СИСТЕМИ ТА МЕТОДИ ОБРОБКИ ІНФОРМАЦІЇ

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O.V. Rybalsky,
Doctor of Technical Sciences, professor,
V.I. Solovyov,
Candidate of Technical Sciences, associate professor,
V.V. Zhuravel,
A.N. Shablia,
Candidate of Technical Sciences, senior staff scientist,
T.A.Tatarnikova

AUTOMATIC CALCULATION OF THE COEFFICIENTS OF FRACTAL SCALE IN THE PROGRAM "FRACTAL"

In the paper the results of the development of the system of automatic calculation of coefficients of fractal scale of software are considered intended for the examining of digital phonograms and digital apparatus of the audio recording. It is shown that the finished expert program and methodology of examining provide the rightness of the acceptance of expert decision.

Keywords: *examination of phonograms, diagnostic researches of phonograms, authentication of digital apparatus of the audio recording, comparative researches, fractals.*

Due to the widespread application of the equipment of digital audio track and the comparative simplicity of handling and manipulation of digital honograms the creation of reliable tools for expert studying of such equipment and phonograms at the present stage of the development of criminology requires an unusually large significance [1]. Based on these considerations, during a number of years, the authors designed and implemented into expert practice the program and methodology for the examination "Fractal", implementing identification research of the equipment of digital audio track and diagnostic studies of original digital phonograms [2].

In the process of developing and debugging of the program and techniques the proposal of automatization of such an examination was made, which allowed to reduce labor costs as well as its duration. The most labor-intensive in this review was the operation of the determining of the fractal scale – a scale at which it is necessary to conduct comparative studies of digital phonograms [2]. This feature of such studies is caused by the strict identity as of the equipment of digital audio track and digital phonogram and that is why it was proposed to automate this operation, and a pre-defined algorithm in automatic mode [3].

After the introduction of the program of the first version of the automazation system there were created new challenges, as related to the algorithm, the decision-

making criteria and forms of presentation of information and clarification and methods of examination. In the process, numerous experiments have been conducted, which allowed to find the answers to all your questions, as well as to make the necessary adjustments to programs and methods and to confirm their compliance with the objectives of development.

The purpose of this paper is to show solutions to the encountered problems during development and to consider the features of an advanced program and IU-using the technique.

The main part

The research began with the development of requirements changes in the Program needed to accomplish the task. Its construction should provide the comparisons of the two soundtracks on all their long-work with different coefficients of fractal scale with the definition of such a result of this comparison to determine the probability of the error of the first kind of the obtained solution. Obviously, such a comparison should be carried out with a step discontinuity. Based on the computation speed and accuracy of the obtained results was adopted step discrete 100 that meets the eligibility requirements for the time spent for the examination.

It was also evident that the results of the comparison should be presented in the form of a graph according to the probability of error of the first kind on the value of the fractal scale. But the results of the calculation with different coefficients of fractal scale, as established by numerous experiments conducted previously, depend on the amount by the scale and depending on them can give a different result. Therefore, the program should provide expert visibility before the presentation of a full picture of the distribution of such scale factors for both research results and methods to ensure the correctness of the decision by the expert. It should be noted that to the understanding of this “simple”thought, the authors did not come immediately. It was the result of the long-aqueous search with a number of intermediate experiments. But the efforts of the authors led to the development of expert program and IU-todeco examination, based on this approach, which is in charge of awareness and correct decision of the expert.

Thus, on the first stage of solving the fundamental problem it was solved a number of special problems. First, to determine the step discontinuity when carrying out the automatic calculation of the fractal dimensions. Secondly, the requirements for the presentation of the results of these calculations ensured their software implementation. This ensured complete results of automatic requirements to the construction programme and methodology-dick, which ensures an absence upon the double sense when determining the required scaling factors and decision-making expert.

Below there are several examples of experimental studies of the worked-out expert program with an automated determination of the coat-the rest of the scale together with a description of the methods of examination, illustrating the development.

