Hardware and Software Complex for the Formation of Speech-Like Noise

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Abstract

Solving the problem of ensuring the protection of confidential information, especially for small organizations, is important. It is proposed to implement a unified systematic approach to assessing the security of information based on the measurements and the formation of control actions on the elements of the information security system of such organizations. A methodology has been developed for constructing a research complex for monitoring the security characteristics of corporate information, which provided the creation of a hardware and software complex (HSC) "Resources of protecting information from leakage through technical channels." Layout of this HSC has been created, special software has been developed that allows studying the process of information leakage through technical channels and optimizing the characteristics of the corporate information protection system. HSC, in addition, is applicable in the process of training information security (IS) specialists. The created HSC model provides an opportunity to study the process of information leakage through technical channels and methods of its protection, as well as to use various modules and special software (software) that clearly demonstrate various methods of information security, for their qualitative and quantitative comparison. This complex includes test benches that simulate acoustic, vibroacoustic, acoustoelectric channels and a channel for incidental electromagnetic radiation and interference. At each of the stands there are information security means that prevent the leakage of confidential information through the corresponding technical channel. To configure the information security tools acoustic and vibroacoustic channels, software will be developed that will allow you to adjust the level of the generated acoustic interference to meet the security requirements of the room and at the same time to comfortably conduct a conversation in this room. In order to demonstrate the impact of technical information security on the incidental electromagnetic radiation and interference channel, the HSC will include a number of software modules. It is advisable to use the developed HSC not only as a measuring complex for scientific and practical purposes, but also as a training complex for information security specialists..

Keywords

Speech-like noise, hardware-software complex, acoustic channel, vibroacoustic channel

1. Introduction

In acoustic channels of information leakage, the technical unmasking (reconnaissance) feature of the objects of protection is acoustic waves. Such leakage channels are typical for acoustic speech reconnaissance (for intercepting speech information from places of human communication) and acoustic signal reconnaissance (for obtaining intelligence about acoustic "portraits" of various acoustic devices, the operation of which is accompanied by acoustic fields).

Speech is a source of acoustic information, the carrier of which is acoustic signals. In air, the signal propagates in the form of a longitudinal elastic wave, which is the vibration of air particles along the direction of wave propagation. The acoustic signal can be intercepted by an intruder using a

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microphone, which converts the signal into electrical and allows the signal to be transmitted outside the monitored room.

The main means of protecting speech information from leakage through these channels are sound insulation of premises, search for embedded devices and active acoustic masking. The basis of the means of concealment are jammers. In practice, noise oscillators have found the most widespread use. The application of this method allows to reduce the signal-to-noise ratio at the input of the technical means of reconnaissance by increasing the level of interference.

However, acoustic interference created by technical means of information protection should not bring significant discomfort to the participants in the dialogue present in the room. The problem arises of bringing the power of acoustic interference to an optimal level that meets the requirements of both the security of the room and the comfortable conduct of a conversation.

The process of perception of speech in noise is accompanied by the loss of the constituent elements of the speech message. The intelligibility of a speech message is characterized by the number of correctly received words, reflecting the qualitative area of intelligibility, which is expressed in the categories of the details of the certificate of the intercepted conversation compiled by the attacker.

As a solution, it was proposed to use an instrumental-computational method for assessing speech intelligibility, which allows you to select the level of noise interference of the protection means in such a way that the radiation of the generator is minimal, but ensures the protection of speech information from leakage. The power that meets these criteria is proposed to be considered optimal. Thus, it is necessary to measure the parameters set by the method, calculate the verbal intelligibility and adjust the masking tool to the optimal radiation level.

The method of forming speech-like interference correlated in level, spectrum and time with a hidden signal is the most effective method of active protection of speech information.

The use of speech-like interference in the information protection system against leakage through an acoustic channel is not only an effective method of preventing speech information leakage, but also is a "softer" method in relation to people in the room. A lower noise level required to achieve the set level of protection (relative to the use of generators of a different type), a signal spectrum close to human speech - these factors make comfortable and calm working in the protected area.

In systems of active protection of speech information in rooms for negotiations, it is possible to use speech-like signals and speech sequences as masking signals, which are formed taking into account the linguistic features of the language and the statistical characteristics of the occurrence of phonemes in a given language, as well as the length of words and sentences. Understanding active protection system against unauthorized listening shown in Figure 1.

The formation of speech-like signals can be performed by the compilation method based on the structural units of speech. As a result, the speech-like signals formed in this way retain all the shades of the speech of a certain speaker, and it is very difficult to distinguish them from the information signals of the same speaker.

