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**GENERAL METHODOLOGY OF HIGH-EFFICIENCY
DIAGNOSTICS OF TRACKS OF EDITING IN DIGITAL PHONOGRAMS**

Into the complete set of tool necessary for the judicial technical examination of materials and apparatus of the audio recording, the programs and methodologies (tool) for diagnostic researches of authenticity of phonograms are obligatorily included. Diagnostics of authenticness of phonograms unites researches of originality (i.e. to priority) of phonogram and presence (or absence) in it the tracks

of editing. Presently for the record of the phonograms the digital apparatus of the audio recording is mainly used, and editing is produced with the use of digital processing of the signals fixed in phonograms. Therefore there is an insistent necessity of creation of tool for the exposure of tracks of digital treatment (tracks of the digital editing) in phonograms. It is offered by us, along with the instruments worked out before, to apply the neuron networks of the deep learning for creation of the expert tool intended for the exposure of tracks of digital treatment in phonograms. Preliminary researches are completed, and the first version of the program of such high-efficiency system is built.

An aim of the study is the creation of general methodology of examining of the authenticity of digital phonograms, based on the tool worked out by authors.

In the construction of such system it is suggested to come from that for editing phonogram it is possible from different pre-product – phonograms taped on the different apparatus of the audio recording, and phonograms, taped on one apparatus. For the exposure of tracks arising up at such types of editing, it is necessary to use a different tool, that allows considerably to shorten labour intensiveness and time of examination. For diagnostics of editing, made from the records taped on different apparatus, it is expedient to use the tool built on the basis of fractal approach, in particular, the automated tool is «Fractal». For diagnostics of editing, made from the records taped on one apparatus of the audio recording, it is expedient to use the tool built on the basis of neuron network of the deep learning. Both types of tool are worked out by authors. Such approach allows to bring down labour intensiveness and time of examining.

Keywords: audio recording, authenticity of phonogram, digital phonogram, examination of authenticity of phonograms.

REFERENCES

1. Rybalskyi, O.V., Solovyov, V.I., Zhuravel, V.V. (2018) Osnovnye trebovaniya k systeme vyyavleniya toчек tsifrovogo montazha v fonogrammakh i metodologiya eye sozdaniya. “The Basic Requirements to the System of Exposure

of Points of the Digital Editing in Phonograms and Methodology of Its Creation”. *Informatica ta matematchi metody v modeluvanni = Informatics and Mathematical Methods in Simulation* 3, 232–237 [in Russian].

2. *Korycki, R.* (2010) Methods of time-frequency analysis in authentication of digital audio recordings. *INTL Journal of Electronics and Telecommunication*. Vol. 56, No 3, pp. 257–262 [in English].

3. *D.P. Nicolalde and J.A. Apolinario* (2009) Evaluating digital audio authenticity with spectral distances and ENF phase change, in *Proc. IEEE International Conference on Acoustics, Speech and Signal Processing*, P. 1417–1420 [in English].

4. *D.P. Nicolalde and J.A. Apolinario, L.W.P Biscainho* (2010) Audio authenticity: Detecting ENF discontinuity with high precision phase analysis, *IEEE Transactions on Information Forensics and Security*. Vol. 5, pp. 534–543 [in English].

5. *A.J. Cooper* (2009) An automated approach to the Electric Network Frequency (ENF) criterion-Theory and practice. *International Journal of Speech Language and the Law*. Vol. 16, pp. 193–218 [in English].

6. *M. Huijbregtse and Z. Geradts* (2009) Using the ENF criterion for determining the time of recording of short digital audio recordings. *Computational Forensics*, pp. 116–124 [in English].

7. *Grigoras, Catalin* (2010) Statistical Tools for Multimedia Forensics Presented at the 39th AES International Conference Audio Forensics- Practices and Challenges, Hillerod, Denmark, June 17–19 [in English].

8. *Jenkins, Christopher W.* (2011) An Investigative Approach to Configuring Forensic Electric Network Frequency Databases. Master’s Thesis, University of Colorado Denver [in English].

9. *Brixen, Eddy* (2011) Audio Metering Measurements, Standards and Practices: Second Edition. United States: Elsevier [in English].

10. *Grigoras, Catalin, et al.* (2011) Advances in ENF Database Configuration for Forensic Authentication of Digital Media. Presented at 131st

convention of the Audio Engineering Society, New York, New York, October 20–23 [in English].

11. *Rappaport D.* Establishing a Standard for Digital Audio Authenticity: A Critical Analysis of Tools, Methodologies, and Challenges Thesis directed by Catalin Grigoras. URL: <http://aquarius.ime.eb.br/~apolin/papers/IEEETIFS2010Daniel.pdf> (Date of Application: 22.07.2019) [in English].

