Digital Watermarking of Speech Signals

Dmytro Peleshko[1], Yuriy Pelekh[1], Ivan Izonin[1], Marta Peleshko[2]

1. Publishing Information Technologies Department, Lviv Polytechnic National University, S. Bandery Str., 12, Lviv, 79013, UKRAINE,

2. Lviv State University of Vital Activity Safety, Kleparivska str., 35, Lviv, 79007, UKRAINE
E-mail: peleshko@lp.edu.ua

Abstract – In this paper the blind method of robust speech signal watermarking is presented.

Key words – digital watermark, speech signal, compression, digital signal processing, information security.

I. Introduction

The main purpose of watermark usages is to be a recognizable element which can be used to prove the identity or ownership of the object. The most common example would be a banknote where watermark is added at the manufacturing process for the authenticity of the sample. The advantage of a digital watermark, as a rule, is that it should not be visible to the user.

Digital watermarking is the process of embedding extra information into a digital signal in a way that is difficult to remove. This signal can contain multiple different digital watermarks at a time.

The signal may be audio, pictures or video. Most file formats of digital media devices contain additional information in the form of metadata that is stored separately from the signal. However the digital watermark is placed inside the signal.

Furthermore digital watermark can be used not only to protect information against unauthorized use or illegal copying, but also to identify the individual (specific) data. For example of the speech signal, it is possible to identify its content in real time or to identify unknown sounds using online applications.

The basic requirements of the digital watermarking are invisibility, stability, and correct extraction. The most popular methods of embedding and extracting digital watermark is methods based on a "blind" decoding scheme. These methods do not require the original signal or a digital watermark.

In this paper is proposed the "blind" method of encoding and decoding a digital watermark.

II. Watermarking Method

On the first step we should split the input signal onto the same length segments. The single segment length depends on the speech signal parameters. In our experiments we use segment length values of 2^8-2^{10} samples. Then determine the signal frequency band for a watermarking by digital filters. Digital filters can be implemented based on Fast Fourier transformation (FFT). There is the most common solution.

To provide better stability watermark should be embedded to a lowest frequency as possible (more stable to converting and compressing).

Within the selected band find the amplitude maximum which will be a destination for the watermarked bit. In case of 0-bit is embedded the less significant bits of three left samples should be reset, in case of 1-bit – reset less significant bits of the three right samples. To extract the digital watermark all operations until finding the amplitude maximum should be repeated. Then perform sums comparison of the less significant bits of three left and right samples. Extract the marked bit based on the result.

III. Results

The solution implemented on a Windows Phone using XNA Game Studio for recording and playback of speech signals before and after watermarking. A simple text was taken as a digital watermark, which was inputted from the application interface.

The quality of encoding and decoding of the digital watermark is calculated using the Ratio of Correct Bits Recovered formula:

$$RoCBR = \frac{100}{K}\sum_{n=0}^{K-1}\begin{cases}1, w_n = w'_n;\\ 0, w_n \neq w'_n,\end{cases} \quad (1)$$

where w_n-n^{th} watermarked bit, w'_n-n^{th} extracted bit, K – total number of embedded bits.

The average result achieved is higher then 80%.

Conclusion

In this paper is proposed a new robust method of speech signal watermarking. Extraction of watermark doesn't depend on source signal or watermark itself what makes this method easily integrated with other digital signal processing (DSP) systems.

References

[1] *Д. Д. Пелешко*, Ю. М. Пелех, "Модифікація методу маркування мовних сигналів на основі моментів Зернике", ISDMCI'2012, ст.392-393, травень 2012.

[2] *Н. В. Кошкина*, "Криптографічні та стеганографічні методи захисту інформації", Захист інформації і безпека інформаційних систем 2012, ст.120-121, 31 травня – 1 червня 2012.

[3] *Н. В. Кошкина*, "Внедрение ЦВЗ в аудиосигналы на основе пакетной вейвлет-декомпозиции и частотного маскирования", Искусственный интеллект, ст.381-387, квітень 2010.

[4] *R. Tachibana*, "Audio Watermarking for Live Performance", Tokyo Research Laboratory, IBM, Jun. 2003.

[5] *R. Healy*, "Digital audio watermarking with semi-blind detection for in-car music content identification", 36th International Conference: Automotive Audio, Jun. 2009.