

Architecture of the Computer-linguistic System for Processing of Specialized Web-communities' Educational Content

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Abstract. The aim of the article is the architecture of the computer-linguistic processing system of web-communities' educational content, which makes it possible to predict and form qualitative students' contingent of higher education institutions and to make management decisions based on the motivational intentions of potential entrants. The paper proposes the architecture and functional structure of the computer-linguistic processing system of educational communities' content for effective planning to provision of educational services based on procedures selection of potential entrants' motivational intentions and the quality of information content for educational communities. Chart data streams of complex information system automated processing of specialized educational content describes the operation of software agents working out of the content. The proposed software agents select relevant thematic educational discussions, identify motivational intentions of potential entrants, and formulate reaction of higher education institutions to selected postings to provide and create quality content for specialized online education communities. The results of the research are applied and can be used to effectively plan educational services and to create quality content for specialized educational communities, taking into account the motivational intentions of potential entrants.

Keywords: Educational Content, Data Flow Diagram, Software Agent, Computer-linguistic Processing System, Architecture and Functional Structure.

1 Introduction

Today, higher education institutions (HEI) are the focus to the provision of educational services for higher education applicants. In general, the educational service is interpreted as the end result of the planning process and providing these services.

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That is why the developed information systems are oriented to support the main forms of introduction of educational services in the educational process. However, the absence of educational consumers makes it impossible to carry out the process of providing these services of higher education institutions. HEIs need to undergo major changes in their management approach [1], which will change the way institutions manage their processes, services and structures; and will force them to evolve into frameworks when such elements become instruments of flexibility and innovation rather than obstacles to growth and development [2].

Therefore, a prerequisite for the existence of HEI in the market of educational services is to predict the consumers' contingent of these services. For this reason, the main task of this article is creation the architecture of the computer-linguistic processing system of the specialized communities' educational content for the formation of a qualitative contingent of educational services consumers and for management decision-making by HEI.

2 Related Works

There are several areas for studying the architecture of information systems, in particular for the efficient operation of higher education institutions today.

An analysis of the process of development of information systems architecture, as well as instructions and rules for the development, presentation and understanding of information systems architecture is considered in [3-5]. In particular, it is determined that the development of information systems architecture should consist of five stages, such as the planning and design phase, the operational analysis phase, the requirements analysis phase, the function analysis phase, the physical synthesis phase.

The papers [6-8] formulate recommendations for the development and improvement of information technologies and systems for supporting organizational goals to increase their competitiveness.

Integrated processing method of heterogeneous information resources of web-systems, which simplifies the technology of integrated automation and content management described in [9]. Informational resources processing intellectual systems (IRPISes) with textual commercial content linguistic analysis usage creation, that widespread usage is considered in [10-12].

As the vast majority of HEIs today can be considered labor-intensive and human organizations, information systems architectures as important tools for supporting several different institutional educational processes and providing users with relevant data are discussed in [13-15].

The reference model for higher education institutions towards a unified information system is described in [16-17] and aims to integrate mixed information systems and applications for the effective and competitive existence of HEIs in the educational services market.

But, none of the research areas examines the architecture of the computer-linguistic processing system of the specialized communities' educational content for the purpose of predicting and create a high-quality contingent of university students and for

making management decisions taking into account the motivational intentions of potential entrants.

The procedures of computer-linguistic processing of specialized web communities' content for planning the provision of educational services of HEI [18-20] are rather cumbersome and require sufficiently large computational actions. Therefore, their practical application required the creation of an appropriate system of computer-linguistic processing of content.

The main functions of such a system are the collection, processing, creation of reactions and preservation of results (dictionary of motivational intentions), but also the continuous monitoring and analysis of the quality of the educational web-communities' content.

This is due to changes in the entry campaign rules and requirements for entry into the HEI, which are the key to planning the provision of high quality HEIs educational services.

3 Architecture of Information System for Computer-Linguistic Processing of Educational Content for Predicting Higher Education Students

Prediction and formation of high-quality students' contingent of higher education institution is directly connected with consumers of educational services [2].

Therefore, consideration of their motivational intentions and the formation of reactions by the HEI is a prerequisite for the architecture of the computer-linguistic processing system of educational information content.

The architecture of the information system for computer-linguistic processing of educational information content, which takes into account the motivational intentions of educational services consumers, generates appropriate reactions from them by HEI and conducts constant monitoring and analysis of the quality of information content of educational communities is presented in Fig. 1.