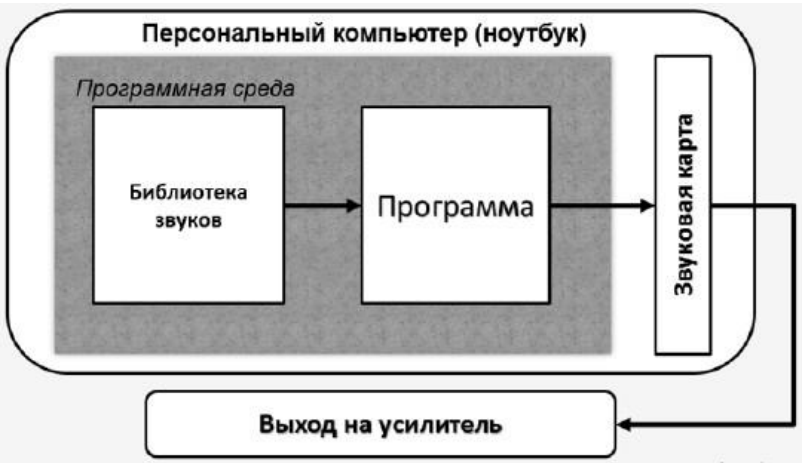

Figure 1: General view of the active protection system against unauthorized eavesdropping

In this case, the quality of synthesized speech can be improved by using exponential spline functions at the boundaries of the transition from one phonemic structure to another and by superimposing the end of one phonemic structure on the beginning of the second phonemic structure. In this case, there will be some more rapid damping of the oscillation amplitudes of the end of one phonemic structure and an increase in the amplitude of the beginning of the second phonemic structure. This mechanism of compilation speech synthesis will eliminate signal jumps at the boundaries of phonemic structures. To perform such a compilation speech synthesis, a base of phonemic structural units of speech with slightly enlarged segments in the time domain is needed, since during the synthesis the end of one phonemic structure is superimposed on the beginning of the second phonemic structure.

The analysis of speech segmentation methods showed that for the formation of the base of phonemic structural units of speech for speech synthesis by the compilation method, the segmentation method using dynamic programming is the most convenient. To do this, you must have a phonetic record of continuous speech, labeled manually into phonemic structural elements and containing all phonemic structural units necessary for the base. Usually these are 300-400 allophones for Russian, Kazakh, Belarusian speech and about 1200 phonemic structural units.

Since the phonetic bases of the structural elements of speech at the beginning and at the end contain transition areas, then when synthesizing speech, splines for the transition areas should be used. It is recommended to use the so-called "stitching" of allophones when compiling speech synthesis. The transition section of the end of the previous allophone, multiplied by a decreasing function varying from 1 to 0, is superimposed on the transition section of the subsequent allophone, multiplied by an increasing function from 0 to 1. If the lengths of the overlapping transition sections are not equal, then the length of the formed transition region is chosen equal to the length of the longer transition section.

Acoustic and vibroacoustic masking systems use interference of both “white” and “pink” noises, as well as speech-like interference. In protection complexes, interference is used to mask speech, which is similar in structure to masked speech. It can be interference from an external source or interference from a speech-like noise synthesizer phoneme cloner. The interference created by such a synthesizer is not just speech-like, the phonemic cloner ensures the formation of such interference that maximally corresponds to the sounds of the speech of a particular person or group of people whose conversations are protected from eavesdropping.

2. A model of a speech-like noise generator

A model of a speech-like noise generator based on the Matlab mathematical package is proposed. The model is built on the basis of standard objects of the Simulink visual design environment. In the presented model, it is proposed to multiply the transition areas by linear functions varying from 1 to 0 and from 0 to 1. However, due to the fact that hearing sensitivity is nonlinear, it is more efficient to use spline functions of a higher order (up to the third degree).

