

Speech and Multimodal Interfaces Laboratory

Head of the Laboratory: D.Sc. (Eng.), Assoc.Prof. Alexey Karpov – development of speech and multimodal human-computer interfaces and systems, karpov@iias.spb.su, <http://hci.nw.ru>

Laboratory Staff: 11 members

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.

Research Fellows

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

D.Sc. (Bio.), Prof., principal researcher – Elena Lyakso – paralinguistic speech analysis, psycho-emotional states detection from speech, analysis of children's speech, lyakso@gmail.com

Junior researcher – Denis Ivanko – audio-visual Russian speech recognition with the use of a microphone and a high-speed video camera, denis.ivanko11@gmail.com

Junior researcher – Dmitry Ryumin – automatic recognition of gestures and elements of Russian sign language, dl_03.03.1991@mail.ru

Junior researcher – Oksana Verkholyak – automatic recognition of speaker's emotional states using voice characteristics and tonality of the text of the statement, overkholyak@gmail.com

Junior researcher – Alena Velichko – methods for automatic detection of destructive paralinguistic phenomena in colloquial speech, velichko.a.n@mail.ru

Junior researcher – Ildar Kagirov – 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

Programmers (master students)

Alexander Axyonov – visual features calculation methods for automatic lip-reading, a.aksenov95@mail.ru

Maxim Markitantov – automatic gender and age recognition from speech, m.markitantov@yandex.ru

Nikita Markovnikov – methods for end-to-end continuous Russian speech recognition, niklemark@gmail.com

Grants and Projects

A. Karpov – Agreement N 14.616.21.0095 (ID: RFMEFI61618X0095) with the Ministry of Science and Higher Education of the Russian Federation, Special federal programme “Research and development in priority areas of development of the scientific and technological complex of Russia for 2014-2020” (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.

A. Karpov – Project of the Russian Science Foundation N 18-11-00145 “Development and research of an intelligent system for complex paralinguistic analysis of speech”, 2018-2020.

A. Karpov – Grant of the President of the Russian Federation № MD-254.2017.8 “Development and research of an automatic system for recognition of human’s natural emotions from speech”, 2017-2018.

I. Kipyatkova – Grant of the President of the Russian Federation № MK-1000.2017.8 “Development of a neural network based acoustic model for a Russian speech-to-text conversion system”, 2017-2018.

A. Karpov – Project of RFBR N 16-37-60100-mol_a_dk “Development of a universal assistive information technology based on multimodal human-computer interfaces”, 2016-2019.

I. Kipyatkova – Project of RFBR N 18-07-01216-a “Development of an end-to-end continuous Russian speech recognition system using deep neural networks”, 2018-2020.

A. Karpov – Project of RFBR N 18-07-01407-a “Automatic bimodal recognition of natural emotions in Russian speech”, 2018-2020.

D. Ivanko – Project of RFBR N 18-37-00306-mol_a “Methods, models and algorithms of visual signals processing for lip-reading”, 2018-2020.

I. Kipyatkova – Grant of the Committee on Science and Higher Education of the Government of St. Petersburg for young PhD researchers “Development and research of hybrid acoustic models based on artificial neural networks with long short-term memory for a system of continuous Russian speech recognition”, 2018.

O. Verkholyak – Grant of the Committee on Science and Higher Education of the Government of St. Petersburg for young researchers “Automatic recognition of speakers’ emotional states from voice features in the flow of a dialogue speech (based on long short-term memory artificial neural networks)”, 2018.

A. Karpov – R&D contracts on “Development of voice control module software for a robotic exoskeleton for medical purposes” with the Volga State Technological University (VSTU, Yoshkar-Ola) within the framework of the integral project in the framework of the Government Statement No. 218, 2017-2019.

A. Karpov – R&D contract with Huawei Technologies Co. (Shenzhen, China), within the framework of the innovation research program HIRP Open, 2017-2019.