The peculiarity of such a complex information system for automated computer-linguistic processing of information content is its functioning at three architectural levels:

1. the level of local information system;
2. the level of information processing agents;
3. the level of external information services and resources.

At the first level, work is done with information content within the local information system, which provides:

- formation of the necessary elements of educational information content;
- identification of indicative features;
- monitoring the quality of the content and the vocabulary of motivational intentions;
- specifying selection options relevant to the entry campaign period, thematic discussions and posts.

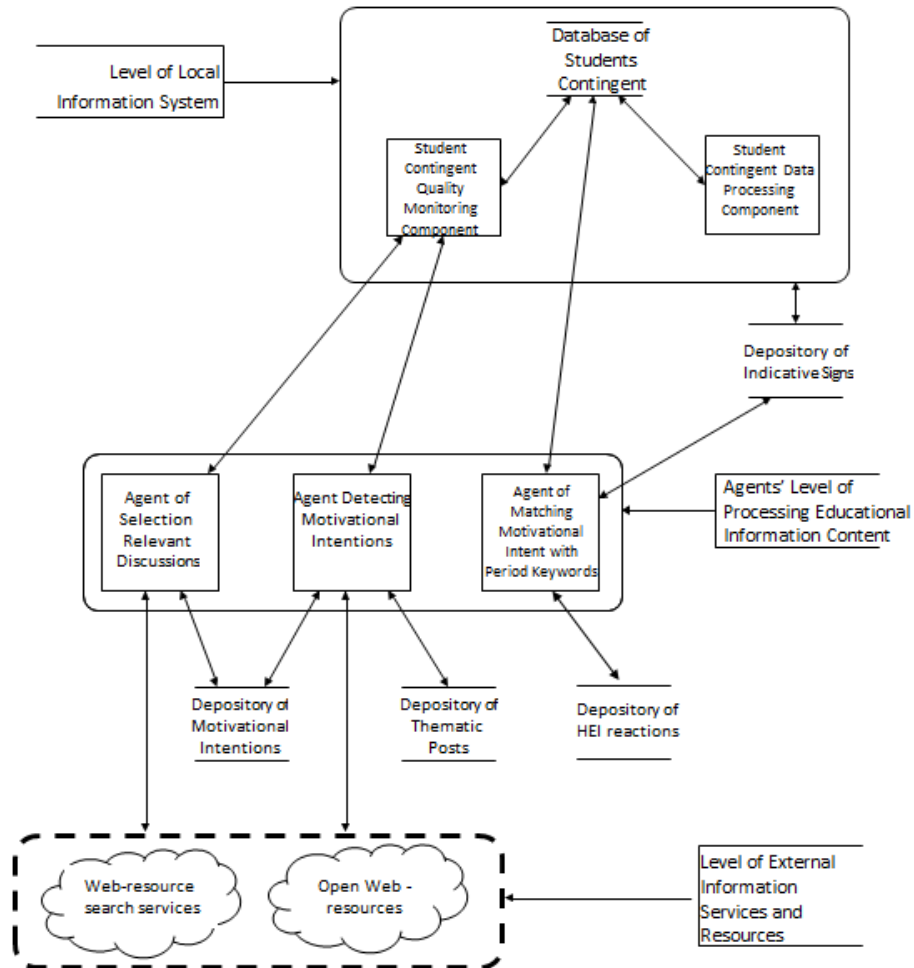


Fig. 1. Architecture of information system for computer-linguistic processing of educational content

At the second level, there are software agents of information processing which are intended for:

- selection of relevant educational discussions;
- keeping thematic posts;
- detecting users' motivational intent in posts;
- matching the keywords of the entry campaign period with the identified motivational intentions;
- retention of motivated intentions;
- dictionary of the motivational intentions database formation.

- selection of HEI reactions to identified motivational intentions

At the third level, external information services and resources are used to process the information content:

- Web-resource search services (search engines);
- open Web-resources that serve as sources of educational information for content.

4 Functional structure of the automatic content processing system for specialized educational web-communities

Functional structure of the automatic content processing system of specialized educational communities is based on the architecture of a complex information system of automated computer-linguistic information content processing. The context diagram of a complex information system for automatic processing of specialized educational communities information content is presented in Fig. 2.

