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SYSTEM FOR PROTECTING VOICE INFORMATION FROM LEAKAGE THROUGH ACOUSTIC CHANNELS

ABSTRACT
of thesis for the master's degree

in specialty 1-98 80 01 «Information Security»

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INTRODUCTION

Human speech is the natural and most common way of exchanging information between people, and attempts to intercept (eavesdrop) this information have been going on since ancient times to the present.

Information protection is a purposeful activity of information owners (state, state and federal bodies, enterprises, institutions and organizations, commercial firms, individual citizens, etc.), aimed at excluding or significantly limiting the uncontrolled and unauthorized distribution (leakage) of the information they protect, and also various types of influences on functional information processes implemented by owners.

The level of technical protection of confidential information, as well as the list of necessary protection measures, is determined differentially based on the results of a survey of the protected object, taking into account the ratio of the costs of organizing information protection and the amount of damage that may be caused to the owner of information resources.

Assessment of the protection of speech information from leakage through technical channels (acoustic, vibroacoustic, acoustoelectric, etc.) is a necessary component of the certification of protected premises of informatization objects. For speech signals, the criterion for the security of speech information is considered a given value of speech intelligibility.

The protection of acoustic information is a rather expensive and complex measure, therefore, in practice, it is advisable in institutions and firms to have specially allocated places with guaranteed (according to a given category) protection of acoustic information - the so-called protected (dedicated) rooms.

GENERAL DESCRIPTION OF WORK

Relevance of the research. Currently, the influence of global information technology on most spheres of modern society is increasing. There is a high rate of development of unified global information and telecommunication spaces, new social groups have formed in society, a significant impact on the historically established way of life of people. At the same time, against a background of rapid development of new technologies there is an active growth of variety of computer attacks, planned and carried out with their use.

At the present stage of society development problems of information security come to the fore in most spheres of society. This is due to a significant number of currently implemented projects of informatization. Most of them are aimed at building a single information space in order to optimize the processing of large volumes of various kinds of information, including ensuring its reliable storage and quick access for participants of information exchange.

Thus, the relevance of the work is due to the fact that currently for the interception of voice information are used various technical devices: directional and laser microphones, voice recorders, etc. In this regard, protection of information from leakage through direct acoustic channel is one of the most important tasks at the present time.

Aim and tasks of the research. The **aim** of the work is to assess the influence of the type of interference signal and the signal-to-noise ratio on the security of speech information when it leaks through a direct acoustic channel.

In accordance with the goal, the following **tasks** were set:

- study the direct acoustic channel of information leakage;
- to study the features of the propagation of acoustic waves in the room;
- to analyze the methods of forming speech-like noise;
- to study the effect of signal-to-noise ratio on speech intelligibility.

Speech and noise signals were selected as the **objects** of the research.

The **subject** of the research is presented by algorithms of speech intelligibility analysis.

Area of the research. The content of the thesis corresponds to the educational standard of higher education of the second level (master's degree) specialty 1-91 80 01 «Information Security».

Scientific novelty. Speech-like interference level 6-8 dB below the white noise level provides a comfortable environment for the user and meets the requirements of voice information protection.

The main provision for the defense. The following main results are presented for defense:

1. The algorithm in programs SpeechGen for generating speech signal directly from speaker's speech and Cool Edit Pro for editing sound recordings and generating noise allows a qualitative assessment of the effect of noise on speech intelligibility.

Theoretical significance of the dissertation. The possibility of forming a speech-like interference of the "speech chorus" type from a random mixture of sounds was shown.

Practical significance of the dissertation. The results of the research indicate a high efficiency of using speech-like interference to mask voice information. It is shown that the speech-like interference can be generated on an ordinary computer with a sound card.

Approbation and implementation of the results of the research. The main theoretical results and completed stages of the dissertation, as well as the results of applied research and development have been reported on 57 Scientific Conference of BSUIR Postgraduate, Graduate and Undergraduate Students. – Minsk, 2021. One article was also prepared for publication at the XIX Belorussian-Russian Scientific and Technical Conference «Technical means of information protection».