A. Karpov – R&D contract with “ASM Solutions” LLC. (Moscow), 2018.

University Courses

ITMO University: Speech Recognition (A. Karpov)

SUAI University: Automated information management systems, Speech Recognition Technologies (I. Kipyatkova)

Scientific and organizational activity

Organization and holding of 20th international conference on Speech and Computer SPECOM-2018. <http://specom.nw.ru/history/sites/2018>. Leipzig, Germany, 18–22 September 2018 г. – A. Karpov (co-chairperson). Proceedings published in: Speech and Computer. Springer International Publishing Switzerland. A. Karpov et al. (Eds.): SPECOM 2018, LNAI 11096, 2018, 791 p. <https://www.springer.com/de/book/9783319995786>.

International Cooperation

Joint research and organization of scientific events in cooperation with the University of West Bohemia (Czech Republic), Bogazici University (Turkey), Namik Kemal University (Turkey), Leipzig University of Telecommunications (Germany), University of Patras (Greece), Dresden University of Technology (Germany), Ulm University (Germany), United Institute of Information Problems of the National Academy of Sciences of Belarus, University of Aizu (Japan), University of Hertfordshire (Great Britain), Huawei Technologies company (China).

Conferences

20th International Conference "Speech and Computer" SPECOM-2018, 12-16 September 2018, Leipzig, Germany – A. Karpov, I. Kipyatkova, D. Ivanko (conference co-organization);

3rd International Conference on Interactive Collaborative Robotics ICR-2018, 18-22 September 2018, Leipzig, Germany – D. Ivanko, A. Karpov;

19th International Conference INTERSPEECH-2018, 2-6 September 2018, Hyderabad, India – A. Karpov, O. Verkholyak;

11th International Conference “Empirical Methods in Natural Language Processing” EMNLP-2018, 31 October – 4 November 2018, Brussels, Belgium – O. Verkholyak;

Conference “Information Technologies in Control” (ITU-2018) (as a part of the 11th Multi-conference on Control Problems MKPU-2018), 2-4 October 2018, St. Petersburg – A. Karpov, I. Kagirov, O. Verkholyak, A. Velichko, M. Markitantov, N. Markovnikov, I. Kipyatkova (organization of the section “IT in HCI”);

16th St. Petersburg International Conference “Regional Informatics” (RI-2018), 24-26 October 2018, St. Petersburg – I. Kagirov;

Workshop “Emotion AI”, 30 March 2018, St. Petersburg – A. Velichko, O. Verkholyak.

XXIII St. Petersburg Assembly of Young Scientists and Specialists, 10 December 2018, St. Petersburg – O. Verkholyak, I. Kipyatkova.

Membership in Domestic and International societies, editorial boards, etc.

A. Karpov – expert of the RAS; member of the European Association for Signal Processing (EURASIP), EURASIP Local Liaison Officer in Russia, member of the International Speech Communication Association (ISCA), member of the International Association for Pattern Recognition (IAPR); Editorial board member of the journals “SPIIRAS Proceedings” (St. Petersburg), “Speech Technologies” (Moscow) and “Informatics” (Minsk); Guest editor of the Journal on Journal on Multimodal User Interfaces (Springer), Speech Communication (Elsevier), Journal of Electrical and Computer Engineering (Hindawi); reviewer of several international journals 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.; co-chair of the International Conference SPECOM series, technical/program committee member of the international conferences INTERSPEECH, ICASSP, ICPR, SLTU, SPECOM, Baltic HLT, HBU, SIU, DOGS, etc.

I. Kipyatkova – technical/programme committee member of the international conferences INTERSPEECH, ICASSP, SPECOM, ISNN, member of the organizing committee of the international conference SPECOM series; member of the International Speech Communication Association (ISCA).

O. Verkholyak – member of the International Speech Communication Association (ISCA), member of the Association for Computational Linguistics (ACL).

Intellectual Property registered

Certificate on Software Registration № 2018662956 issued on 17 October 2018 by the Russian Federal Service for Intellectual Property. A. Velichko, V. Budkov, A. Karpov. “Software system for automatic identification of deceptive and true information in speech”, <https://rosrid.ru/rid/3XZ0PEQR3IJWC0CG1WED6BCR>

Recent Results

1. End-to-end models have been developed based on connectionist temporal classification (CTC) and attention-based encoder-decoder model with the use of convolutional neural networks, recurrent neural networks, long

short-term memory models (LSTM), bidirectional LSTM-models, and residual convolutional networks; the end-to-end models were experimentally studied with the usage of different types of acoustic features and language models for Russian speech recognition; they demonstrate less memory consumption and higher recognition speed that makes it possible to use the designed models on mobile platforms. [6, 13, 25].