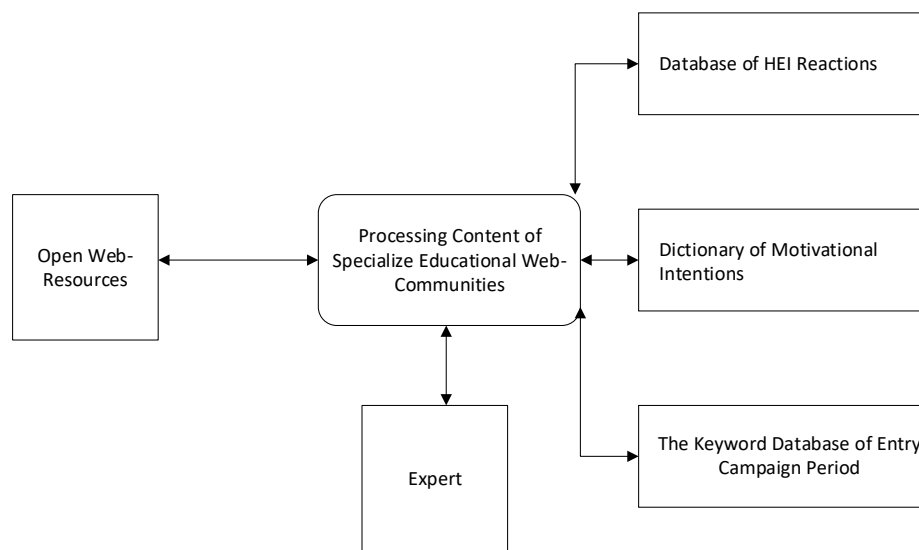


Fig. 2. The context diagram of a complex information system for automatic processing of specialized educational communities information content

Chart data streams of the complex information system for automated processing of information of specialized educational web-communities' content is presented in Fig.3. It highlights the following features:

1. agent of selection relevant discussions;
2. agent of motivational intentions selection;

3. processing of motivational intentions;
4. HEI reactions;
5. monitoring the quality of educational information content.

The agent for selection of relevant discussions consists of the following functions:

- keyword formation in relation to the periods of the entry campaign;
- checking the relevance of the thematic discussion;
- defining topical thematic discussions regarding the entry campaign periods.

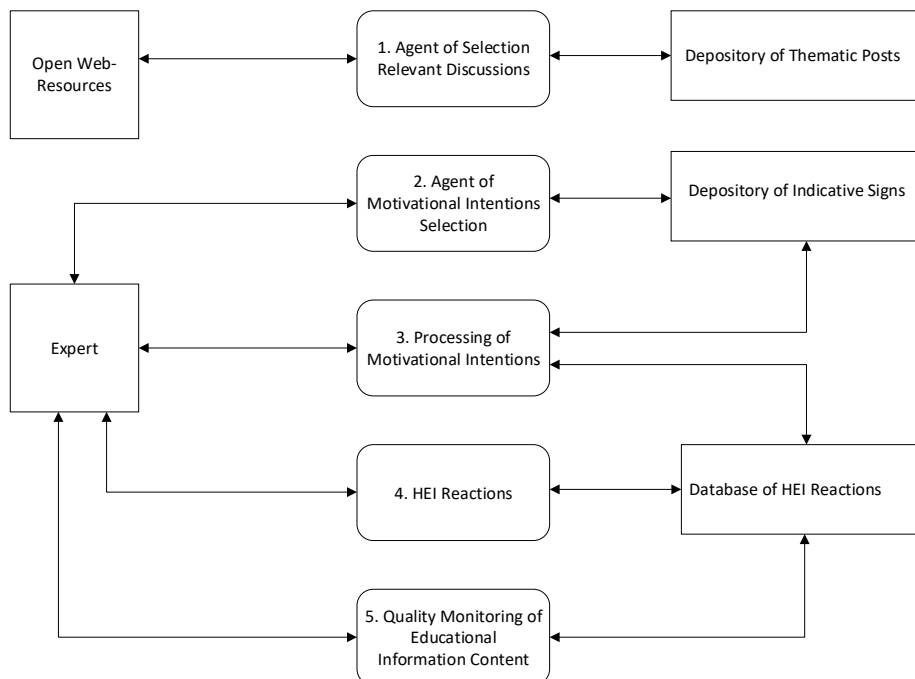


Fig. 3. Chart data streams of the complex information system for automated processing of information of specialized educational web-communities' content

Agent of motivational intention selection based on the motivational intention selection algorithm [20] contains the following functions:

- identifying indicative signs of motivational intent in the posts;
- matching indicative features to keywords;
- maintaining motivation.

Considering the algorithm of selection of motivational intentions from thematic posts of specialized web-communities, Processing of Motivational Intentions contains the following functions:

- setting indicative features;
- reviewing educational content;
- assessment of the importance of the identified motivational intentions;
- export of motivational intentions.

