Laboratory of Speech and Multimodal Interfaces

Head of the laboratory:

Alexey A. Karpov, Dr. Tech. Sci., Assoc. Prof. - development of speech and multimodal human-computer interfaces and systems, karpov@iias.spb.su, http://hci.nw.ru/en

Research activities

Research and development of methods for natural human-computer interaction. Automatic audio-visual speech recognition and understanding. Multimodal user interfaces. Intelligent rooms and spaces. Assistive information technologies and systems for disabled people. Russian sign language research. Computational paralinguistics. Psycho-emotional states recognition.

Laboratory staff: 13 members.

Research fellows and brief information of the research-work direction

Alexey A. Karpov, chief researcher, Dr. Tech. Sci., Assoc. Prof. - development of speech and multimodal human-computer interfaces and systems, karpov@iias.spb.su, http://hci.nw.ru/en

Irina S. Kipyatkova, senior researcher, Ph.D. - methods for language and acoustic modeling based on artificial neural networks for automatic Russian speech recognition systems, kipyatkova@iias.spb.su.

Dmitry A. Ryumin, researcher - automatic recognition of gestures and elements of Russian sign language, ryumin.d@iias.spb.su.

Denis V. Ivanko, researcher - audio-visual Russian speech recognition with the use of a microphone and a high-speed video camera, ivanko@iias.spb.su.

Alexander A. Axyonov, junior researcher - visual features calculation methods for automatic lip-reading, axyonov.a@iias.spb.su

Alena N. Velichko, junior researcher - methods for automatic detection of destructive paralinguistic phenomena in conversational speech, velichko.a@iias.spb.su.

Oksana V. Verkholyak, junior researcher - automatic recognition of speaker's emotional states using voice characteristics and tonality of the text of the statement, verkholyak.o@iias.spb.su

Ildar A. Kagirov, junior researcher - formal representation of Russian sign language grammatical structures, collection and annotation of Russian sign language databases, investigation of gesture based user interfaces in the area of service robotics, kagirov@iias.spb.su.

Maxim V. Markitantov, junior researcher – automatic gender and age recognition from speech, markitantov.m@iias.spb.su.

Elena E. Lyakso, leading researcher, Dr. Bio. Sci., Prof. - paralinguistic speech analysis, psycho-emotional states detection from speech, analysis of children's speech, lyakso@gmail.com.

Lev A. Stankevich, leading researcher, Ph.D. - multimodal interfaces and robotic systems, stankevich_lev@inbox.ru.

Postgraduate students

Alena N. Velichko – "Automatic system for detection of destructive paralinguistic phenomena in speech" (research advisor – Karpov A.).

Programmers (master students)

Anastasia A. Dvoynikova – automatic recognition of emotional states by text data, dvoynikova.a@iias.spb.su.

Elena V. Ryumina – automatic recognition of human emotions by facial expressions, ryumina.e@iias.spb.su.

Grants and projects

Karpov A. Agreement No. 14.616.21.0095 (Reference ID: RFMEFI61618X0095) with the Ministry of Science and Higher Education of the Russian Federation, Special federal program "Research and development in priority areas of development of the scientific and technological complex of Russia for 2014-2021" (Event 2.2), project "Multi-modal interface based on gestures, speech, and sign language for control of an assistive mobile information robot - AMIR", foreign partner:

The University of West Bohemia, Pilsen, Czech Republic, 2018-2020 (jointly with A. Saveliev's laboratory).

Karpov A. Project of the Russian Science Foundation No. 18-11-00145 "Development and research of an intelligent system for complex paralinguistic analysis of speech", 2018-2020.

Karpov A. Project of RFBR No. 20-04-60529-viruses "Analysis of voice and facial features of a human in a mask", 2020-2022.

Karpov A. Project of RFBR No. 19-29-09081-mk "Software and infoware for intelligent analysis of video and audio information for assistive mobile systems in vehicles", 2019-2022 (jointly with A. Smirnov's laboratory)

Kipyatkova I. Project of RFBR No. 18-07-01216-a "Development of an end-to-end continuous Russian speech recognition system using deep neural networks", 2018-2020.

Karpov A. Project of RFBR No. 18-07-01407-a "Automatic bimodal recognition of natural emotions in Russian speech", 2018-2020.

Ivanko D. Project of RFBR No. 18-37-00306-mol_a "Methods, models and algorithms of visual signals processing for lip-reading", 2018-2020.