2. A software system for automatic identification of deceptive and true information in the flow of speech has been developed, based on combining bagging-based data classification methods and k-nearest neighbors algorithm (kNN) and revealed the best results of deceptive speech detection (71.0% UAR – Unweighted Average Recall) on the data taken from Deceptive Speech Database and Real-Life Trial Deception Detection Dataset corpuses; the system can find good prospects in contact centers in order to prevent ‘telephone terrorism’ actions, as well as in the banking sector when making a decision about a loan, during polygraph tests, etc. [10, 22, 27].

3. A software system for cross-corpus speech emotion recognition has been developed based on recurrent neural networks with long short-term memory (LSTM), carrying out tasks of feature preprocessing, domain adaptation, training and prediction of emotional activation and valence; the system differs from analogous systems in that it combines several emotional speech corpora for system training on the segmental markup stage and its application for classification of whole spoken statements. [1, 8, 9].

4. A geometric visual features extraction method has been developed in order to describe configuration of the speaker's lips on the basis of a set of 24 pairs of key points on the speaker's lips and mouth, which makes it possible to maximize the accuracy of tracking the speakers' lips movements and which is characterized by the use of continuous Russian speech video recordings obtained with a high-speed video camera that improves both accuracy and robustness of audio-visual speech recognition in acoustically noisy environments [3, 14, 25].

5. A multimedia database (TheRuSLan – Thesaurus of Russian Sign Language) of Russian sign language (St. Petersburg dialect) has been created; the database was collected with the use of Microsoft Kinect 2.0 sensor, includes gestures of 150 different lexical items; the recorded sign language data have been annotated based on a set of differential features (handshape, movement modality, localization) and divided into classes for a further teaching of automatic sign language recognition systems based on probabilistic neural networks [11, 15].

Awards, certificates, scholarships

Certificate of the winner of a grant of the Government of St. Petersburg and Saint Petersburg Scientific Center of the Russian Academy of Sciences for outstanding academic results in science and technology in the nomination

“Technical and engineering sciences” – Euler Prize (for young scholars under the age of 35) – I. Kipyatkova.

Diploma of the winner of the St. Petersburg grant competition in 2018 for young PhD from the Government of St. Petersburg – I. Kipyatkova.

Diploma of the winner of the St. Petersburg grant competition in 2017 for young researchers from the Government of St. Petersburg – O. Verkholyak.

Publications

Articles prepared jointly with foreign organizations

1. Kaya H., Karpov A. Efficient and Effective Feature Normalization Strategies for Cross-Corpus Acoustic Emotion Recognition // *Neurocomputing*. Elsevier, Vol. 275, 2018, pp. 1028-1034. <https://doi.org/10.1016/j.neucom.2017.09.049> (WoS Q1 JCR=3,241, Scopus Q1)
2. Ivanko D., Karpov A., Fedotov D., Kipyatkova I., Ryumin D., Ivanko Dm., Minker W., Železný M. Multimodal Speech Recognition: Increasing Accuracy using High Speed Video Data // *Journal on Multimodal User Interfaces*, Springer, Vol. 12, № 4, 2018, pp. 319-328. <https://doi.org/10.1007/s12193-018-0267-1> (WoS Q3 JCR=1,140, Scopus Q2)
3. Karpov A., Mporas I. Speech Communication Integrated with Other Modalities // *Journal on Multimodal User Interfaces*, Springer, Vol. 12, № 4, 2018, pp. 271-272. <https://doi.org/10.1007/s12193-018-0275-1> (WoS Q3 JCR=1,140, Scopus Q2)
4. Kaya H., Fedotov D., Yesilkanat A., Verkholyak O., Zhang Y., Karpov A. LSTM based Cross-corpus and Cross-task Acoustic Emotion Recognition. In *Proc. 19th International Conference INTERSPEECH-2018*, Hyderabad, India, ISCA, 2018, pp. 521-525. <https://doi.org/10.21437/Interspeech.2018-2298>
5. Fedotov D., Kaya H., Karpov A. Context Modeling for Cross-Corpus Dimensional Acoustic Emotion Recognition: Challenges and Mixup. In *Proc. 20th International Conference on Speech and Computer SPECOM-2018*, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 155-165.
6. Hlaváč M., Gruber I., Železný M., Karpov A. LipsID using 3D Convolutional Neural Network. In *Proc. 20th International Conference on Speech and Computer SPECOM-2018*, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 209-214.
7. Ivanko D., Ryumin D., Axyonov A., Železný M. Designing Advanced Geometric Features for Automatic Russian Visual Speech Recognition. In *Proc. 20th International Conference on Speech and Computer SPECOM-2018*, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 245-254.