The HEI reactions, which are the result of the algorithm of formation of the dictionary of motivational intentions concerning a certain period of the entry campaign [21] and the previous experience of the HEI reactions to certain situations according to the identified motivational intentions and the period of the entry campaign, have the following functions:

- formation of the HEI reactions;
- reviewing the HEI reactions;
- evaluation of results;
- modernization of HEI reactions.

Quality monitoring of educational content is based on the indicators of quality of educational content, based on the criteria [21].

Quality monitoring of educational content contains the following features:

- analysis of plural keywords;
- analysis of plural motivational intentions;
- analysis of the relevance content;
- analysis of the assistance level of HEI reactions;
- analysis of the deficiencies.

5 Results

Since the architecture of the computer-linguistic processing system of web-communities' educational content takes into account motivational intentions consumers of educational services and generates appropriate reactions from the HEI, informative indicators of this system are the speed of HEI reactions in the process of communicative activity and analysis of enrollment of potential entrants.

According to the results of the analysis of educational web-forum for entrants communication activity and relevant thematic groups in social networks of Lviv Polytechnic National University, the reaction time indicator decreased by 20% - 40% depending on the period of the entry campaign (Fig. 4), and, on average, 30% for the 2016/2019 introductory campaigns (Fig. 5).

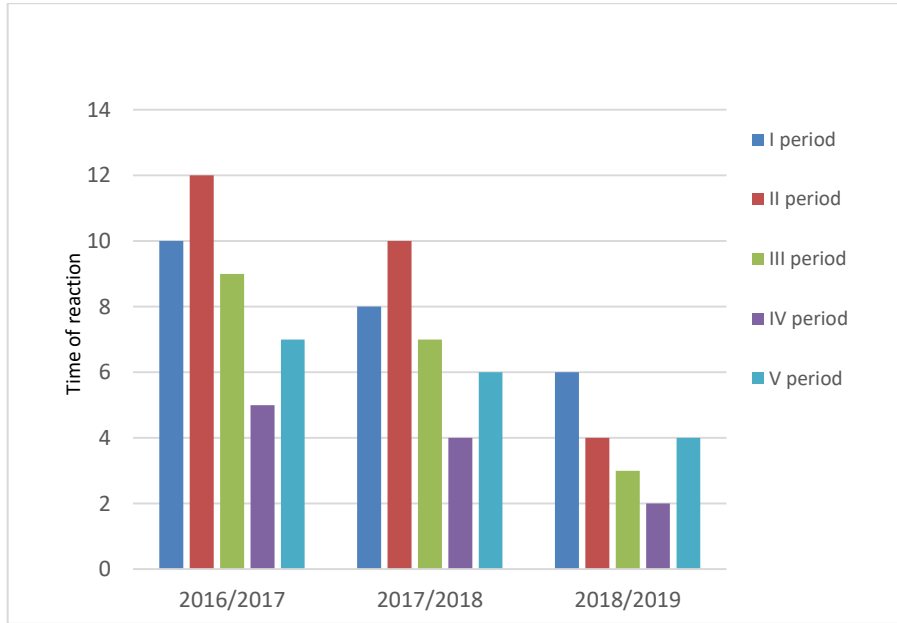


Fig. 4. Dynamics of the reaction time by HEI in relation to the periods of entry campaign for the 2016/2019 entry campaigns

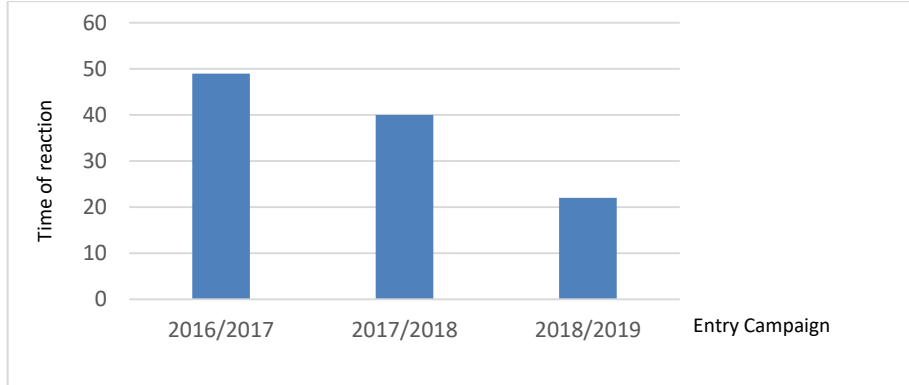


Fig. 5. Dynamics of the reaction time by HEI for the 2016/2019 entry campaigns

The analysis of the information system work shows the positive dynamics of change in the number of enrolled students for 2016/2019 to the Lviv Polytechnic National University, by an average of 3%.