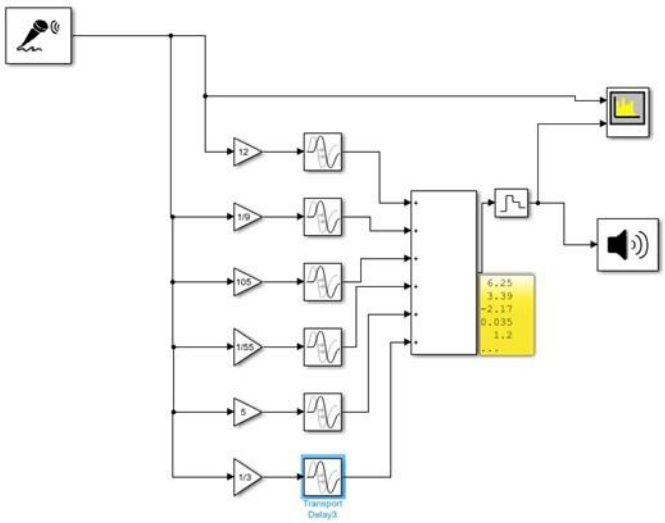

Figure 2: Example figure

Studies of the model have shown that an increase in the number of allophone cascades leads to a change in both the spectrum of the generated speech-like noise and its amplitude. These changes are clearly visible in the transition from a three-stage scheme to a four-stage one.

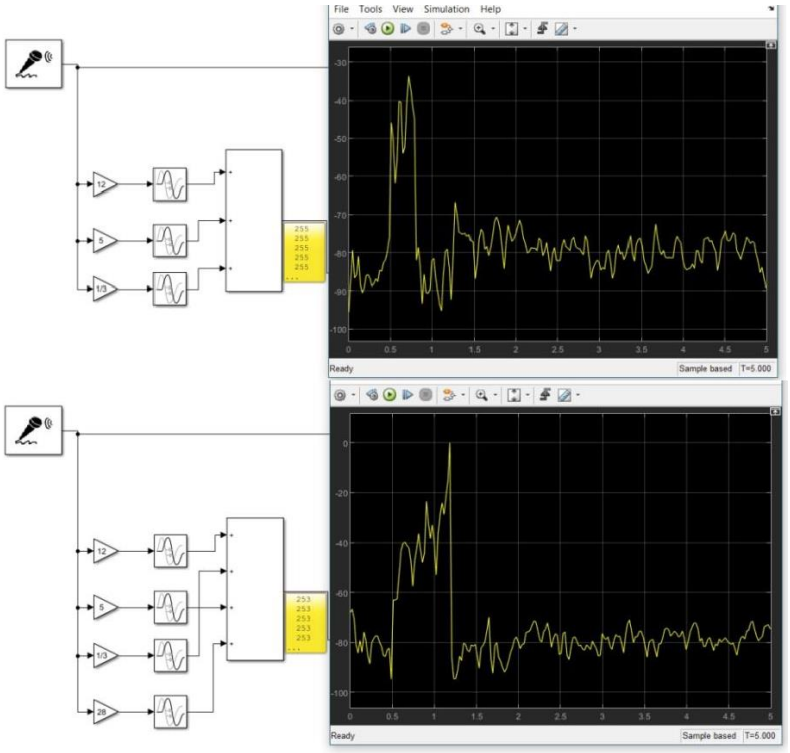

Figure 3: Simulation results of a speech-like noise generator with a different number of shaper stages

Figure 4 shows the spectra of the speech message of the interlocutors and the speech-like noise synthesized by the generator. The simulation result shows a sufficient similarity of the spectra data.

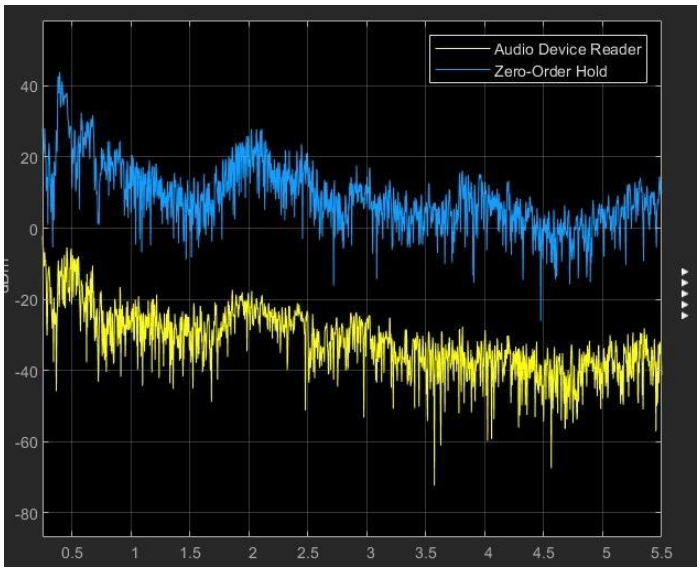

Figure 4: The spectra of the speech message of the interlocutors and the speech-like interference synthesized by the generator

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