12. *Tatarnikova, T.O.* (2011) Analiz stanu expertizy materialiv ta zasobiv tsyfrovogo zvukozapysu v riznykh krainakh. “An Analysis of the State of Examination of Materials and Facilities of the Digital Audio Recording in Different Countries”. *Nauka i pravoohorona = Science and law enforcement* 3 (13), 89–92 [in Ukrainian].

13. *Cooper, A.J.* (2008) Detection of Copies of Digital Audio Recordings Produced Using Analogue Interfacing. *International Journal of Speech, Language, and the Law*. Vol. 15, No1, pp. 67–95 [in English].

14. *C.-B. Moon, H. Kim, B.M. Kim* (2014) Audio recorder identification using reduced noise features, in: *Ubiquitous Information Technologies and Applications*, Springer, pp. 35–42 [in English].

15. *R. Aggarwal, S. Singh, A.K. Roul, N. Khanna* (2014) Cellphone identification using noise estimates from recorded audio, in: *Communications and Signal Processing (ICCSP)*. International Conference on, IEEE, pp. 1218–1222 [in English].

16. *D. Garcia-Romero, C.Y. Espy-Wilson* (2010) Automatic acquisition device identification from speech recordings, in: *Acoustics Speech and Signal Processing (ICASSP)*, 2010 IEEE International Conference on, IEEE, pp. 1806–1809 [in English].

17. *Simeng Qi, Zheng Huang, Yan Li, Shaopei Shi.* Audio Recording Device Identification Based on Deep Learning.

URL: <https://arxiv.org/ftp/arxiv/papers/1602/1602.05682.pdf> (Date of Application: 22.07.2019) [in English].

18. *Rybalsky, O.V., Zharikov, Y.F.* (2003) *Sovremennye metody proverki autentichnosti magnitnykh fonogramm v sudebno-akusticheskoy expertize*. “Modern Methods of Verification of Authenticness of Magnetic Phonograms in Judicial and Acoustic Examination”. Kyiv, NAVSU Publ. 300 p. [in Russian].

19. *Rybalsky, O.V.* (2004) *Zastosuvannya velvet-analizu dlya vvyavleniya slidiv tsyfrovoy obrobki analogovykh i tsyfrovyykh fonogramm u sudovo-akustychniy expertizi*. “Application of Wavelet Analysis for the Exposure of Tracks of Digital Treatment of Analogue and Digital Phonograms in Judicial Acoustic Examination”. Kyiv, NAVSU Publ., 167 p. [in Ukrainian].

20. *Solovyov, V.I., Rybalsky, O.V., Zhuravel, V.V.* (2020) *Obosnovanie printsipialnoi vozmozhnosti primeneniya neironnykh setey glubokogo obucheniya dlya postroeniya systemy vvyavleniya sledov tsyfrovoy obrabotki fonogramm* “Grounds of Fundamental Possibility of Neuron Networks of the Deep Learning for the Construction of the System of Exposure of Tracks of Digital Processing of Phonograms”. *Cibernetika i systemny analiz = Cybernetics and analysis of the systems* 1 (in press) [in Russian].

21. *Solovyov, V.I., Rybalsky, O.V., Zhuravel, V.V.* (2019) *Metod vyayvleniya svyazi klassicheskikh modeley s rezultatamy binarnoi klassifikatsii ob'ektov v neironnykh setaykh glubokogo obucheniya*. “Method of Exposure of Connection of Classic Models with the Results of Binary Classification of Objects in the Neuron Networks of the Deep Learning”. *Problemy upravleniay i informatiki = Journal of Automation and Information Sciences* 6 (in press) [in Russian].

22. *Rybalsky, O.V., Solovyov, V.I., Zhuravel, V.V.* (2016) *Sledy montazha v tsyfrovyykh fonogrammakh, vypolnennogo sposobom vyrezaniya i perestankovki fragmentov*. “Tracks of Editing in Digital Phonograms, Excision and Transposition of Fragments Executed by a Method”. *Registratsiya, zberigannya i obrobka danykh = Data recording, Storage & Processing* 1, 32–41 [in Russian].

23. *Rybalsky O.V., Solovyov, V.I., Zhuravel, V.V.* (2016) *Experimentalnaya proverka efekta izmeneniya fractalnogo sostava signalov pri montazhe fonogrammy sposobom vyrezaniya i perestankovki fragmentov*. “Experimental

Verification of Effect of Change of Fractal Composition of Signals at Editing of Phonogram by the Method of Excision and Transposition of Fragments”. Suchasna spetsialna tekhnika = Modern Special Technique 3, 75–85 [in Russian].