technologies for structurally complex areas of modeling. This methodology is based on the paradigm of constructivism of all components of subject domains, on the revealed properties and unified models of representing concept structures, concepts and basic relations in CSM. At the same time, it has been made possible to create and maintain models of conceptual systems of subject domains that are different from taxonomy, given the uncertainties in the choice of the structure of conceptual models, both for systems of concepts of subject areas and their distinctive features.

Keywords: constructive-synthesizing modeling, ontology, conceptualization, unification of models, constructive object.

References

1. Palagin, A. V. (2016). Ontologicheskaya kontseptsiya informatizatsii nauchnyh issledovaniy. Kibernetika i sistemnyy analiz, 52 (1), 3–9.
2. Frye, L., Cheng, L., Heflin, J. (2014). TRIDSO: Traffic-based Reasoning Intrusion Detection System using Ontology. Journal of Research and Practice in Information Technology, 46 (4), 215–233.
3. Manuja, M., Garg, D. (2015). Intelligent text classification system based on self-administered ontology. Turkish Journal of Electrical Engineering & Computer Sciences, 23, 1393–1404. doi: 10.3906/elk-1305-112
4. Luke, S., Spector, L., Rager, D. (1996). Ontology-Based Knowledge Discovery on the World-Wide Web. AAAI Technical Report WS-96-06, 96–102.
5. Fensel, D., Hendler, J. A., Lieberman, H., Wahlster, W. (Eds.) (2005). Spinning the Semantic Web: bringing the World Wide Web to its full potential. Mit Press, 272.
6. Bechhofer, S. (2009). OWL: Web ontology language. Encyclopedia of Database Systems. Springer, 80.
7. Gruber, T. R. (1995). Toward principles for the design of ontologies used for knowledge sharing? International Journal of Human-Computer Studies, 43 (5-6), 907–928. doi: 10.1006/ijhc.1995.1081
8. Noy, N. F., McGuinness, D. L. (2001). Ontology Development 101: A Guide to Creating Your First Ontology. Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-0880. Available at: http://protege.stanford.edu/publications/ontology_development/ontology101.html
9. Guarino, N. (1998). Formal ontology and information systems. Proceedings of FOIS, 98, 81–97.
10. Nardi, J. C., De Almeida Falbo, R., Almeida, J. P. A., Guizzardi, G., Pires, L. F., Van Sinderen, M. J. et. al. (2015). A commitment-based reference ontology for services. Information Systems, 54, 263–288. doi: 10.1016/j.is.2015.01.012
11. Kazi, Z., Kazi, L., Radulovic, B., Bhatt, M. (2016). Ontology-Based System for Conceptual Data Model Evaluation. International Arab Journal of Information Technology, 13 (5), 542–551.
12. Alexopoulos, P., Wallace, M., Kafentzis, K., Askounis, D. (2010). Utilizing Imprecise Knowledge in Ontology-based CBR Systems by Means of Fuzzy Algebra. International Journal of Fuzzy Systems, 12 (1).
13. Titenko, S. V. (2012). Ontologicheski-orientirovannaya sistema upravleniya kontentom informatsionno-uchebnyh Web-portalov. Obrazovatel'nye tekhnologii i obshchestvo, 15 (3), 522–533.
14. Shynkarenko, V. I., Il'man, V. M. (2014). Konstruktivno-produktsionnye struktury i ih grammaticheskie interpretatsii. I. Obobshchennaya formal'naya konstruktivno-produktsionnaya struktura. Kibernetika i sistemniy analiz, 50 (5), 8–16.
15. Shynkarenko, V. I., Sablin, O. I., Ivanov, O. P. (2016). Constructive modelling for zone of recovery energy distribution of dc traction. Science and Transport Progress. Bulletin of Dnipropetrovsk National University of Railway Transport, 5 (65), 125–135. doi: 10.15802/stp2016/84036
16. Shinkarenko, V. I., Il'man, V. M., Zabula, G. V. (2014). Konstruktsionno-produktsionnaya model' struktur dannyh na logicheskom urovne. Problemi programuvannya, 2-3, 10–16.
17. Shynkarenko, V. I., Kuropyatnik, E. S. (2016). Konstruktivno-produktsionnaya model' grafovogo predstavleniya teksta. Problemi programuvannya, 2-3, 63–72.
18. Shynkarenko, V. I., Vasetskaya, T. N. (2015). Modelirovanie protsessa adaptatsii algoritmov szhatiya sredstvami konstruktivno-produktsionnyh struktur. Kibernetika i sistemniy analiz, 6, 19–34.
19. Shynkarenko, V. I., Vasetskaya, T. N. (2016). Modelirovanie protsessa ranzhirovaniya al'ternativ metodom analiza ierarhiy sredstvami konstruktsionno-produktsionnyh struktur. Matematychni mashyny ta systemy, 1, 39–47.