Karpov A. Project of RFBR No. № 20-37-90144-Ph.D. students "Development and research of an automatic system for detection of destructive paralinguistic phenomena in speech", 2020-2022 (PhD student Velichko A.N.).

Kipyatkova I. Grant-subsidy of the Committee on Science and Higher Education of the Government of St. Petersburg for young PhD researchers "Research of application of transfer learning at end-to-end Russian speech recognition model training", 2020.

Verkholyak O. Grant-subsidy of the Committee on Science and Higher Education of the Government of St. Petersburg for young researchers "Automatic recognition of emotions and psychophysiological states of the elderly using the acoustic and linguistic characteristics of the speech signal", 2020.

Ivanko D. Grant-subsidy of the Committee on Science and Higher Education of the Government of St. Petersburg for young researchers

"Development and research of neural network models for automatic Russian speech recognition of by video information", 2020.

Markitantov M. Grant-subsidy of the Committee on Science and Higher Education of the Government of St. Petersburg for young researchers "Automatic detection of a medical mask by voice characteristics of the speaker based on pre-trained neural network models", 2020.

Karpov A. Contracts with Huawei и “ASM Solutions” LLC (Moscow)

University courses

Karpov A., ITMO University, St. Petersburg University.
Kipyatkova I., SUAI University.

Scientific and organizational activity

Karpov A., Ryumin D., Axyonov A., Kagirov I., Ivanko D., Kipyatkova I. – joint research project with The University of West Bohemia (Czech Republic).

Karpov A., Verkholyak O., Markitantov M. – joint participation in international INTERSPEECH Computational Paralinguistics Challenge (ComParE 2020) with the Utrecht University (Netherlands) and the Ulm University (Germany).

Karpov A., Verkholyak O., Markitantov M., Ryumin D., Axyonov A., Kagirov I., Kipyatkova I., Stankevich L. – joint publications with the University of Novi Sad (Serbia), the University of West Bohemia (Czech Republic), the Utrecht University (Netherlands), Ulm University (Germany), the University of Magdeburg (Germany), University of Hertfordshire (England), Tel Aviv University (Israel).

Membership in Russian and International societies, dissertation Councils

Karpov A. – Expert of the RAS; Coordinator of the Outreach Geographical Sub-Committee on the Eastern Europe of the International Speech Communication Association (ISCA); Local Liaison Officer in Russia of the European Association for Signal Processing (EURASIP);

Member of the international associations IEEE, ACM and IAPR; Editorial board member of the journals "Informatics and Automation" (SPIIRAS Proceedings), "Speech Technologies" (Moscow), "Informatics" (Minsk, Belarus), "Multimodal Technologies and Interaction" (MDPI, Switzerland); Guest editor of the Journal on Journal on Multimodal User Interfaces (Springer), Speech Communication (Elsevier), Journal of Electrical and Computer Engineering (Hindawi); Reviewer of many international journals including IEEE/ACM Transactions on Audio, Speech and Language Processing; IEEE Transactions on Affective Computing; IEEE Transactions on Biomedical Engineering; IEEE Journal of Biomedical and Health Informatics; Neurocomputing; Computer Speech & Language; Speech Communication; IEEE Signal Processing Letters, Pattern Recognition Letters; Pattern Recognition; Language Resources and Evaluation; Soft Computing; Journal of Information Science; Acoustical Physics, etc.; General Chair of the series of International Conferences SPECOM; Technical/program committee member of the international conferences INTERSPEECH, ICASSP, ICPR, SLTU, SPECOM, Baltic HLT, HBU, SIU, DOGS, etc., member of dissertation Council 002.199.01.

Kipyatkova I. – Technical/programme committee member of the international conferences INTERSPEECH, ICASSP, SPECOM, member of the organizing committee of the International Conference SPECOM.

Verkholyak O. – Member of the International Speech Communication Association (ISCA), member of the Association for Computational Linguistics (ACL), member of the IEEE Young Professionals and IEEE Membership.

Ivanko D. – Scientific committee member of the international conference LREC, IEEE Membership.

Intellectual property

1. Patent of the Russian Federation for the invention: "A way for multimodal contactless control of a mobile information robot", authors: Ryumin D., Kipyatkova I., Kagirov I., Axyonov A., Karpov A., No. 2737231, dated 26.11.2020.

2. Computer software registration: "Software for multimodal interface for an assistive mobile information robot

(MultimodalHMinterface)", authors: Ryumin D., Kipyatkova I., Karpov A., No. 2020619331, dated 17.08.2020.

