- simplifies the consistency of existing information and the addition of new information;
- standardizes support for methods and tools to enhance existing information;
- enables the creation of a personalized experience for any end-user.

It is also worth noting that the solution proposed within this paper — *OSTIS Glossary* — is:

- a part of the *OSTIS Metasystem* Knowledge base, as known the *OSTIS Standard*, which allows:
  - to develop the *OSTIS Glossary* by the same means by which any intelligent computer system based on the *OSTIS Technology* is developed;
  - use the same tools to view and navigate the text of the *OSTIS Glossary*;
  - automatic consistent development of the *OSTIS Glossary* and the *OSTIS Standard*;
- a simplified version of the *OSTIS Standard*, which allows:
  - to quickly search and reuse existing information;
  - to quickly provide consistency and integrate new information;
  - to reduce the circle of entry for new people to develop the *OSTIS Technology*;
- an environment for social and creative learning and development of new staff in the field of Artificial Intelligence.

The introduction of such information resources can significantly improve the quality and efficiency of various activities.

The authors believe that this paper will be useful not only for those who are researching innovative methods and technologies for more effective organisation of teamwork, but also for those who are just beginning research in this area.

VI. Acknowledgment

The authors would like to thank the scientific staff of the Department of Intelligent Information Technologies of the Belarusian State University of Informatics and Radioelectronics for their help and valuable comments.

References

[1] V. V. Golenkov, N. Guliakina, V. Golovko, V. Krasnoproshin, "Methodological problems of the current state of works in the field of artificial intelligence," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. 5, V. Golenkov, Ed. BSUIR, Minsk, 2021, pp. 17–24.

[2] A. M. Ouksel, "Semantic interoperability in global information systems," SIGMOD Rec., vol. 28, no. 1, p. 5–12, Mar. 1999.

[3] V. Golenkov, V. Golovko, N. Guliakina, and V. Krasnoproshin, "The standardization of intelligent computer systems as a key challenge of the current stage of development of artificial intelligence technologies," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. 4, V. Golenkov, Ed. BSUIR, Minsk, 2020, pp. 73–88.

[4] V. Golenkov, N. Guliakina, V. Golovko, and V. Krasnoproshin, "Artificial intelligence standardization is a key challenge for the technologies of the future," in *Open Semantic Technologies for Intelligent System*. Cham: Springer International Publishing, 2020, pp. 1–21.

[5] P. Hagoort, "Semantic unification," in *The cognitive neurosciences*, 4th ed. MIT press, 2009, pp. 819–836.

[6] A. Iliadis, "The tower of babel problem: Making data make sense with basic formal ontology," *Online Information Review*, vol. 43, no. 6, pp. 1021–1045, 2019.

[7] J. H. Siekmann, "Universal unification," in *International Conference on Automated Deduction*. Springer, 1984, pp. 1–42.

[8] A. P. Sokolov and A. O. Golubev, "System of computeraided design of composite materials. part 3. graph-oriented methodology of development of means of user-system interaction," 2021, pp. 43–57.

[9] G. Evgenev, "Expertopaedia as a means of creating an ontological internet of knowledge," *Ontology of Design*', vol. 9, no. 3 (33), pp. 307–320, 2019.

[10] V. Polonskiy, "Why do i need a dictionary?" *Nauka i shkola*, no. 1, pp. 214–226, 2019.

[11] M. Yahya, J. G. Breslin, and M. I. Ali, "Semantic web and knowledge graphs for industry 4.0," *Applied Sciences*, vol. 11, no. 11, p. 5110, 2021.

[12] J. Han, S. Sarica, F. Shi, and J. Luo, "Semantic networks for engineering design: state of the art and future directions," *Journal of Mechanical Design*, vol. 144, no. 2, p. 020802, 2022.

[13] Robinson, I., *Graph databases*. O'Reilly Media, Inc., 2015.

