

Formation of Acoustic Interference Based on a Microcontroller for the Suppressor of Unauthorized Speech Recording

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Abstract—The report analyzes the effectiveness of suppressing unauthorized speech recording with acoustic countermeasures. To significantly increase the efficiency of suppression, it is proposed to adapt the acoustic method taking into account the peculiarities of the propagation of acoustic oscillations in the air and the psychophysical perception of sounds by the human ear. The results of experimental researches are given and the means of counteraction on the basis of the microcontroller are offered.

Keywords—speech, unauthorized recording, microcontroller, speech protection device.

I. INTRODUCTION

The urgency of protecting language information is mainly due to two factors: the first - language information is very informative and the second - the widespread use of language recording devices, starting with modern smartphones (today there are more than 4 billion units in the world) who record speech, various dictaphones and ending with special means of recording language that have the ability to counteract the means of suppressing unauthorized recording [1, 2]. Unfortunately, none of the currently known methods of preventing and suppressing unauthorized recording of speech can, without knowledge of the type of recording device, guarantee complete prevention of unauthorized recording of speech information. The article proposes a method and on its basis a tool that significantly increases the effectiveness of counteracting unauthorized recording of voice information, regardless of the type of recording device.

II. ADAPTATION OF ACOUSTICS METHOD FOR INCREASE EFFICIENCIES OF SUPPRESS OF UNAUTHORIZED SPEECH RECORDING

To significantly increase the efficiency of suppression, it is proposed to adapt the acoustic method taking into account the peculiarities of the propagation of acoustic oscillations in the air, psychophysical perception of sounds by the human ear and improving the technical characteristics of the acoustic suppression system. Namely:

1) the distance between the source of the acoustic interference and the probable location of the recorder must be minimized and made smaller than the distance between the source of speech and the recorder;

2) to form an acoustic barrier from the speech of interlocutors. Such a speech interference cannot be filtered out because it occupies the same frequency band as the speech signal. To form an acoustic barrier off the speech of the interlocutors. Such a speech interference cannot be filtered out because it occupies the same frequency band as the speech signal;

3) significantly improve the technical parameters of the speaker system for the emission of speech interference, using an electrostatic acoustic system of radiation, abandoning the use of traditional electrodynamic emitters, which will lead to:

- a) increasing the linearity of the frequency response of the speaker system;
- b) reducing the magnitude of its nonlinear distortions;
- c) narrowing directional diagram of the speaker system.

These changes in the technical parameters of the speaker system will bring the spectral characteristics of the interference as close as possible to the voices of the interlocutors. A narrowing of the directional diagram of the electrostatic speaker system with the same radiant power will lead to:

- increasing the power flux density of the interference signal, which increases the efficiency of suppression of speech recording;
- some reduction in the intensity of the interference signal on the hearing organs of the interlocutors due to the spatial orientation of the acoustic emitter on the possible location of the recording device in the clothes of the visitor.

III. RESULTS OF THE EXPERIMENTAL STUDY OF THE EFFICIENCY OF THE ADAPTED ACOUSTIC METHOD OF SUPPRESS OF UNAUTHORIZED RECORDING OF SPEECH

To evaluate the effectiveness of the adapted acoustic method of suppression of unauthorized speech recording using an interference generated by an electrostatic emitter, an experiment was conducted - comparison of technical parameters of protection against unauthorized speech recording built using adapted acoustic (EST-ST, EST-P), electromagnetic (SHUMOTRON-3, PD - 2) and ultrasonic (USPD-C, UltraSonic-50) suppression methods for five modern types of sound recorders - digital voice recorders and smartphones (Olimpus VP-20, Edic-mini B76, Galaxy S8 +, Iphone Xs Max, Iphone 12 Pro Max.) The results of the experiment are presented in tables 1-3.

Table I shows the distance of complete suppression of dictaphones when using electromagnetic suppressors "SHUMOTRON-3" and "PD-2"

TABLE I.