3. Computer software registration: "Software for Complex Paralinguistic Analysis of Speech (ComPAS – Complex Paralinguistic Analysis of Speech)", authors: Verkholyak O., Markitantov M., Velichko A., Kipyatkova I., Karpov A., No. 2020664233, dated 10.11.2020.

4. Computer software registration: "Software for Speech Emotion Recognition (ProSpER – Program for Speech Emotion Recognition)", authors: Velichko A., Verkholyak O., Karpov A., No. 2020664234, dated 10.11.2020.

5. Database registration: "Multimedia database of Russian sign language elements (TheRuSLan)", authors: Ryumin D., Axyonov A., Kagirov I., Karpov A., No. 2020621419, dated 13.08.2020.

6. Database registration: "Multimodal Corpus for Russian Audio-Visual Speech in Cars (RUSAVIC)", authors: Lashkov I., Axyonov A., Ivanko D., Ryumin D., Karpov A., Kashevnik A. No. 2020622063, dated: 27.10.2020.

Awards, certificates, scholarships

Verkholyak O., Karpov A. - Winners (first award) of the INTERSPEECH Computational Paralinguistics Challenge (ComParE-2020) in the "Elderly Emotion Sub-Challenge".

Markitantov M., Karpov A. - Winners (first award) of the INTERSPEECH Computational Paralinguistics Challenge (ComParE-2020) in the "Breathing Sub-Challenge".

Kipyatkova I. - diploma of the winner of the St. Petersburg grant competition in 2020 for young PhD from the Government of St. Petersburg.

Verkholyak O., Ivanko D., Markitantov M. - diplomas of the winners of the St. Petersburg grant competition in 2020 for young scientists from the Government of St. Petersburg.

Ryumin D., Ivanko D. - letters of gratitude from the Committee on Youth Policy and Interaction with Public Organizations for the great contribution to the popularization of science among the youth of St. Petersburg and education of the younger generation.

Recent Results

A software system for automatic recognition of Russian sign language (RSL) items in a complex dynamic background environment has been developed. The software is characterized by multimodal analysis of meaningful hand movements (gestures) through detection and localization of human hand landmarks using the MediaPipe software toolkit, which allows stable recognition of both static and dynamic signs of the hands of a user and is aimed at creation of effective tools of contactless human-machine interaction, including these used in mobile robotic platforms, exoskeletons and manipulators [3,6,14,18].

A universal approach for analysis of various paralinguistic phenomena in speech has been developed. The approach differs from existing methods and shows higher generalization ability due to ensemble classification, as well as an effective approach for machine learning of the classification system using the cross-validation technique instead of the conventional train/validation/test splits. We investigated the effectiveness of both acoustic and linguistic features. A set of various pre-trained neural network models were effectively used to speed-up the training process and increase the accuracy on the small data sets. The proposed approaches have allowed us to reach the highest classification results at the INTERSPEECH 2020 Computational Paralinguistics Challenge [4,5,8].

Various end-to-end (E2E) models including Connectional Temporal Classification (CTC) model and attention-based encoder-decoder model using different types of attention mechanisms, such as coverage-based attention, 2D location-aware attention, as well as their combination have been developed for automatic recognition system of continuous Russian speech. The models have allowed achieving higher recognition speed comparing to the baseline end-to-end models [23,30,33].

A method for sentiment-analysis of Russian language transcriptions obtained by two automatic speech recognition systems (Speech Recognition by Google and SpeechKit by Yandex) of audio data using Support Vector Machine (SVM) as a machine classifier and Word2Vec method for text vectorization has been developed. The method has allowed

reaching the unweighted average recall (UAR) measure of almost 90%; the result is one of the first in the field of sentiment-analysis of text transcriptions in Russian, so it can be considered as the baseline for future research [12,22,36].

A method for automatic emotion recognition based on analysis of human's facial expressions has been developed. The method is based on geometric facial characteristics (such as distances between facial landmarks), the importance of which was scored using ensemble classifiers. An artificial neural network with a Long Short-Term Memory (LSTM) was used as a machine learning technique for evaluating spatial-temporal dependences in the change in the movements of human's facial muscles [15,27,37].