20. Zholtkevich, G. N., Semenova, T. V., Fedorchenko, K. A. (2004). Predstavlenie poluskhem predmetnyh oblastey informatsionnyh sistem sredstvami relyatsionnyh baz dannyh. Visnyk Khark. nats. un-tu im. V. N. Karazina. Seriya: Matematychne modeliuvannia. Informatsiyni tekhnolohiy. Avtomatyzovani systemy upravlinnia, 629 (3), 11–24.
21. Pancerz, K., Lewicki, A., Tadeusiewicz, R. (2015). Ant-based extraction of rules in simple decision systems over ontological graphs. International Journal of Applied Mathematics and Computer Science, 25 (2). doi: 10.1515/amcs-2015-0029
22. Pancerz, K. (2016). Paradigmatic and Syntagmatic Relations in Information Systems over Ontological Graphs. Fundamenta Informaticae, 148 (1-2), 229–242. doi: 10.3233/fi-2016-1432
23. Grabusts, P., Borisov, A., Aleksejeva, L. (2015). Ontology-Based Classification System Development Methodology. Information Technology and Management Science, 18 (1). doi: 10.1515/itms-2015-0020
24. Kogut, P., Cranefield, S., Hart, L., Dutra, M., Baclawski, K., Kokar, M., Smith, J. (2002). UML for ontology development. The Knowledge Engineering Review, 17 (01). doi: 10.1017/s0269888902000358
25. Bova, V. V., Leshchanov, D. V., Kravchenko, D. Yu., Novikov, A. A. (2014). Komp'yuternaya ontologiya: zadachi i metodologiya postroeniya. Informatika, vychislitel'naya tekhnika i inzhenernoe obrazovanie, 4, 44–55.
26. Thomsen, E., Read, F., Duncan, W., Malyuta, T., Smith, B. (2014). Ontological Support for Living Plan Specification, Execution and Evaluation. Semantic Technology in Intelligence, Defense and Security (STIDS), CEUR, 1304, 10–17.
27. Gonen, B., Fang, X., El-Sheikh, E., Bagui, S., Wilde, N., Zimmermann, A. (2014). Ontological Support for the Evolution of Future Services Oriented Architectures. Transactions on Machine Learning and Artificial Intelligence, 2 (6). doi: 10.14738/tmlai.26.784
28. Grishin, M. V., Larin, S. N., Sosnin, P. I. (2015). Tools ontological support of the design template equipment in the aircraft production. V Mire Nauchnykh Otkrytiy, 4, 10. doi: 10.12731/wsd-2015-4-1
29. Breitsprecher, T., Codescu, M., Jucovschi, C., Kohlhase, M., Schröder, L., Wartzack, S. (2014). Towards Ontological Support for Principle Solutions. Mechanical Engineering. InFOIS, 5, 427–432.
30. Khalipova, N. V. (2016). Vektorna optymizatsiya v zadachakh udoskonalennia mizhnarodnykh transportnykh system. Dnipropetrovsk: Universytet mytnoi spravy ta finansiv, 271.