[14] V. Syskov and V. Borisov, "Method of organisation of collective activity in complex organisational and technical systems," *Sovremennye nauchnye issledovaniye i innovatsii*, no. 11, pp. 284–310, 2015.

[15] W. J. Verhagen, P. Bermell-Garcia, R. E. Van Dijk, and R. Curran, "A critical review of knowledge-based engineering: An identification of research challenges," *Advanced Engineering Informatics*, vol. 26, no. 1, pp. 5–15, 2012.

[16] T. Gruber, "Toward principles for the design of ontologies used for knowledge sharing," *Intern. J. of Human-Computer Studies*, vol. 43, no. 5/6, pp. 907–928, 1995.

[17] A. Palagin and N. Petrenko, "To the question of systemontological integration of subject area knowledge," *Mathematical Machines and Systems*, vol. 1, no. 3-4, pp. 63–75, 2007.

[18] Lim, S.C. Johnson and Liu, Ying and Chen, Yong, "Ontology in design engineering: status and challenges," in *International Conference on Engineering Design 2015 (ICED 2015)*, 07 2015.

[19] L. Yang, K. Cormican, and M. Yu, "Ontology-based systems engineering: A state-of-the-art review," *Computers in Industry*, vol. 111, pp. 148–171, 2019.

[20] I. Davydenko, V. Tarasov, and A. Fedotova, "Ontological approach to building knowledge bases based on semantic networks," in *Open semantic technologies for designing intelligent systems (OSTIS-2016) : proceedings of the VI International scientific-technical conference, Minsk, 18–20 Feb. 2016 y.* Minsk, 2016.

[21] O. Ataeva, N. Kalenov, and V. Serebryakov, "Ontological approach to the description of a unified digital space of scientific knowledge," *Electronic Libraries*, vol. 24, no. 1, pp. 3–19, 2021.

[22] Y. Kravchenko, "Synthesis of heterogeneous knowledge on the basis of ontologies," *Investigations of the Southern Federal University. Technical Sciences*, vol. 136, no. 11 (136), pp. 216–221, 2012.

[23] A. Tuzovskiy, "Development of knowledge management systems based on a unified ontological knowledge base," *Investigations of Tomsk Polytechnic University. Engineering of georesources*, vol. 310, no. 2, pp. 182–185, 2007.

[24] T. Dillon, E. Chang, and P. Wongthongtham, "Ontology-based software engineering-software engineering 2.0," 04 2008, pp. 13– 23.

[25] V. Ryen, A. Soylu, and D. Roman, "Building semantic knowledge graphs from (semi-) structured data: a review," *Future Internet*, vol. 14, no. 5, p. 129, 2022.

[26] P. Barnaghi, A. Sheth, and C. Henson, "From data to actionable knowledge: Big data challenges in the web of things [guest editors' introduction]," IEEE Intelligent Systems, vol. 28, no. 6, pp. 6–11, 2013.

[27] C. Kellogg, "From data management to knowledge management," *Computer*, vol. 19, no. 01, pp. 75–84, 1986.

[28] G. Fischer and J. Otswald, "Knowledge management: problems, promises, realities, and challenges," *IEEE Intelligent systems*, vol. 16, no. 1, pp. 60–72, 2001.

[29] S. E. Hampton and J. N. Parker, "Collaboration and productivity in scientific synthesis," *BioScience*, vol. 61, no. 11, pp. 900–910, 2011.

[30] I. Sechkina and G. Sechkin, "Synthesis as a goal, method and final result of knowledge integration," *Omskiy nauchny vestnik*, no. 3 (129), pp. 191–192, 2014.

[31] Y. Zagorulko and O. Borovikova, "An approach to building portals of scientific knowledge," *Autometry*, vol. 44, no. 1, pp. 100–110, 2008.

[32] P. Van Baalen, J. Bloemhof-Ruwaard, and E. Van Heck, "Knowledge sharing in an emerging network of practice:: The role of a knowledge portal," *European Management Journal*, vol. 23, no. 3, pp. 300–314, 2005.