8. Gruber I., Ryumin D., Hrúz M., Karpov A. Sign Language Numeral Gestures Recognition using Convolutional Neural Network. In Proc. 3rd International Conference on Interactive Collaborative Robotics ICR-2018, Leipzig, Germany, Springer, LNAI vol. 11097, 2018, pp. 70-77.
9. Kanis J., Ryumin D., Krňoul Z. Improvements in 3D Hand Pose Estimation using Synthetic Data. In Proc. 3rd International Conference on Interactive Collaborative Robotics ICR-2018, Leipzig, Germany, Springer, LNAI vol. 11097, 2018, pp. 105-115.
10. Ivanko D., Fedotov D., Karpov A. Accuracy increase for automatic visual Russian speech recognition: viseme classes optimization // Scientific and technical journal of information technologies, mechanics and optics. 2018. Vol. 18. № 2. pp. 346–349. <https://doi.org/10.17586/2226-1494-2018-18-2-346-349>

Papers published in journals and editions, indexed by WoS, Scopus:

1. Kaya H., Karpov A. Efficient and Effective Feature Normalization Strategies for Cross-Corpus Acoustic Emotion Recognition // Neurocomputing. Elsevier, Vol. 275, 2018, pp. 1028-1034. <https://doi.org/10.1016/j.neucom.2017.09.049> (WoS Q1 JCR=3,241, Scopus Q1)
2. Karpov A.A., Yusupov R.M. Multimodal Interfaces of Human-Computer Interaction // Herald of the Russian Academy of Sciences, Springer, Vol. 88, No. 1, 2018, pp. 67-74, <https://doi.org/10.1134/S1019331618010094> (WoS Q3 JCR=0,472, Scopus Q1)
3. Ivanko D., Karpov A., Fedotov D., Kipyatkova I., Ryumin D., Ivanko Dm., Minker W., Železný M. Multimodal Speech Recognition: Increasing Accuracy using High Speed Video Data // Journal on Multimodal User Interfaces, Springer, Vol. 12, № 4, 2018, pp. 319-328. <https://doi.org/10.1007/s12193-018-0267-1> (WoS Q3 JCR=1,140, Scopus Q2)
4. Karpov A., Mporas I. Speech Communication Integrated with Other Modalities (Editorial) // Journal on Multimodal User Interfaces, Springer, Vol. 12, № 4, 2018, pp. 271-272. <https://doi.org/10.1007/s12193-018-0275-1> (WoS Q3 JCR=1,140, Scopus Q2)
5. Verkhodanova V., Shapranov V., Kipyatkova I., Karpov A. Automatic detection of vocalized hesitations in Russian speech // Voprosy Jazykoznanija (Topics in the Study of Language), 2018, No. 6. pp. 104–118. <https://doi.org/10.31857/S0373658X0002022-3> (WoS ESCI, Scopus Q2)
6. Markovnikov N., Kipyatkova I. An Analytic Survey of End-to-End Speech Recognition Systems // SPIIRAS Proceedings. 2018. Issue 3(58). pp. 77-110. <http://proceedings.spiiras.nw.ru/ojs/index.php/sp/article/view/3714>