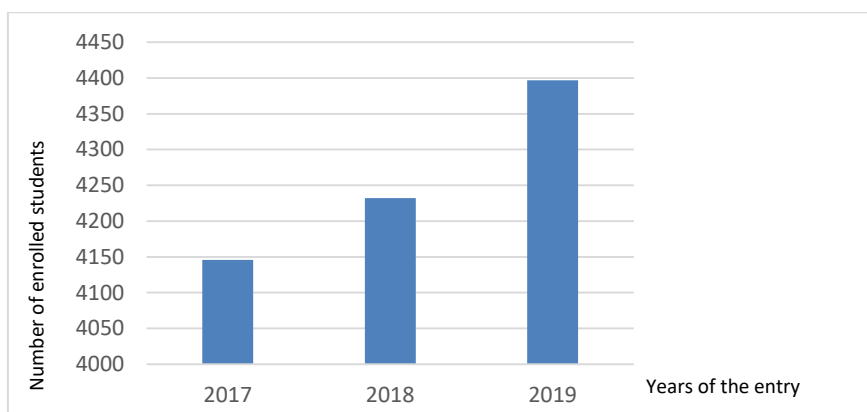


Fig. 6. Dynamics of change in the number of enrolled students for the 2016/2018 entry campaigns

6 Conclusion

Therefore, this article develops the architecture of the computer-linguistic processing system of web-communities' educational content to plan effectively the provision of educational services and to make management decisions by the HEI during the entry campaign based on the procedures for selecting motivational intentions of potential entrants indicators of the quality of the content of educational web-communities , which in practice allowed to establish a system of maintaining the relevance and correctness of educational information the content of educational web-communities and official web-resources of higher education institutions with the ability to properly support the quality of information content. The analysis of the results of the communication activities of the consumers of educational services in specialized web-communities showed a decrease in the time for a response by HEI to the identified motivational intentions of potential entrants, as well as the positive dynamics of actually enrolled entrance in relation to the entry campaigns in recent years for the HEI.

References

1. Pucciarelli, F, Kaplan, A.: Competition and strategy in higher education: Managing complexity and uncertainty. *Business Horizons* 59, 311–320 (2016).
2. Mikhno, N., Sorokina, L.: Trend analysis of the educational choice of university entrants as tool to improve the quality of educational service. *International Journal of Information and Communication Technologies in Education* 6(3), 36-39 (2017).
3. Xuemina, Zh., Zhimingb, S., Pinga, G.: The Process of Information Systems Architecture Development. In *Proceedings of the International Workshop on Information and Electronics Engineering (IWIEE) Procedia Engineering*, 775 – 779 (2012).
4. Abel, R., Brown, M, Suess, J.: A New Architecture for Learning. *Educause Review* 48, 88–102 (2013).