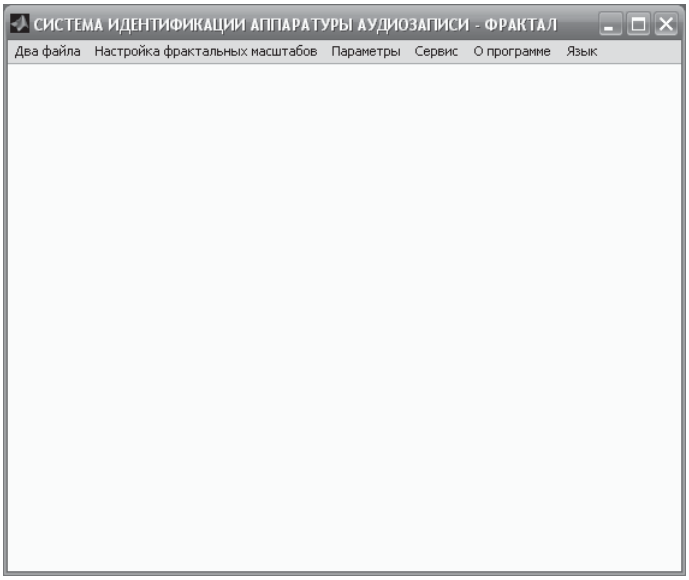

Fig. 1. Programming window with its root menu

Figure 1 shows a window with the main menu of the program. Compared to the version of the program "Fractal" without automation of the selection process of large-scale factors, this version has the menu item "configuration of the fractal scales", which includes the option "Two files". Using this version of the program two files of phonograms are downloaded, and then their automatic comparison throughout the duration of the analyzed phonograms begins. After the completion of the calculations, the results of the analysis are presented in two graphs, housed in two separate windows: the first window shows the dependence of the error of the first kind from the values of the fractal scale of phonograms with matching characteristics, the second – the same dependence for the phonograms with divergent characteristics. This window is shown in Fig. 2 and Fig. 3.

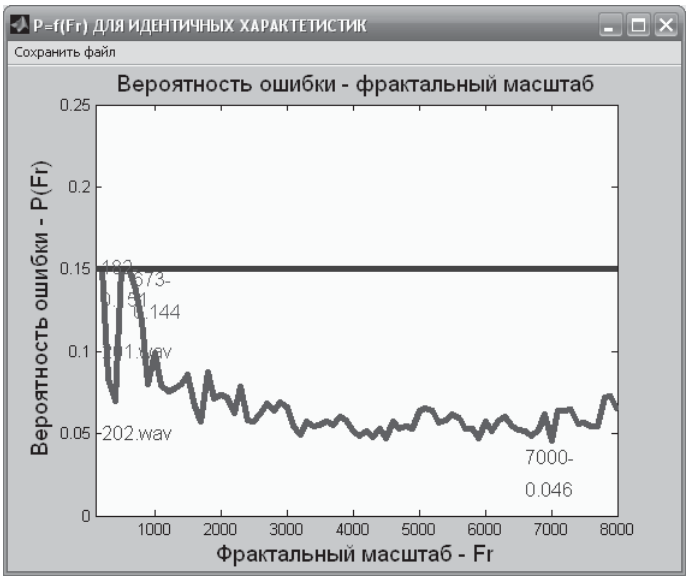

Fig. 2. Window of the results of the definition of fractal scales with parallel characteristics of two exemplary phonograms