DOI: 10.15587/1729-4061.2017.118265

TECHNOLOGY AND SOFTWARE TO DETERMINE ADEQUATE NORMALIZED CORRELATION MATRICES IN THE SOLUTION OF IDENTIFICATION PROBLEMS (p. 69–76)

Ulkar Sattarova
Azerbaijan University of Architecture and Construction, Baku, Azerbaijan
ORCID: http://orcid.org/0000-0002-0174-1412

Statistical methods are widely used in solving problems of automatic management of industrial objects, as they enable us to determine the dynamic characteristics during normal operation of objects. The statistical correlation method for determining these dynamic characteristics is based on the solution of an integral equation that includes the correlation functions $R_{XX}(i\Delta t)$ and $R_{XY}(i\Delta t)$ of the input $X(i\Delta t)$ and output $Y(i\Delta t)$ signals. It allows one to obtain the dynamic characteristics of an object without disturbing its regular operation mode. However, the application of these methods for constructing mathematical models of real-life industrial objects presents the following certain difficulty. Interferences and noises are imposed upon the useful signal, hindering the calculation of the estimates of their static characteristics. The paper presents one possible option of creating alternative methods and technologies for eliminating the error induced by noise during the formation of correlation matrices. The proposed algorithms allow for reducing these matrices to the similar matrices of useful signals.

It is demonstrated in the paper that in the traditional approach, due to the normalization of estimates in the diagonal elements of the correlation matrices, the noise-induced errors disappear, while appearing in the remaining elements. As a result, the expected effect of improving the conditionality from the transition to normalized correlation matrices is not achieved. The technology and software for eliminating this defect are proposed, despite the problems with matrix conditioning. A new software for the rapid formation and analysis of numerous computational experiments confirming the effectiveness of the developed technology is proposed.

Keywords: real signal, noise, correlation function, normalized correlation matrix, equivalent correlation matrix, input signal, output signal.

References

1. Tikhonov, A. N., Arsenin, V. Ya. (1979). Methods for solving III – posed problems. Moscow: Nauka, 288.
2. Samarskiy, A. A. (1997). Introduction to numerical methods. Moscow: Nauka, 288.
3. Solodovnikov, V. V. (1960). Statistical dynamics of linear automatic control systems. Moscow: Fizmatgiz, 665.
4. Aliev, T. (2007). Digital Noise Monitoring of Defect Origin. Springer, 235. doi: 10.1007/978-0-387-71754-8
5. Aliev, T. (2003). Robust Technology with Analysis of Interference in Signal Processing. Springer, 199. doi: 10.1007/978-1-4615-0093-3
6. Bureyeva, N. N. (2007). Multivariate statistical analysis using the «statistica» PPP. Nizhny Novgorod, 114.
7. Ifeachor, E., Jervis, B. (2004). Digital Signal Processing: A Practical Approach. Moscow – Saint Petersburg – Kyiv, 989.
8. Magomedovna, A. P. (2012). Textbook on Multidimensional Statistical Methods. Makhachkala, 75.
9. Syritsyn, T. A. (1981). Reliability of hydraulic and pneumatic lines. Mechanical engineering. Moscow, 249.
10. Kuzmin, V., Kedrus, V. A. (1977). Fundamentals of information theory and coding. Kyiv, 279.
11. Karpov, F. (1968). Calculation of urban electrical distribution networks. Moscow, 224.
12. Horsthemke, W., Lefever, R. (1984). Noise – Induced Transitions. Theory and Applications in Physics, Chemistry, and Biology. Springer, 294. doi: 10.1007/3-540-36852-3
13. Lewandowski, D., Kurowicka, D., Joe, H. (2009). Generating random correlation matrices based on vines and extended onion method. Journal of Multivariate Analysis, 100 (9), 1989–2001. doi: 10.1016/j.jmva.2009.04.008
14. Schott, J. R. (1998). Estimating correlation matrices that have common eigenvectors. Computational Statistics & Data Analysis, 27 (4), 445–459. doi: 10.1016/s0167-9473(98)00027-9

15. Bun, J., Bouchaud, J.-P., Potters, M. (2017). Cleaning large correlation matrices: Tools from Random Matrix Theory. Physics Reports, 666, 1–109. doi: 10.1016/j.physrep.2016.10.005
16. Aliev, T. A., Rzayeva, N. E., Sattarova, U. E. (2017). Robust correlation technology for online monitoring of changes in the state of the heart by means of laptops and smartphones. Biomedical Signal Processing and Control, 31, 44–51. doi: 10.1016/j.bspc.2016.06.015
17. 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
18. Sattarova, U. E. (2017). Technology and Software for Calculating Correct Normalization of Correlation Functions. Advances in Intelligent Systems and Computing, 149–159. doi: 10.1007/978-3-319-68720-9_18