7. Vatamaniuk I., Budkov V., Kipyatkova I., Karpov A. Methods and Algorithms of Audio-Video Signal Processing for Analysis of Indoor Human Activity. In: Favorskaya M., Jain L. (eds.) Computer Vision in Control Systems-4. Intelligent Systems Reference Library, Springer, vol. 136. 2018, pp. 139-173. https://doi.org/10.1007/978-3-319-67994-5_6
8. Kaya H., Fedotov D., Yesilkanat A., Verkholyak O., Zhang Y., Karpov A. LSTM based Cross-corpus and Cross-task Acoustic Emotion Recognition. In Proc. 19th International Conference INTERSPEECH-2018, Hyderabad, India, ISCA Association, 2018, pp. 521-525. <https://doi.org/10.21437/Interspeech.2018-2298>
9. Fedotov D., Kaya H., Karpov A. Context Modeling for Cross-Corpus Dimensional Acoustic Emotion Recognition: Challenges and Mixup. In Proc. 20th International Conference on Speech and Computer SPECOM-2018, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 155-165. (Scopus Q2)
10. Velichko A., Budkov V., Kagiroy I., Karpov A. Comparative Analysis of Classification Methods for Automatic Deception Detection in Speech. In Proc. 20th International Conference on Speech and Computer SPECOM-2018, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 737-746.
11. Hlaváč M., Gruber I., Železný M., Karpov A. LipsID using 3D Convolutional Neural Network. In Proc. 20th International Conference on Speech and Computer SPECOM-2018, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 209-214.
12. Kipyatkova I. Improving Russian LVCSR Using Deep Neural Networks for Acoustic and Language Modeling. In Proc. 20th International Conference on Speech and Computer SPECOM-2018, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 291-300.
13. Markovnikov N., Kipyatkova I., Lyakso E. End-to-End Speech Recognition in Russian. In Proc. 20th International Conference on Speech and Computer SPECOM-2018, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 377-386.
14. Ivanko D., Ryumin D., Axyonov A., Železný M. Designing Advanced Geometric Features for Automatic Russian Visual Speech Recognition. In Proc. 20th International Conference on Speech and Computer SPECOM-2018, Leipzig, Germany, Springer, LNAI vol. 11096, 2018, pp. 245-254.
15. Gruber I., Ryumin D., Hrúz M., Karpov A. Sign Language Numeral Gestures Recognition using Convolutional Neural Network. In Proc. 3rd International Conference on Interactive Collaborative Robotics ICR-2018, Leipzig, Germany, Springer, LNAI vol. 11097, 2018, pp. 70-77.
16. Kanis J., Ryumin D., Krňoul Z. Improvements in 3D Hand Pose Estimation using Synthetic Data. In Proc. 3rd International Conference

on Interactive Collaborative Robotics ICR-2018, Leipzig, Germany, Springer, LNAI vol. 11097, 2018, pp. 105-115.

17. Kryuchkov B., Usov V., Ivanko D., Kagirow I. Cognitive Components of Human Activity in the Process of Monitoring a Heterogeneous Group of Autonomous Mobile Robots on the Lunar Surface. In Proc. 3rd International Conference on Interactive Collaborative Robotics ICR-2018, Leipzig, Germany, Springer, LNAI vol. 11097, 2018, pp. 148-158.
18. Verkholiyak O., Karpov A. Combined feature representation for emotion classification from Russian speech. In Proc. 6th International Conference on Artificial Intelligence and Natural Language AINL'17, St. Petersburg, Springer, LNAI vol. 789, 2018, pp. 68-73.
19. Markovnikov N., Kipyatkova I., Karpov A., Filchenkov A. Deep neural networks in Russian language recognition. In Proc. 6th International Conference on Artificial Intelligence and Natural Language AINL'17, St. Petersburg, Springer, LNAI vol. 789, 2018, pp. 54-67.
20. Kipyatkova I., Karpov A. Language Modeling for Continuous Russian Speech Recognition Systems. In Proc. of the R. Piotrowski's Readings in Language Engineering and Applied Linguistics LE & AL'2017, CEUR Workshop Proceedings, vol. 2233, 2018, pp. 64-74. http://ceur-ws.org/Vol-2233/Paper_7.pdf

