Evaluation of the Intelligibility of Pronunciation of Syllables: Method and Algorithms

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Abstract: In this paper, we describe the problem of the automated estimation of the pronunciation quality of syllables through the evaluation of syllabic intelligibility. The method currently used is being considered, as well as other methods of both subjective and objective assessments of the quality of speech. The applicability of speech intelligibility assessment in the field of information security is considered, including in the framework of assessing the security of voice information. A developed algorithm for detecting voice activity for syllable records within the framework of speech rehabilitation sessions is described, based on the calculation of the intensity of the sound flow and its comparison with the value characteristic for silence. The algorithm for dynamic transformation of the time scale for time normalization is implemented to calculate the distance between different implementations of the same syllable (both normal and distorted, that is, without the use of language, pronunciation). The possible measures of difference (distance) between syllables possible for application are considered, the measure with the least number of errors is chosen. An attempt is made to apply smoothing and intensity normalization before applying the temporal scale time transformation algorithm, and the results are described. A method for evaluating the intelligibility of syllables based on the developed algorithms is proposed, input data, limitations, required output values are described. An addition is proposed for the described method for obtaining more easy estimates for the expert interpretation of the speech therapist and the patient. Applicability of the developed algorithms is described both directly in the area for which the algorithms were developed, and in the field of data analysis and information security, for example, as part of the speaker identification and verification systems.

Key words: speech quality estimation, speech intelligibility, VAD, voice activity detection, DTW, dynamic time scale transformation, speech rehabilitation, speech information protection

REFERENCES

[1] GOST R 50840-95 Peredacha rechi po traktam svyazi. Metody otsenki kachestva, razborchivosti i uznavayemosti. – M.: IPK Izdatel'stvo standartov, 1996 – 234 s.

[2] G.G. Yanovskiy Otsenka kachestva peredachi rechi v setyakh IP. – Rezhim dostupa: http://niits.ru/public/2008/2008-008.pdf

[3] Friedemann Koster Introducing a new Test-Method for Diagnostic Speech Quality Assessment in a Conversational Situation/ Friedemann Koster, Sebastian Molle - Technische Universität Berlin, March 2016 – URL: https://www.researchgate.net/publication/303339436_Introducing_a_new_Test-Method_for_Diagnostic_Speech_Quality_Assessment_in_a_Conversational_Situation

[4] Sandoval-Ibarra, YU. Uluchsheniye kachestva rechi s ispol'zovaniyem adaptivnykh spektral'nykh otsenok / YU. Sandoval-Ibarra, V. Diaz-Ramirez, V.I. Kober, V.N. Karnaukhov // Informatsionnyye protsessy. – 2015 - № 3. – URL: http://www.jip.ru/2015/314-323-2015.pdf

[5] Poltorak V. P., Morgal' O. M., Zaika YU. A. Otsenka kachestva peredachi rechi v IP-telefonii// Molodoy uchenyy. — 2014. — №4. — S. 121-123. — URL: https://moluch.ru/archive/63/9849/

[6] Sposoby otsenki sub"yektivnogo kachestva rechi. – Rezhim dostupa: https://habrahabr.ru/post/177099/

[7] Smirnov, V.I. Otsenki zashchishchennosti rechevoy informatsii v vydelennom pomeshchenii s pomoshch'yu instrumental'no-raschetnogo metoda/ V.I. Smirnov // Kibernetika i programmirovaniye. – 2012 - № 2. – URL: http://e-notabene.ru/kp/article_13869.html

[8] Bol'shov, O.A. Ob otsenke zashchishchennosti rechevoy informatsii v radiokanalakh svyazi pri vokodernykh preobrazovaniyakh / O.A. Bol'shov // Trudy MAI. – 2010 - № 41. – URL: http://trudymai.ru/upload/iblock/611/ob-otsenke-zashchishchennosti-rechevoy-informatsii-v-radiokanalakh-svyazi-pri-vokodernykh-preobrazovaniyakh.pdf

[9] Dvoryankin, S.V. Obosnovaniye kriteriyev effektivnosti zashchity rechevoy informatsii ot utechki po tekhnicheskim kanalam/ S.V. Dvoryankin, YU. K. Makarov, A. A. Khorev // Zashchita informatsii. Insayd. – 2007. № 2. – URL: http://www.analitika.info/info1.php?page=1&full=block_article137

[10] Trushin, V.A. o metodicheskikh pogreshnostyakh otsenki slovesnoy razborchivosti rechi v zadachakh zashchity informatsii/ V.A. Trushin, I.L. Reva, A. A. Ivanov // Doklady Tomskogo gosudarstvennogo universiteta sistem upravleniya i radioelektroniki. – 2012. - № 1(25). – URL: http://www.analitika.info/info1.php?page=1&full=block_article137

[11] Roman Meshcheryakov, Evgeny Kostyuchenko, Dariya Ignatieva (Novokhrestova), Alexander Pyatkov, Evgeny Choynzonov, Lidiya Balatskaya Speech quality measurement automation for patients with cancer of the oral cavity and oropharynx. / 2016 INTERNATIONAL SIBERIAN CONFERENCE ON CONTROL AND COMMUNICATIONS SIBCON, Russia, Moscow, May 12-14, 2016

[12] Evgeny Kostyuchenko Model of system quality assessment pronouncing phonemes / Evgeny Kostyuchenko, Roman Meshcheryakov, Dariya Ignatieva, Alexander Pyatkov, Evgeny Choynzonov, and Lidiya Balatskaya // Dynamics of Systems, Mechanisms and Machines (Dynamics), 2016. — URL: http://ieeexplore.ieee.org/document/7819016/

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