Publications:

Papers prepared jointly with foreign organizations:

1. *Bojanić M., Delić V., Karpov A.* Call Redistribution for a Call Center Based on Speech Emotion Recognition // Applied Sciences. 2020. 10(13). ID 4653. DOI: 10.3390/app10134653 (WoS, Scopus, Q1)

2. *Akhtiamov O., Siegert I., Karpov A., Minker W.* Using Complexity-Identical Human- and Machine-Directed Utterances to Investigate Addressee Detection for Spoken Dialogue Systems // Sensors. 2020. 20(9). ID 2740. DOI: 10.3390/s20092740 (WoS, Scopus, Q1)

3. *Ryumin D., Kagirov I., Axyonov A., Pavlyuk N., Saveliev A., Kipyatkova I., Zelezny M., Mporas I., Karpov A.* A Multimodal User Interface for an Assistive Robotic Shopping Cart // Electronics. 9(12). ID 2093. DOI: 10.3390/electronics9122093 (WoS Q2, Scopus Q2)

4. *Markitantov M., Dresvyanskiy D., Mamontov D., Kaya H., Minker W., Karpov A.* Ensembling End-to-End Deep Models for Computational Paralinguistics Tasks: ComParE 2020 Mask and Breathing Sub-Challenges // Proceedings of INTERSPEECH-2020, ISCA, 2020. pp. 2072-2076 DOI: 10.21437/Interspeech.2020-2666 (Scopus)

5. *Soğancıoğlu G., Verkholyak O., Kaya H., Fedotov D., Cadée T., Salah A., Karpov A.* Is Everything Fine, Grandma? Acoustic and Linguistic Modeling for Robust Elderly Speech Emotion Recognition // Proceedings

of INTERSPEECH-2020, ISCA, 2020. pp. 2097-2101. DOI: 10.21437/Interspeech.2020-3160 (Scopus)

6. *Kagirov I., Ryumin D., Železný M.* Gesture-Based Intelligent User Interface for Control of an Assistive Mobile Information Robot // Lecture Notes in Computer Science, Springer LNAI 12336, ICR 2020. 2020. pp. 126-134. DOI: 10.1007/978-3-030-60337-3_13 (Scopus)

7. *Hlaváč M., Gruber I., Železný M., Karpov A.* Lipreading with LipsID // Lecture Notes in Computer Science, Springer LNAI 12335, SPECOM 2020, 2020, pp. 176-183. DOI: 10.1007/978-3-030-60276-5_18 (Scopus)

8. *Kaya H., Verkholyak O., Markitantov M., Karpov A.* Combining Clustering and Functionals based Acoustic Feature Representations for Classification of Baby Sounds. In Companion Publication of the 2020 International Conference on Multimodal Interaction ICMI'20 Companion, WoCBU'20 Workshop Proceedings, ACM, 2020, pp. 509-513. DOI: 10.1145/3395035.3425182 (Scopus)

9. *Bojanić M., Delić V., Karpov A.* Effect of Emotion Distribution on a Call Processing for an Emergency Call Center, In Proc. 28th Telecommunications Forum TELFOR 2020, IEEE, Belgrade, Serbia, 2020, pp. 1-4. DOI: 10.1109/TELFOR51502.2020.9306564 (Scopus)

Papers published in editions, indexed by WoS, Scopus:

10. *Kagirov I., Kapustin A., Kipyatkova I., Klyuzhev K., Kudryavcev A., Kudryavcev I., Loskutov Y., Ryumin D., Karpov A.* Medical exoskeleton "Remotion" with an intelligent control system: Modeling, implementation, and testing // Simulation Modelling Practice and Theory. 2020. 102200. DOI: 10.1016/j.simpat.2020.102200 (WoS, Scopus, Q1)

11. *Kagirov I., Ryumin D., Axyonov A., Karpov A.* Multimedia Database of Russian Sign Language Items in 3D // Topics in the Study of Language (Voprosy Jazykoznanija), 2020, No. 1, pp. 104-123 (in Russian). DOI: 10.31857/S0373658X0008302-1 (WoS, Scopus, Q2)

12. *Dvoynikova A., Karpov A.* Analytical review of approaches to russian text sentiment recognition // Information and Control Systems. 2020. No.4. pp. 20–30 (in Russian). DOI: 10.31799/1684-8853-2020-4-20-30 (Scopus, HAC/VAK, RSCI)

13. *Ryumina E., Karpov A.* Analytical review of methods for emotion recognition by human face expressions // Scientific and Technical Journal of Information Technologies, Mechanics and Optics, 2020, Vol. 20, No. 2, pp. 163–176 (in Russian). DOI 10.17586/2226-1494-2020-20-2-163-176 (Scopus, HAC, RSCI)

14. *Ryumin D.* Automated hand detection method for tasks of gesture recognition in human-machine interfaces // Scientific and Technical Journal of Information Technologies, Mechanics and Optics, 2020, Vol. 20, No. 4, pp. 525–531 (in Russian). DOI: 10.17586/2226-1494-2020-20-4-525-531 (Scopus, HAC, RSCI)