Papers published in Russian journals and editions, indexed by RCSI:

21. Karpov A.A., Yusupov R.M. Multimodal interfaces of human-computer interaction // Herald of the Russian Academy of Sciences (Vestnik Rossijskoj Akademii Nauk). Vol. 88, № 2, 2018. pp. 146-155. doi:10.7868/S0869587318020056
22. Velichko A., Budkov V., Karpov A. Study of classification methods for automatic truth and deception detection in speech // Science Bulletin of Novosibirsk State Technical University (NSTU). № 3 (72), 2018, pp. 21-32. doi:10.17212/1814-1196-2018-3-21-32
23. Ivanko D., Fedotov D., Karpov A. Accuracy increase for automatic visual Russian speech recognition: viseme classes optimization // Scientific and Technical Journal of Information Technologies, Mechanics and Optics (Nauchno-texnicheskij vestnik informacionnyx texnologij, mexaniki i optiki). 2018. Vol. 18. № 2. pp. 346–349. doi: 10.17586/2226-1494-2018-18-2-346-349
24. Kagirow I., Karpov A. An analytical overview of multimodal interfaces for service robots // Manned Spaceflight (Pilotiruemye polyety v kosmos). Issue 29, № 4, 2018, pp. 77-98.

Other Publications:

25. Markovnikov N., Kipyatkova I. Inquiry of methods for end-to-end Russian speech recognition systems construction. In Proc. Conference "Information Technologies in Control" (ITU-2018) (as a part of the 11th

- Multi-conference on Control Problems MKPU-2018), 2018, St. Petersburg, pp. 518-525.
26. Axonov A., Ryumin D., Ivanko D. Development of a geometric features system for automatic visual Russian speech recognition. In Proc. Conference "Information Technologies in Control" (ITU-2018), 2018, St. Petersburg, pp. 526-533.
 27. Velichko A., Karpov A., Budkov V. Analytical survey of speech corpora for deception detection systems. In Proc. Conference "Information Technologies in Control" (ITU-2018), 2018, St. Petersburg, pp. 534-538.
 28. Markitantov M., Karpov A. An analytical review of approaches for automatic speaker's age recognition. In Proc. Conference "Information Technologies in Control" (ITU-2018), 2018, St. Petersburg, pp. 539-542.
 29. Verkholiyak O. An analytical review of textual corpora in Russian for automatic sentiment analysis. In Proc. Conference "Information Technologies in Control" (ITU-2018), 2018, St. Petersburg, pp. 548-553.
 30. Kagiroy I. Analytical overview of robotics systems with multimodal user interfaces. In Proc. Conference "Information Technologies in Control" (ITU-2018), 2018, St. Petersburg, pp. 563-571.
 31. Kryuchkov B., Usov V., Ivanko D. Prospects for the use of smart spaces for information support of a human - operator at remote monitoring a group of mobile robots on the Lunar surface. In Proc. Conference "Information Technologies in Control" (ITU-2018), 2018, St. Petersburg, pp. 572-581.
 32. Kagiroy I. Basic concept of a robotic shopping cart enabling speech and Russian hand language recognition. In Proc. Conference "Regional Informatics and Information Security". Issue 5, pp. 273-277.
 33. Kagiroy I. Salient features of a multimodal user interface enabling Russian (sign) language recognition within a framework of development a robotic shopping. In Proc. XVI Conference "Regional Informatics" (RI-2018). St. Petersburg, 2018, pp. 307-308.
 34. Kipyatkova I. Development and research of hybrid acoustic models based on artificial neural networks with long short-term memory for a continuous Russian speech recognition system. Materials of the XXIII St. Petersburg Assembly of Young Scientists and Specialists, 2018, pp. 152.
 35. Verkholiyak O. Automatic recognition of speakers' emotional states from voice features in the flow of a dialogue speech (based on long short-term memory artificial neural networks). Materials of the XXIII St. Petersburg Assembly of Young Scientists and Specialists, 2018, pp. 64.