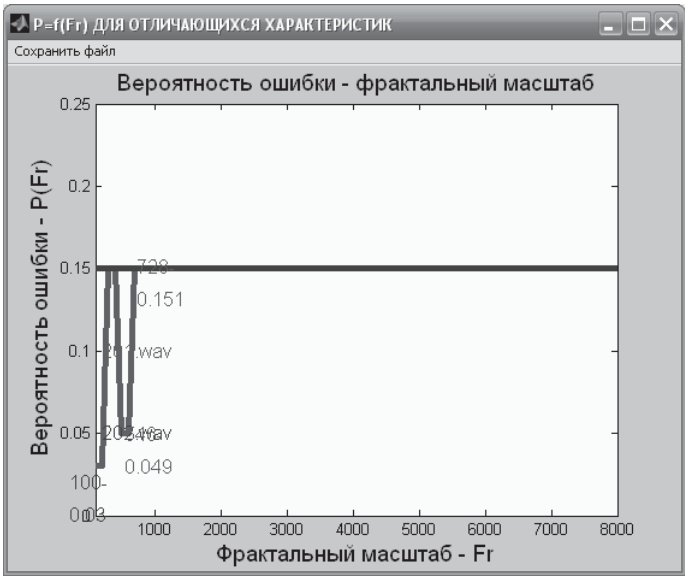

Fig. 3. Window of the results of the definition of fractal scales with divergent characteristics of two exemplary phonograms

As it can be seen from the graphs presented in Fig. 2 and Fig. 3, the nature of co-rates fractal scales (scale factors) chemical network, applied to self-similar structures contained in phonograms by ambivalent and has a clear boundary. To identify by their size phonogram may be perceived as having different characteristics, after this value – as having similar characteristic indices. The physical nature of this phenomenon is explained by the difference in level of signals (and therefore the amount of information), studied at times – different scale factors. But how can the expert, faced with this paradox, choose the scope of the factors for making the right decisions?

The answer to this question lies in the method of examination. During the examination the examiner is of equipment of digital audio track, which, being-positive, was recorded and analyzed (controversial) soundtrack. Expert records on this instrument at least three of their experimental (model) phonograms, and therefore the fact of their entry on the equipment of digital audio track is of no doubt. Then the expert compares these phonograms and gets a boundary. A priori knowing that all the coefficients belowing to the obtained bounds, are false, the expert can compare the IP-subjugated phonogram with each of the standard of phonograms and using IU-mode similarity to determine how close it is obtained in these cases the boundaries with the boundaries obtained by the standard phonograms. At the same time the standard phonogram shall be recorded in different conditions, but which are close to the sound environment, recorded in the disputed thereon. For example, if controversial soundtrack is recorded in the premises, the samples should be recorded in different rooms with character noises about-reflects the level and nature of noise on the soundtrack. Thus, based on the results of experimental studies of phonograms, well-established in the automatic mode, the expert defines the scope of application of scaling factors for decision-making on controversial thereon. The decision process is illustrated in Fig. 4 and Fig. 5.

Proceeding from the obtained results it was decided that presented for examination soundtrack recorded on equipment of digital audio track and selected fractal scale

1550. After this decision, in the manual mode has been set this scale factor, and the curves of probability density for these phonograms, as it is shown in Fig. 6.

As the above illustrations refer to one of the numerous experiments conducted during the development and testing of the developed expert program and methods of examination, it should be noted that for the purity of the experiment there were presented the exemplary recordings made on two different devices of the same type and brand.

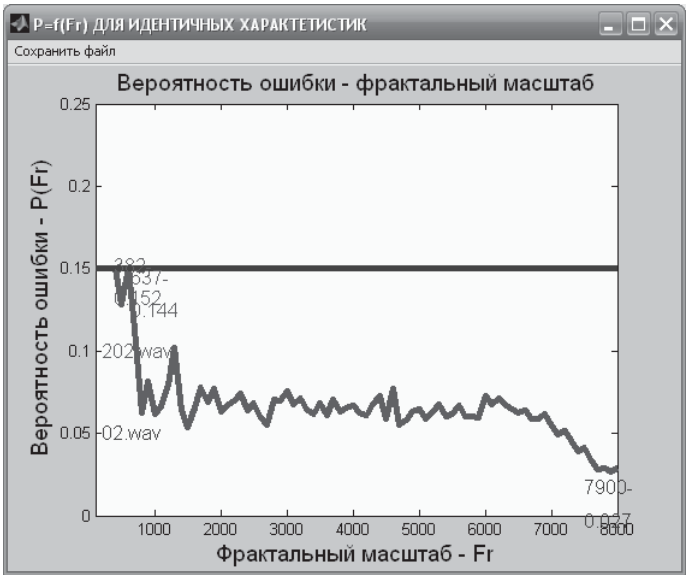

Fig. 4. Window of the results of the definition of fractal scales with parallel characteristics of the exemplary and controversial phonograms