5. Xiaohai, L., Yafei, T.: Architecture Framework and its Design Method. *Fire Control & Command Control* 1, 6-8 (2010).
6. Prayitno, T.: Planning of Higher Education Information Technology Strategy Using TOGAF. *Indonesian Journal of Information Systems* 2(1). 67-79 (2019).
7. Luftman, J. N., Lewis, P.R., Oldach, S.H.: Transforming the enterprise: The alignment of business and information technology strategies, *IBM System Journal* 32(1), 198–221(2010).
8. Mardiana, Araki, K.: EA-MDA Model to Resolve is Characteristic Problems in Educational Institutions. *International Journal of Software Engineering & Applications* 4(3), 1–20 (2013).
9. Kanishcheva, O., Vysotska, V., Chyrun, L., Gozhyj, A.: Method of integration and content management of the information resources network. *Advances in Intelligent Systems and Computing* 689, 204-216. Springer (2018).
10. Vysotska, V.: Linguistic analysis of textual commercial content for information resources processing. *Modern Problems of Radio Engineering, Telecommunications and Computer Science. Proceedings of the 13th International Conference on TCSET 2016*, Art No. 7452160, pp. 709-713 (2016).
11. Su, J., Vysotska, V., Sachenko, A., Lytvyn, V., Burov, Y.: Information resources processing using linguistic analysis of textual content. *Proceedings of the 9th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, IDAACS 2017*, Vol. 2, No. 8095038, 573-578 (2017).
12. Davydov, M., Lozynska, O.: Information system for translation into Ukrainian sign language on mobile devices. *Proceedings of the 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2017*, Vol. 1, Art No. 8098734, pp. 48-51 (2017).
13. Bidan M, Rowe F, Truex D.: An empirical study of IS architectures in French SMEs: integration approaches. *European Journal of Information Systems* 21, 287–302 (2012).
14. Natek, S, Lesjak, D.: The process architecture of information systems - higher education institution's managerial tool. *Issues Information Systems* 1, 29– 34 (2010).
15. Natek, S, Lesjak, D.: Integrated Higher Education Information systems - Professors' knowledge management tools. *Issues Information Systems* 12, 80–86 (2011).
16. Sanchez-Puchola, F., Pastor-Collado J. A., Borrell, B.: Towards an Unified Information Systems Reference Model for Higher Education Institutions. *Procedia of computer science* 121, 542-553 (2017).
17. Charles Sturt University. Higher Education Process Reference Model. Charles Sturt University. *Work Process Improvement* (2010). [Electronic resource] Available at: <http://www.csu.edu.au/special/wpp/resources/reference-model>
18. Zhezhnych, P., Shilinh, A., Melnyk, V.: Linguistic analysis of user motivations of information content for university entrant's web-forum. *International Journal of Computing* 18(1), 67-74 (2019).
19. Shilinh, A., Zhezhnych, P.: Linguistic approaches to the planning of educational services in higher education institution. *ECONTECHMOD* 7(4), 13-20 (2018).
20. Zhezhnych, P., Shilinh, A., Tkachuk, V.: Computer-linguistic Selection of Potential Entrances' Motivation Intentions from Posts of Education Web-Community. In *Proceedings of the 1st International Workshop on Control, Optimization and Analytical Processing of Social Networks (COAPSN-2019)*, pp.134–146. Lviv (2019).
21. Systems and software engineering. Systems and software Quality Requirements and Evaluation (SQuaRE). System and software quality models. ISO/IEC 25010.2:2008. Mode of access: http://sa.inceptum.eu/sites/sa.inceptum.eu/files/Content/ISO_25010.pdf. (2008).

22. Trach, O., Fedushko, S. Determination of measures of counteraction to the social-oriented risks of virtual community life cycle organization (2020) *Advances in Intelligent Systems and Computing*, 1080 AISC, pp. 680-695. DOI: 10.1007/978-3-030-33695-0_46
23. Fedushko, S., Kolos, S., Malynovska, Y. MBTI principles in detecting emotional manipulators among digital platforms users (2019) *CEUR Workshop Proceedings*, 2588, .
24. Fedushko, S., Syerov, Y., Kolos, S. Hashtag as a way of archiving and distributing information on the internet (2019) *CEUR Workshop Proceedings*, 2386, pp. 274-286.
25. Mastykash, O., Peleshchyshyn, A., Fedushko, S., Trach, O. and Syerov, Y.: *Internet Social Environmental Platforms Data Representation*. 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), Lviv, Ukraine, 2018, pp. 199-202. doi: 10.1109/STC-CSIT.2018.8526586
26. Syerov Yu., Fedushko S., Loboda Z.: *Determination of Development Scenarios of the Educational Web Forum*. Proceedings of the XIth International Scientific and Technical Conference (CSIT 2016), pp. 73-76. Lviv (2016).
27. Mastykash O., Peleshchyshyn A., Fedushko S., Trach O., Syerov Y.: *Internet Social Environmental Platforms Data Representation*, IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), pp. 199-202. Lviv, Ukraine (2018).
28. Korobiichuk I., Syerov Y., Fedushko S.: *The method of semantic structuring of virtual community content*. *Advances in Intelligent Systems and Computing*, vol. 1044, pp. 11-18 (2020).
29. Korobiichuk I., Fedushko S., Juś A., Syerov Y.: *Methods of Determining Information Support of Web Community User Personal Data Verification System*. In: Szewczyk R., Zieliński C., Kaliczyńska M. (eds) *Automation 2017. ICA 2017*. *Advances in Intelligent Systems and Computing*, vol. 550, pp. 144-150. Springer (2017).
30. Korzh R., Peleschyshyn A., Syerov Yu., Fedushko S.: *Principles of University's Information Image Protection from Aggression*. Proceedings of the XIth International Scientific and Technical Conference (CSIT 2016), pp. 77-79. Lviv, Ukraine (2016).