[33] R. Mack, Y. Ravin, and R. J. Byrd, "Knowledge portals and the emerging digital knowledge workplace," *IBM systems journal*, vol. 40, no. 4, pp. 925–955, 2001.

[34] V. V. Golenkov and N. A. Gulyakina, "Graphodynamic models of parallel knowledge processing: principles of construction, implementation and design," in *Open semantic technologies of designing intelligent systems (OSTIS-2012) : proceedings of the II International scientific-technical conference, Minsk, 16–18 Feb. 2012 y*. Minsk, 2012, pp. 23–52.

[35] V. V. Golenkov, "Ontology-based design of intelligent systems," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. Iss. 1. Minsk : BSUIR, 2017, pp. 37–56.

[36] V. Golenkov, N. Guliakina, I. Davydenko, A. Eremeev, "Methods and tools for ensuring compatibility of computer systems," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. 4, V. Golenkov, Ed. BSUIR, Minsk, 2019, pp. 25–52.

[37] A. Zhmyrko, "Family of external languages of next-generation computer systems, close to the language of the internal semantic representation of knowledge," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*. Minsk : BSUIR, 2022, pp. 65–80.

[38] K. Bantsevich, "Metasystem of the ostis technology and the standard of the ostis technology," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. Iss. 6, V. Golenkov, Ed. BSUIR, Minsk, 2022, pp. 357–368.

[39] V. V. Golenkov and N. A. Gulyakina, "Open project aimed at creating a technology for component-based design of intelligent systems," in *Open Semantic Technologies for Designing Intelligent Systems (OSTIS-2013) : proceedings of the III International Scientific and Technical Conference, Minsk, 21-23 Feb. 2013 y*. Minsk, 2013, pp. 55–78.

[40] A. Zagorskiy, "Principles for implementing the ecosystem of nextgeneration intelligent computer systems," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*. BSUIR, Minsk, 2022, p. 347–356.

[41] V. Ivashenko, "General-purpose semantic representation language and semantic space," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. Iss. 6. Minsk : BSUIR, 2022, pp. 41–64.

[42] K. Bantsevich, "Structure of knowledge bases of next-generation intelligent computer systems: a hierarchical system of subject domains and their corresponding ontologies," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, ser. Iss. 6, V. Golenkov, Ed. BSUIR, Minsk, 2022, pp. 87–98.

[43] A. Goylo and S. Nikiforov, "Means of formal description of syntax and denotational semantics of various languages in nextgeneration intelligent computer systems," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for designing intelligent systems (OSTIS2022)]*. Minsk, 2022, pp. 99–118.

[44] A. Zagorskiy, "Factors that determine the level of intelligence of cybernetic systems," in *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*. BSUIR, Minsk, 2022, p. 13–26.

[45] O. Parshina, "A question about lexicographic description of didactic terms," *Vestnik Volzhskogo universitet n.a. Tatishchev*, no. 7, pp. 34–40, 2011.

[46] A. Tazetdinov, "Technology of structuring and visualisation of educational information in tutoring systems," *Information and control systems*, no. 1, pp. 60–65, 2009.

ГЛОССАРИЙ OSTIS — ИНСТРУМЕНТ ДЛЯ ОБЕСПЕЧЕНИЯ СОГЛАСОВАННОЙ И СОВМЕСТИМОЙ ДЕЯТЕЛЬНОСТИ ПО РАЗРАБОТКЕ ИНТЕЛЛЕКТУАЛЬНЫХ СИСТЕМ НОВОГО ПОКОЛЕНИЯ

Зотов Н. В., Ходосов Т. П., Остров М. А., Позняк А. В., Романчук И. М., Рублевская Е. А., Семченко Б. А., Сергиевич Д. П., Титов А. В., Шаров Ф. И.