15. *Ryumina E., Karpov A.* Comparative analysis of methods for imbalance elimination of emotion classes in video data of facial expressions // Scientific and Technical Journal of Information Technologies, Mechanics and Optics, 2020, Vol. 20, No. 5, pp. 683-691 (in Russian). DOI: 10.17586/2226-1494-2020-20-5-683-691 (Scopus, HAC, RSCI)

16. *Gundelakh F., Stankevich L., Sonkin K., Nagornova G., Shemyakina N.* Application of Brain-Computer Interfaces in Assistive Technologies. // SPIIRAS Proceedings. Vol. 19. No. 2, 2020, pp. 277-301 (in Russian). https://doi.org/10.15622/sp.2020.19.2.2 (Scopus, HAC, RSCI)

17. *Bakhshiev A., Korsakov A., Stankevich L.* The Hierarchical Memory Based on Compartmental Spiking Neuron Model // Artificial General Intelligence. 2020. pp. 34-43. DOI: 10.1007/978-3-030-52152-3_4 (Scopus)

18. *Ryumin D., Ivanko D., Kagirov I., Axyonov A., Karpov A.* Vision-Based Assistive Systems for Deaf and Hearing Impaired People // Intelligent Systems Reference Library. 2020. 175. pp. 197-224. DOI: 10.1007/978-3-030-33795-7_7 (WoS, Scopus)

19. *Velichko A., Budkov V., Kagirov I., Karpov A*. Applying Ensemble Learning Techniques and Neural Networks to Deceptive and Truthful Information Detection Task in the Flow of Speech. Studies in Computational Intelligence, Springer SCI 868, IDC-2019. 868. 2020. pp. 457-466. DOI: https://doi.org/10.1007/978-3-030-32258-8_56 (Scopus)

20. *Kagirov I., Ivanko D., Ryumin D., Axyonov A., Karpov A*. TheRuSLan: Database of Russian Sign Language // Proceedings of the 12th Language Resources and Evaluation Conference LREC-2020. 2020. pp. 6079-6085 (Scopus)

21. *Kipyatkova I., Karpov A.* Class-based LSTM Russian Language Model with Linguistic Information // Proceedings of the 12th Conference on Language Resources and Evaluation LREC-2020. 2020. pp. 2470–2474 (Scopus)

22. *Dvoynikova A., Verkholyak O., Karpov A*. Emotion Recognition and Sentiment Analysis of Extemporaneous Speech Transcriptions in Russian // Lecture Notes in Computer Science, Springer LNAI 12335, SPECOM 2020. 2020. pp. 136-144. DOI: 10.1007/978-3-030-60276-5_14 (Scopus)

23. *Kipyatkova I., Markovnikov N*. Experimenting with Attention Mechanisms in Joint CTC-Attention Models for Russian Speech Recognition // Lecture Notes in Computer Science, Springer LNAI 12335, SPECOM 2020. 2020. pp. 214–222. DOI: 10.1007/978-3-030-60276-5_22 (Scopus)

24. *Markitantov M*. Transfer Learning in Speaker's Age and Gender Recognition // Lecture Notes in Computer Science, Springer LNAI 12335, SPECOM 2020. 2020. pp. 326-335. DOI: 10.1007/978-3-030-60276-5_32 (Scopus)

25. *Ivanko D., Ryumin D., Karpov A*. An Experimental Analysis of Different Approaches to Audio–Visual Speech Recognition and Lip-Reading // Proceedings of 15th International Conference on Electromechanics and Robotics "Zavalishin's Readings" ZR-2020. 2020. pp. 197-209. DOI: 10.1007/978-981-15-5580-0_16 (Scopus)

26. *Gundelakh F., Stankevich L., Kapralov N., Ekimovskii J.* Cyber-Physical System Control Based on Brain-Computer Interface. In Proc. International Conference on Cyber-Physical Systems and Control CPS&C 2019. Lecture Notes in Networks and Systems, Springer, vol. 95, 2020, pp. 458-469. https://doi.org/10.1007/978-3-030-34983-7_45 (Scopus)

27. *Ryumina E., Karpov A.* Facial Expression Recognition using Distance Importance Scores Between Facial Landmarks // CEUR

