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SPEECH PROCESSING IN THE GSM STANDARD

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Abstract
This article is devoted to speech processing processes in the GSM standard, which are aimed at ensuring high quality of transmitted messages and implementing additional service capabilities, as well as improving the consumer qualities of subscriber terminals.

Keywords: DTX – Discontinuous Transmission, VAD – Voice Activity Detector, LPC – Linear Predictive Coding.

Introduction

Speech processing is performed using the established Discontinuous Transmission (DTX) system. The Discontinuous Transmission (DTX) system ensures that the transmitter is activated only when the user initiates a conversation and deactivates it during pauses and at the end of a conversation.

DTX controlled by a speech activity detector (VAD – Voice Activity Detector),

This system detects and isolates speech transmission intervals with noise and speech-free noise, even when the noise level is comparable to the speech level. The intermittent speech transmission system also includes a comfort noise generator, which is activated and audible during pauses in speech when the transmitter is turned off.

Experiments have shown that disabling background noise at the receiver output during pauses when the transmitter is turned off irritates the subscriber and reduces speech intelligibility. Therefore, the use of comfort noise during pauses is considered necessary. The DTX process in the receiver also includes interpolation of speech fragments lost due to errors in the communication channel.1.

The structural diagram of speech processing processes in the GSM standard is shown in Fig. 1. The main device in this diagram is the speech codec.

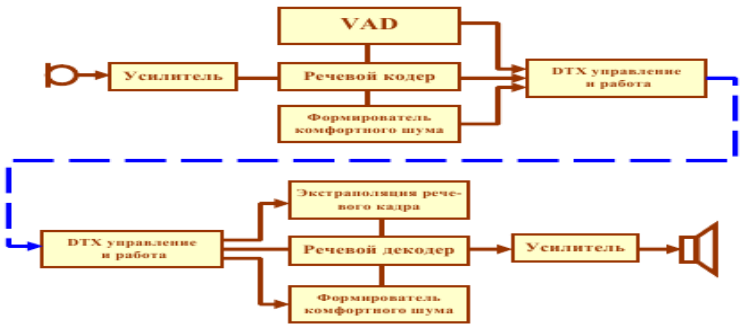

Рис. 1. Structural diagram of speech processing processes in the standard GSM.

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Speech coding in the GSM standard is based on the linear prediction method (LPC – Linear Predictive Coding), the essence of which is that it is not the parameters of the speech signal that are transmitted, but the parameters of a certain filter equivalent to the vocal tract, and the excitation parameters of this filter. Speech quality is superior to that of analog radiotelephone systems.[2]

Theoretically, the delay time of the speech signal in the code is equal to the segment duration and is 20 ms. The actual delay time, taking into account channel coding and interleaving operations, and the physical execution of the operations in question is 70–80 ms.

The Voice Activity Detector (VAD) plays a crucial role in reducing battery consumption in portable subscriber terminals. It also reduces interference by switching idle channels to passive mode. Implementation VAD depends on the type of speech codec used. The main task in designing VAD Ensure reliable discrimination between active and passive channel conditions. If the channel is momentarily clear, it can be blocked if the speaker's average speech activity is below 50%, which can lead to significant battery savings.

The GSM standard uses a frequency-domain VAD scheme.

Its operation is based on the differences in the spectral characteristics of speech and noise.

The background noise is considered to be stationary over a relatively long period of time, and its spectrum also changes slowly over time.

VAD Determines the spectral deviations of the input signal from the background noise spectrum.

Comfort noise is generated during pauses in active speech and is controlled by a speech decoder.

When speech activity detector (VAD) When the transmitter detects that the speaker stops speaking, the transmitter remains on for the next five speech frames. During the first four of these, the background noise characteristics are estimated by averaging the gain and LPC filter coefficients. These average values are transmitted in the next fifth frame, which contains information about the comfortable noise (SID frame).

In the speech decoder, comfort noise is generated based on LPC analysis of the SID frame. To eliminate the annoying effects of noise modulation, the comfort noise must match the amplitude and spectrum of the actual background noise at the transmission location. In mobile communications, background noise can constantly change. This means that noise characteristics must be transmitted from the transmitting side to the receiving side not only at the end of each speech burst, but also during speech pauses, so that there are no sharp discrepancies between the comfort and real noise in subsequent speech frames. For this reason, SID frames are sent every 480 ms during speech pauses.[3]

Dynamic change of comfort noise characteristics ensures natural reproduction of speech messages when using an intermittent speech transmission system.

It was found that the loss of a single speech frame can be significantly compensated for by repeating the previous fragment. During significant interruptions in communication, the previous fragment is no longer repeated, and the signal at the speech decoder's output is gradually muted to indicate to the user that the channel has been disrupted.

The same thing happens with the SID frame. If an SID frame is lost during a speech pause, comfort noise is generated with the parameters of the previous SID frame. If another SID frame is lost, the comfort noise is gradually attenuated.

The use of speech extrapolation in digital transmission, the formation of smooth acoustic transitions during signal fading in channels, in combination with the full DTX process, significantly improves consumer communication qualities compared to existing analog cellular communication systems.[4]

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