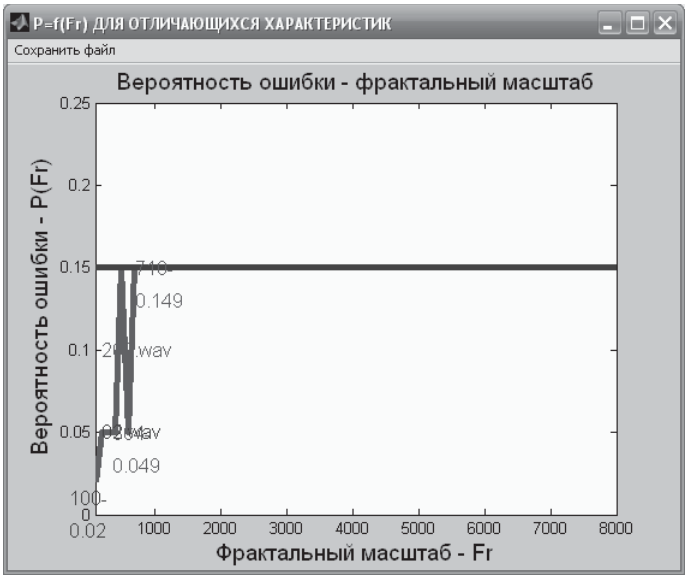

Fig. 5. Window of the results of the definition of fractal scales with divergent characteristics of the exemplary and controversial phonograms

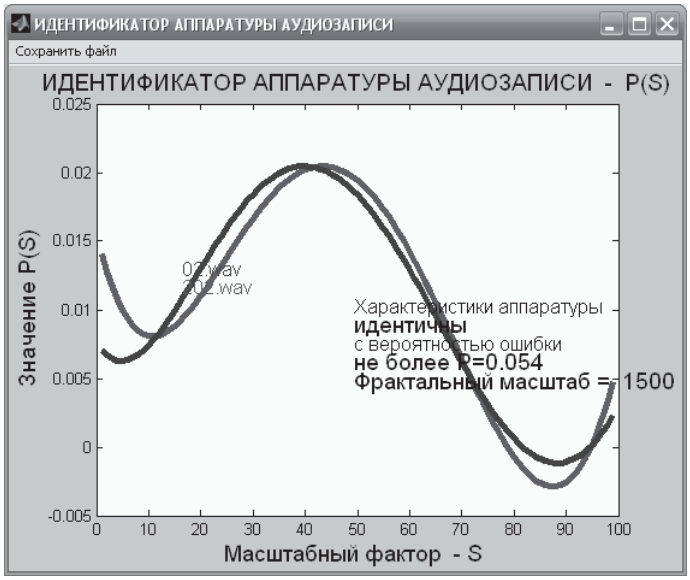

Fig. 6. Probability density of self-similar structures of the exemplary and controversial phonograms

Therefore, confirmation of this summary lies in the comparison of model records and controversial recordings made on another machine, as it is shown in Fig. 7, Fig. 10.

In these graphs we see that the boundary for the associated models records does not significantly coincide with the boundary for the compared exemplary and controversial phonograms.

The boundary for the model of phonograms in Fig. 7 and Fig. 8 exceeds the value 1000, and on the graphs presented in Fig. 9 and Fig. 10 this value does not exceed 800. The difference of 200 units is quite significant, given that this distinction for the first apparatus does not exceed 30 units (see Fig. 2– Fig.5).