Structure and scope of the dissertation.

The total volume of the dissertation is 62 pages, 33 figures on 28 pages, 12 tables on 8 pages, a bibliography list of 31 sources.

SUMMARY

Dissertation consists of introduction, general description of work, three chapters with conclusions for each chapter, general conclusion and bibliography.

The introduction and the general description of the work define the main directions of research, justify the relevance of the topic of the thesis, formulate the aim and objectives of the work, set out the main provision for the defense, and also show the need for research in this area.

First chapter is devoted to a review of publications on the topic of the research, in particular the main channels of information leakage, methods of determining the intelligibility of speech, its classification, as well as methods of protection of speech information from leakage. It is noted that the assessment of the protection of speech information from leakage through technical channels (acoustic, vibroacoustic, acoustoelectric, etc.) is a necessary component of the certification of protected premises of informatization objects. The main quantitative criterion for the protection of speech information from leakage through technical channels is the coefficient of verbal intelligibility *W*. One of the methods, which can be used to protect confidential speech information, is considered to be the noise of informative speech signal.

In **second chapter** the direct channel of acoustic information leakage on the example of a room located on the fourth floor of a four-story building made of prefabricated reinforced concrete was studied. It is shown that in the room can be allocated points, which are characterized by the presence of resonance. Thus, when studying the direct acoustic information leakage channel, it seems reasonable to choose such points for the location of voice information interception facilities.

The **third chapter** substantiates the methodology and conducts experimental studies on the protection of speech information from leakage. During the research it was found that in order to provide the required level of speech intelligibility, the level of speech-like interference can be 6 - 8 dB lower than the level of white noise, which will provide more comfortable conditions for users.

CONCLUSION

As a result of the study of the effect of the type of interference signal on speech intelligibility in a direct acoustic channel, the effectiveness of using speech-like interference for masking useful information was experimentally proved.

Using the example of a room, the direct acoustic channel and the acoustic characteristics of the room were studied. For the installation of the equipment, special points were selected at the joints of the dihedral corners (wall / floor, wall / ceiling). Signals such as white noise and speech-like noise were used as an interfering signal. A “speech chorus” was used as a speech-like signal. A signal that is formed from the voices of several speakers. The interference has no semantic meaning, but is formed taking into account the statistics of the Russian language.

It is shown that points can be distinguished in a room, which are characterized by the presence of resonance. Thus, when studying the direct acoustic channel of information leakage, it seems expedient to choose such points for placing the means of intercepting speech information.

The values of the three linear dimensions of a rectangular room: length, width and height, determine the corresponding values of its three main resonant frequencies, that is, longitudinal, transverse and vertical resonances. These frequencies are distinguished by seniority: the first, second and third, and the first of them, the lowest in frequency, in a rectangular room corresponds to the largest size - length. Therefore, for a room used to study a direct acoustic channel, it is proposed to use wall / ceiling, wall / floor joints (in the zones of dihedral corners) as such points.

Using the example of a room with placed equipment (three laptops with installed software Cool Edit Pro2, Manom-4/2, acoustic system Edifier R1900 T3, microphone BEHRINGER C-1 with a preamplifier), the influence of the type of interference signal and the signal-to-noise ratio on intelligibility was studied speech information in the event of its leakage through a direct acoustic channel.

In order to simulate the direct acoustic channel, information and interference signals were reproduced with a signal-to-noise ratio of 5dB, -1dB and -8dB for white noise used as interference. For speech-like noise, the ratios -1dB and -22dB were used. White noise and speech-like noise of the speech chorus type were used as an interfering signal. The interference does not carry a semantic load, however, it is formed taking into account the statistics of the Russian language.

It has been found that to ensure the required level of speech intelligibility, the level of speech-like interference can be 6 - 8 dB below the white noise level, which will provide more comfortable conditions for users.

LIST OF PUBLICATIONS OF THE APPLICANT

1-A Homayoon A. Analysis of basic speech information for constructing speech-like noise // 57 Scientific Conference of BSUIR Postgraduate, Graduate and Undergraduate Students. – Minsk, 2021. – 2 pp.