Model	SHUMOTRON-3 Radiation power 15W	PD-2 Radiation power 8W
Olimpus VP-20	2,2m	1,6m
Edic-mini B76	0,6m	0,2m
Galaxy S8+	0,3m	0,1m
Iphone Xs Max	0m	0m
Iphone 12 Pro Max	0m	0m

Table II shows the range of complete suppression of voice recorders when using ultrasonic suppressors.

TABLE II.

Model	USPD-C(26 emitters, acoustic pressure 115dB)	UltraSonic-50 (50 emitters, acoustic pressure 115dB)
Olimpus VP-20	0,9m	1,2m
Edic-mini B76	1,1m	1,3m
Galaxy S8+	6m	8m
Iphone Xs Max	1,8m	2,4m
Iphone 12 Pro Max	2,2m	3m

Table III shows the range of complete suppression of dictaphones by ultrasonic suppressors provided that their microphone is closed by a pocket material (the dictaphone is in the pocket).

TABLE III.

Model	USPD-C(26 emitters, acoustic pressure 115dB)	UltraSonic-50 (50 emitters, acoustic pressure 115dB)
Olimpus VP-20	0,1m	1,1m
Edic-mini B76	0,2m	0,3m
Galaxy S8+	0,4m	0,5m
Iphone Xs Max	0,15m	0,2m
Iphone 12 Pro Max	0,2m	0,25m

Table IV shows the range of complete suppression of dictaphones when using electrostatic suppressors "EST-ST" and "EST-P".

TABLE IV.

Model	EST-ST (acoustic sensitivity 88dB)	EST-P (acoustic sensitivity 86dB)
Olimpus VP-20	3,5m	3,2m
Edic-mini B76	2,8m	2,6m
Galaxy S8+	2,46m	2,4m
Iphone Xs Max	2,2m	2m
Iphone 12 Pro Max	1,8m	2m

IV. DEVELOPMENT A WORK ALGORITHM OF THE PROTECTION DEVICE AGAINST UNAUTHORIZED RECORDING WITH SOUND RECORDING DEVICES

The means of protection against unauthorized recording by sound recording devices consists of one device. The device includes a microphone, two amplifiers, a unit for generating interference processing and a speaker for signal (interference) reproduction. The functional diagram of the tool is shown in Fig. 1.

When turned on, the device starts recording voice information, namely the voice of the person generating the information to be protected from unauthorized recording on various devices. This is necessary in order to create a language-like interference based on this voice in real time. Once the microphone has generated a signal, it is amplified by a microphone amplifier. With this amplifier, we convert a weak signal from a microphone to a linear one. When the amplifier has done its job, the signal is transmitted to the main executive unit of the formation and processing of the interference, which is a microcontroller. At this stage, the signal is digitized and written to the array. After that, based on the array using the algorithm to create a speech-like interference, a speech-like interference is generated.

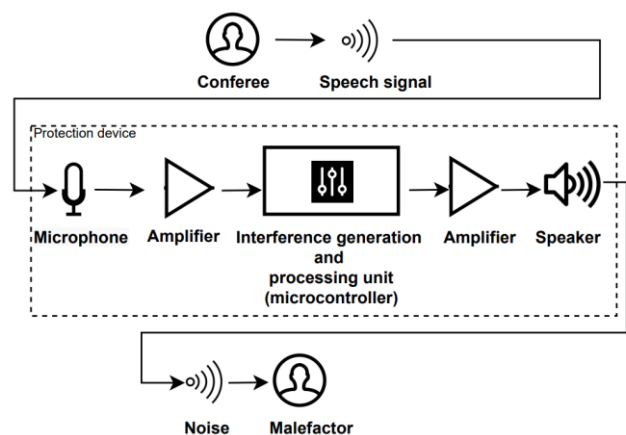


Fig. 1. Functional diagram of the means of protection against unauthorized recording of speech.