Fig. 7. Window of the results of the definition of fractal scales with parallel characteristics of two exemplary phonograms, recorded on the second machine

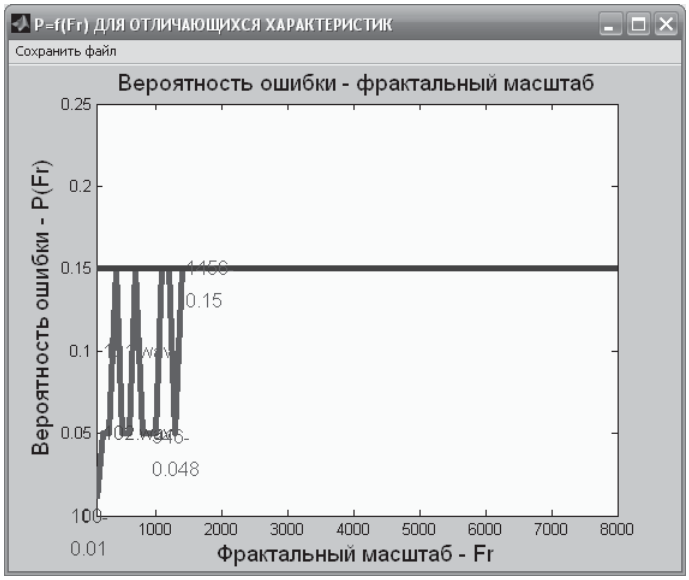

Fig. 8. Window of the results of the definition of fractal scales with divergent characteristics of two exemplary phonograms, recorded on the second machine

Fig. 9. Window of the results of the definition of fractal scales with parallel characteristics for exemplary and controversial phonograms, recorded on the second machine

It should be noted that in the process of research, conducted for the development and testing of the automated program and expert methods, the following facts were established 1. Phonograms are separated to boundary and non-boundary. For digital phonographs, without such boundaries, the schedule for phonograms with matching characteristics is a direct needful line with the probability of error of the first kind of 0.2. This means that the probability of coincidence of characteristics of phonograms does not fit the specified confidence interval for this error. It should be noted that such phonograms most, and this greatly simplifies the examination; 2.The boundary coefficients fractal scale increases with increasing noise level in the pause between speech signals.

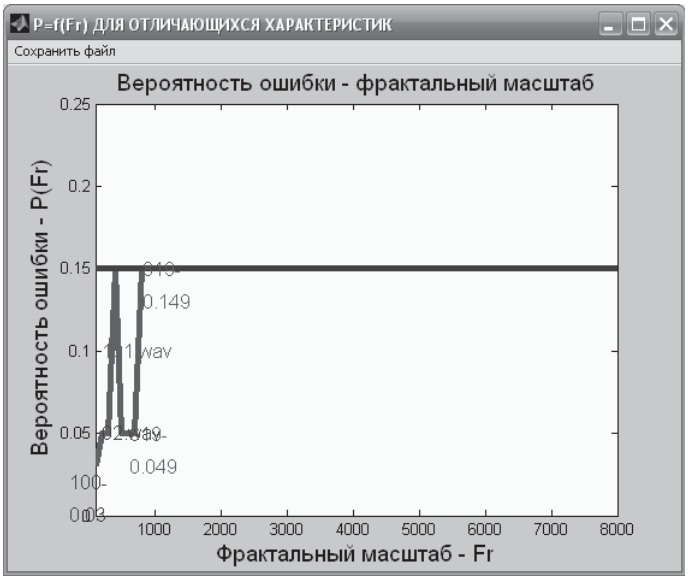

Fig. 10. Window of the results of the definition of fractal scales with divergent characteristics for controversial and exemplary (recorded on the machine 2) phonograms

Conclusions

Modification of the expert program "Fractal", intended for the identification studies of the equipment of digital audio track and diagnostics of its originalality, providing an automatic calculation of the coefficients of fractal scale has been developed. This approach greatly simplifies the examination and reduces time and labor costs for its implementation. The method of expert studies by using this program provides an unambiguous making of expert decisions.

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Reviewer Horoshko V.O., D.E., professor