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METHODS FOR MEASURING ELECTRICAL ECHOES UNDER ECHO COMPENSATOR OPERATING CONDITIONS

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This paper is about possible methods for detecting and measuring the electrical echo parameters with echo cancellers in operation. This task could be important for identifying fraudulent calls to bank customers and other illegal activities involving telephones. Echo is a common interference in telecommunications systems, and echo cancellers are used to suppress it. They reduce the echo to a level imperceptible to the ear. Four methods are proposed that can allow for the acquisition and measurement of an echo signal, even with echo cancellers in operation.

To protect bank customers from fraudsters and in other situations, it is important to measure the parameters of electrical echo (EE) during a telephone conversation (discussed in more detail in [1]). In modern phones, the presence of effective echo compensators makes this task quite difficult. Some proposals for measuring EE under EC operating conditions have already been discussed in [2]. We are talking about sudden changes in the level of the probing signal and taking measurements against a background of noise. In this paper, we will consider a number of other methods.

The structural diagram of the echo compensator shown in Fig. 1 is supplemented with a so-called double-talk detector. Its purpose is to determine when both subscribers are speaking at the same time. To avoid loss of information and discomfort for the interlocutors, the adjustment of the EC coefficients is stopped at this time; they are “frozen” or fixed.

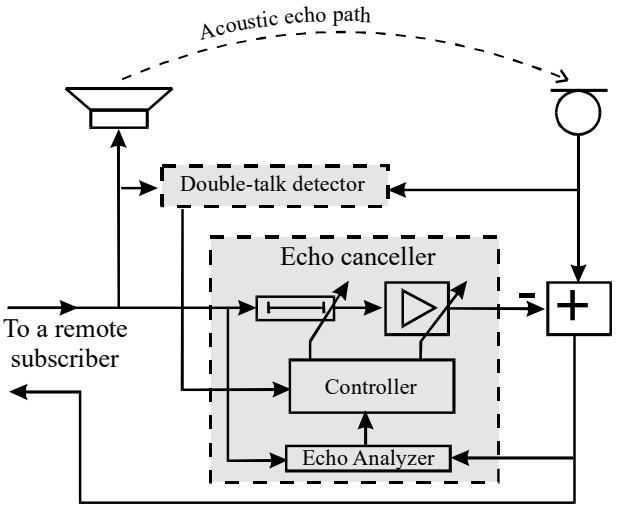

Fig. 1

The first method for measuring EE consists of generating a probe signal against the background of the remote subscriber's speech. We expect that an EC with fixed coefficients will not be able to effectively suppress the probe signal. In this case, echo detection will also have to be performed against the background of the speech signal from the remote subscriber.

The second method is based on the finiteness of the impulse response of an adaptive filter, which is essentially what an EC is. We believe that if a copy of

the probing signal is added to it, delayed for a certain time (according to our estimates, from 50 to 100 ms), as shown in Fig. 2, then we can expect the EC to accept the second signal as an incompletely suppressed echo. In this case, the filter coefficients will be calculated with errors, which will actually lead to incomplete echo suppression.

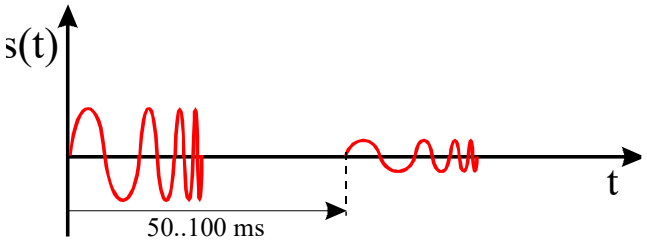

Fig. 2

It's possible that not one, but two or more signal copies should be added, and their amplitude may need to be changed, which can be verified experimentally. When receiving and analyzing such a complex probing signal, it's important not to get confused by the numerous copies and to accurately measure the delay.

Another method is based on the fact that the telephone is, after all, designed to transmit voice signals. Accordingly, all of its components: DAC, ADC, filters etc. are designed for the frequency and time characteristics of speech. Therefore, using signals for measurement whose parameters differ from those of speech can lead to a decrease in the effectiveness of the EC. Such signals can be chirps signals, phase-shift keying and other complex signals. They can also be narrowband signals with frequencies close to the limits of the range reproducible by the telephone.

The fourth method involves making the probing signal so weak that it doesn't trigger the echo canceller. Naturally, the echo signal will also be very weak. To ensure that such a signal can be received and processed, it should have a long base. When using the long signal duration, we would like to have the maximum possible frequency range. To detect it and measure its parameters, correlation processing will have to be used.

The assumptions made can be tested experimentally, and the effectiveness of the methods can be verified experimentally too.

References

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