The microcontroller controls all the units of the device and performs the main function, namely the generation of speech-like interference. In this device, you can use almost all algorithms to create a speech-like interference. For example, one of them, the digitized speech signal is recorded in two arrays then these arrays are shifted in time and form speech-like interference.

Since the device circuit is quite simple, and the algorithm for creating interference is created using software, it allows you to change the algorithm by reprogramming the microcontroller.

The microcontroller processes the received interference for its further reproduction. After the microcontroller, the interference is fed to the amplifier. The amplifier sends a signal to the speaker playback device. You can see the algorithm of the device in Fig. 2.

Almost every microcontroller that has a DAC or ADC is suitable for project implementation. Among the most popular microcontrollers to date, STMicroelectronics microcontrollers, namely STM32, have proven themselves well. 4th generation microcontrollers (STM32F4 ...) are ideal for this project.

The choice of this microcontroller is also due to the convenient software supplied by the company. It is very convenient to work in the STM32CubeIDE development environment. You can configure HAL in CubeIDE and then do the connection schema.

It was decided to use MAX9814 when choosing a microphone. The module consists of an electronic microphone and a special amplifier on the MAX9814 chip from Maxim. The chip amplifies the sound much better than other amplifiers due to the built-in automatic gain control, which suppresses "loud" sounds and amplifies "quiet" sounds. The module has an additional GAIN input, with which you can adjust the "maximum gain", if you do not connect it, the maximum gain will be 60 dB.

CONCLUSION

The algorithm of work of the mean of protection of the information on the basis of the microcontroller is developed. This tool uses an adapted acoustic method to counter unauthorized speech recording. This method is equally effective for all types of recording devices, as the interference is formed by a functional channel - acoustic, taking into account the peculiarities of the propagation and perception of acoustic vibrations by humans in the air.

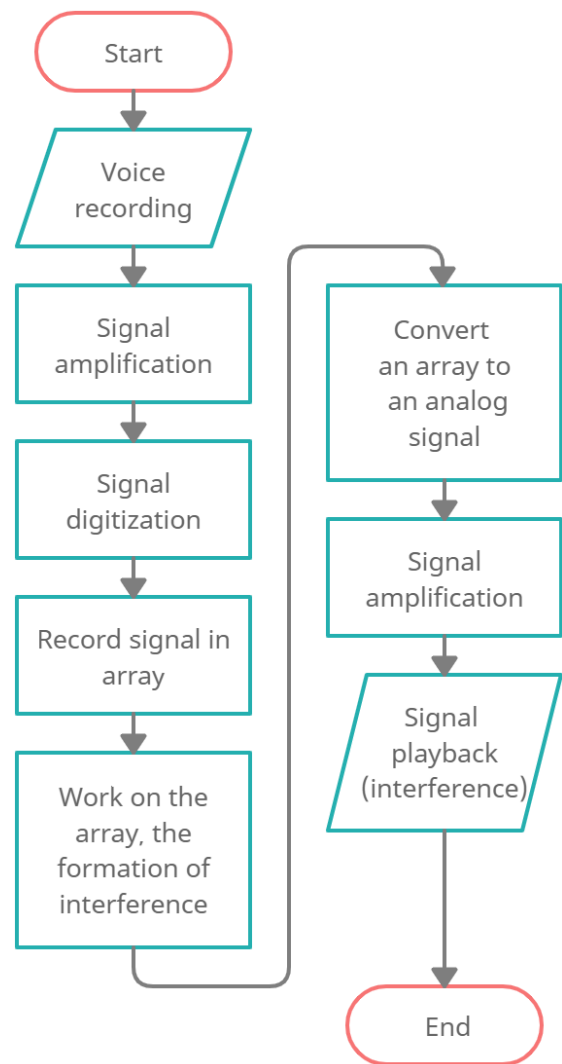


Fig. 2. Algorithm of the device.

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