Workshop Proceedings, 30th International Conference on Computer Graphics and Machine Vision GraphiCon-2020, vol. 2744, 2020, paper 32, http://ceur-ws.org/Vol-2744/paper32.pdf, DOI: 10.51130/graphicon-2020-2-3-32 (Scopus)

28. *Velichko A., Karpov A.* A Study of Data Scarcity Problem for Automatic Detection of Deceptive Speech Utterances // CEUR Workshop Proceedings, 3rd International Conference on R. Piotrowski's Readings in Language Engineering and Applied Linguistics PRLEAL-2019, vol. 2552, 2020, pp. 38-46. http://ceur-ws.org/Vol-2552/Paper4.pdf (Scopus)

29. *Dvoynikova A., Verkholyak O., Karpov A*. Analytical review of methods for identifying emotions in text data // CEUR Workshop Proceedings, 3rd International Conference on R. Piotrowski's Readings in Language Engineering and Applied Linguistics PRLEAL-2019, vol. 2552, 2020, pp. 8-21. http://ceur-ws.org/Vol-2552/Paper2.pdf (Scopus)

Papers published in editions, indexed by the Russian Science Citation Index (RSCI):

30. *Kipyatkova I., Karpov A.* A comparative study of neural network architectures for end-to-end speech recognition system // Journal of Instrument Engineering. 2020, Vol. 63, No. 11, pp. 1027-1033. (in Russian) (RSCI, HAC). DOI 10.17586/0021-3454-2020-63-11-1027-1033

31. *Axyonov A., Ivanko D., Lashkov I., Ryumin D., Kashevnik A., Karpov A.* A methodology of multimodal corpus creation for audio-visual speech recognition in assistive transport systems // Informatization and Communication, 2020, no. 5, pp. 87-93 (in Russian). DOI: 10.34219/2078-8320-2020-11-5-87-93 (HAC, RSCI)

32. *Markitantov M., Karpov A.* Automatic human age and gender recognition using time-delay neural networks based on acoustic features // Proceedings of III All-Russian Acoustic Conference, St. Petersburg, 2020, pp. 374-380 (in Russian) (RSCI)

33. *Kipyatkova I., Markovnikov N.* A Study of Methods for Improving End-to-End Speech Recognition System at Lack of Training Data // Proceedings of III All-Russian Acoustic Conference, St. Petersburg, 2020, pp. 361-367 (in Russian) (RSCI)

34. *Axyonov A., Ryumin D., Kagirov I., Ivanko D., Karpov A.* A technique for hand landmarks detection for contactless gesture-based human-machine interaction // Proceedings of 31st International Scientific and Technological Conference «Extreme Robotics», St. Petersburg, 2020, pp. 34-36 (in Russian) (RSCI).

35. *Mikhajlyuk M., Karpov A., Kryuchkov B., Usov V., Dovzhenko V.* Voice control of service robots under conditions of possible limitations of human motor functions in space flight // Proceedings of the XII All-Russian scientific-technical conference "Robotics and artificial intelligence", 2020, pp. 197-201 (in Russian) (RSCI)

36. *Dvoynikova A., Verkholyak O., Karpov A.* Sentiment-analysis of spoken language using a method based on tonal dictionaries // Almanac of scientific works of young scientists of ITMO University. 2020. vol. 3. pp. 75-80 (in Russian) (RSCI).

37. *Ryumina E.* A method for extracting informative video features for emotion recognition // Almanac of scientific works of ITMO University young scientists. 2020, vol. 3. pp. 151-155 (in Russian) (RSCI).

38. *Axyonov A., Ryumina E.* Analytical review of modern methods of face detection // Almanac of scientific works of ITMO University young scientists. 2020, vol. 3. pp. 12-19 (in Russian) (RSCI).

39. *Markitantov M.* Analytical survey of audiovisual speech corpora for automatic speaker's age recognition // Almanac of scientific works of young scientists of the University ITMO. 2020, vol. 3, pp. 124-128 (in Russian) (RSCI).

40. *Dvoynikova A.* Sentiment-analysis of spoken language transcription using automatic machine translation // Proceedings of the IX Congress of Young Scientists of ITMO University. 2020 (in Russian) (RSCI).

41. *Verkholyak O., Karpov A.* Chapter 4 "Automatic analysis of emotionally-colored speech" in a monograph "Child speech portrait with typical and atypical development" / Lyakso E., Frolova O., Grechaniy S., Matveev Yu., Verkholyak O., Karpov A. / St. Petersburg: Publishing and Printing Association of Higher Educational Institutions, 2020, 204 p. ISBN 978-5-91155-096-7 (in Russian) (RSCI).