Данная работа включает подробный анализ проблем организации различных видов коллективной деятельности, сравнительный анализ текущих решений по обеспечению согласованности и совместимости информации из различных областей знаний, а также анализ методов и технологий для создания единых информационных пространств для обеспечения согласованного и совместимого хранения, обработки, накопления и распространения знаний. В работе предлагается один из вариантов реализации единого информационного ресурса для обеспечения согласованной и совместимой деятельности по разработке интеллектуальных компьютерных систем нового поколения— Глоссарий OSTIS. Описывается его структура, правила структуризации, размещения и идентификации знаний в нём, а также принципы работы с ним.

Received 15.03.2024

Fundamentals for the Intelligent Non-Invasive Diagnostics

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***Abstract*—The article elaborates the needs of the design and implementation of a intelligent non-invasive diagnostics system. Technological basis for development and different variants of non-invasive diagnostics are proposed as two fundamental components of such system.**

The domestic Open Semantic Technology of Intelligent Systems (OSTIS) is proposed to be used as a core technological foundation while designing the intelligent diagnostic system. The adaptation of diagnostic tasks within logicalsemantic approach will allow to carry out differential diagnostics (i. e. formulating several diagnostic hypotheses). Various approaches towards the non-invasive diagnostics have been considered: functional-spectral diagnostics (FSDdiagnostics), bioimpedance analysis, preliminary diagnostics based on the assessment of the basic parameters of functional state, diagnostics by Zakharyin-Ged zones, diagnostics by Nakatani method, frequency-resonance diagnostics.

***Keywords*—non-invasive diagnostics, artificial intelligence, diagnostic decision support system.**

I. Introduction

Health is the most valuable resource of the state. One of the task of modern society is to timely detect the disease risk. The implementation of this task requires new diagnostic tools based on the latest technologies. Risk diagnosis will provide significant economics savings towards disease prevention and treatment, as well as improve the quality of primary health care. Risk is the probability of developing a disease [1].

The current problem in the area of risk diagnostic is the creation of non-invasive technology for examination and detection of diseases at early stages in order to carry out individualized prevention. The emerging modern technologies provide ample opportunities for solving this problem [2]. At the same time, let us quote a doctor's critical statements about informatization of medicine: "The global problem is the lack of resources. And we are not talking about the shortage of money, but about the shortage of time. The time of professionals is the main world deficit. Information technology offers great opportunities to save money. Telemedicine, for example, has a huge potential. Support for medical decision making is of enormous value, but it is not being deployed and practiced" [3].

The importance of the intelligent non-invasive diagnostics problem has several aspects. Firstly, it is **caring** for people's health that leads towards the individual health improvement and preventive care. Secondly, it is an **increase in the quality** of individual preventive care to the population. Thirdly, it is **beneficial** from the economic point of view, as the costs of prevention and treatment are minimized. Taking into account the problem of "time shortage", it is important to minimize time costs, as the procedures are carried out quickly enough. It is important that non-invasive diagnostics procedures are safe and painless.

Therefore, there is a need to continue to investigate and develop the intelligent non-invasive diagnostics, with the primary focus on the development of an intelligent system to support the decision making for non-invasive diagnostic.

The proposed architecture for the intelligent diagnostic ostis-system allows to assess the risk of diseases in patients, and creates the "windows of opportunity" not only for patients and doctors, but also for developers in terms of expanding the functionality of the system.

The main aim of this paper is to create an intelligent non-invasive diagnostic system architecture suitable for screening of systemic and nosological risks and early diagnosis of diseases, i. e. for diagnosing latent and initial stages of pathological process development for the purpose of primary and secondary prevention or timely treatment.

II. Overview of Existing Solutions

The quality of medical care depends on the level of doctors' training and on systems that support decision making, including in the field of diagnosing the diseases at various stages.

While there are many medical decision support systems in various fields, the deployment of such systems into the everyday practice is relatively slow.