Thus, if the sum of simultaneously acting amplitudes of harmonics A3 + A5 + A9 + A7 + A11 is equal to or less than 8% of the amplitude of the first harmonic, the coefficient harmonic distortion of voltage does not exceed 7%, and the absolute error of its determination the formula (15) is not more 1.3%.

With a coefficient of the voltage harmonic distortion up to 7% of the proposed formula for determining the coefficient work and allows us to estimate nonsinusoidal voltage with an absolute error less than 1.3%.

This is verified and the trapezoidal waveform voltage in the range of angle changes from 40 degrees to 60 degrees, and at a voltage in the form of an arbitrary mixture of harmonics up to k = 11 inclusive.

In this article an attempt is made to approximate determination of the coefficient harmonic distortion voltage indications of the voltmeter, measure the rms value of the distorted sinusoidal voltage U_D and peak value U_{Dm} the same voltage.

We received approximate expression (7) for the calculation of the coefficient of harmonic distortion of the voltage according to the testimony of voltmeters.

The formulated tasks for the metrological studies obtained expression to determine the possibility of practical application of the obtained formulas for calculation of the coefficient of the harmonic distortion of the voltage according to the testimony of voltmeters.

The expression (8) can be used for approximate assessment of nonsinusoidal periodic voltage via the measured RMS voltage and of its peak value in a limited range of coefficient for voltage harmonic distortion up to 7% with an absolute error no more than 1,3%.

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DETERMINATION OF THE FINE STRUCTURE INFORMATION SIGNS OF THE SPEECH SIGNAL

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The paper presents the research results of methods to assess primary features of the speech signal: the frequency of the mail tone and formants. Deviation of the calculated values of the main tone investigated by means of these methods was ± 1,37%. The most resistant to noise method for estimating the frequency of the man tone is the autocorrelation method. The paper also presents the research results of methods for determining the basic phonemes of Russian formants. According to the research the first phoneme of Russian formant "a" is the most resistant to noise.

The determination of primary features of the speech signal, such as the period (or frequency) of the main tone (MT) F_0 , is a necessary criterion for determining the presence of speech in high level noise. The determination of the formants $F_1, F_2, \ldots, F_n$. is the source of additional, but not less important information, not only about the speech signal, but also about the individual signs of the speaker. The analysis of works by L.R. Rabiner, R.V. Shafer, J. Markel, A.H. Gray, I.O. Arkhipova, V.B. Gitlin, V.G. Mikhailov, L.I. Zlatoustova, A.N. Golubinsky, S.I. Rasskazova [1-6] and others shows that existing methods for determining the frequency of the main tone and formants of speech were tested in normal conditions and practically were not studied in terms of influencing factors. Therefore, the evaluation of primary features of elements of the speech signal such as the frequency of the main tone and formants in terms of influencing factors, is one of the most important tasks of the design and control of communication equipment and systems for the protection of speech information from losses by technical channels [7].

In order to identify the best methodologies for assessment of the frequency of the main tone we studied Russian language phonemes without influencing factors. The deviation of the calculated values of the MT frequency was ± 1,37%. Based on studies of eight methods for assessing MT frequency from their noise immunity and sensitivity, as well as the analysis and processing of the results we chose the following three methods: amplitude, cepstral and autocorrelation. Further, these methods have been studied in terms of influencing factors. Influencing factors were white Gaussian noise with the distribution of amplitude and chaotic pulse sequence noise. For additional signal distortion different kinds of clipping have been used.

Studies were performed on the basis of Russian vowel phonemes *а, о, у, э, и, ы* pronounced by male and female voices, with an average duration of 0.3 s. Evaluation of the main tone frequency was performed at various signal/noise ratio. The frequency of the main tone and the intelligibility of phonemes at different levels were estimated and the thresholds of cutoff signal clipping were specified.

Studies based on the method of amplitude selection using cueing points in the maximum values of quasi-periodic signal portions showed that, despite the fact that this method is simple to implement and requires few computational resources, its evaluation results are of very low precision and stability even at low noise levels. When clipping is high, the chance of missing the maximum and incorrect definition of the main tone is frequent. When the cutoff threshold is higher than 30-40%, this calculation is not possible.

Cepstral analysis method was developed by R.V. Schafer and L.R. Rabiner [1]. This method is based on the calculation and analysis of the cepstrum – an inverse Fourier transform of the logarithm of the power spectrum of the signal. This method is the best to assess vocal sounds. One of the features of this method is an increasing influence of a low-frequency noise component due to the operation logarithm spectrum. Work was in the unreal-time, and to improve the precision in estimating the time window, the smoothing operation should be applied. Therefore, the cepstral method has not been widely used to determine the main tone because it has low resistance to noise and computational complexity.

On the basis of experimental data, the autocorrelation method is the best to estimate the periodicity of the signal depending on the delay. A short-term autocorrelation function (ACF) is used for the analysis of the speech signal. For the vocal phonemes ACF has a clear maximum in the delay, equal to the period of the main tone. This method allows us to determine the frequency of the main tone of the spoken phonemes exactly and allows us to detect a voice signal, despite the background of strong noise and different types of clipping. It has been found that the central cutoff at high levels of threshold changes the frequencies of the main tone. This leads to a change in voice and a significant decrease in intelligibility. When determining the main tone frequency from vowels spoken by a female voice, sounds *у, и* are subject to change significantly, while sounds *а, э* are not. In the study of a male voice we observed noticeable changes in sounds *у, и, ы*. Sounds *а, э, о* are less susceptible to changes.

There are several properties of the cepstrum: it fully preserves information about the spectrum amplitude of the original signal, and decreases the contrast of the frequency components. These properties make it resistant to the formant structure of signals. Therefore cepstral analysis method was chosen out of the investigated methods of discrete Fourier transform, linear predictive coding and wavelet transform.

The criteria for evaluation were deviations of phoneme formants allocated for various influencing factors from phoneme formants isolated in the absence of any influences. Analysis of the data evaluation formant frequencies from the literature does not allow us to make a conclusion about the use of different methods and conditions for assessing the formants. The results of our experiments match the results obtained by M.A. Sapozhkov for vowel phonemes [8].

Under applicable in phonetics vowel quadrangle described by E. Skuchik [9] or so-called triangle (trapezoid) vowels described by L.V. Scherba, was built some curve, establishing spread dependencies second formant frequency F_2 of the first formant F_1 for investigated phonemes (fig. 1).

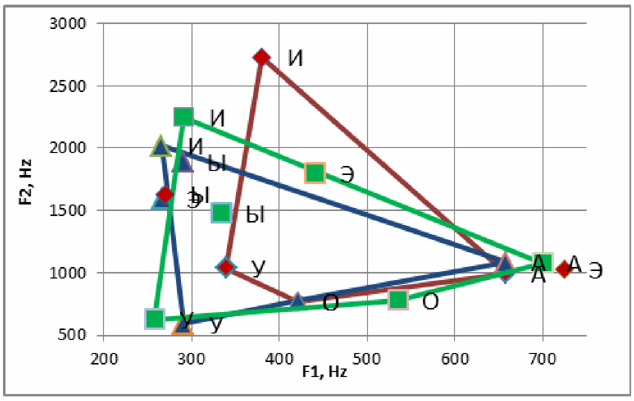

Fig. 1. Formants triangles

The vertices of the quadrilateral are sounds *a*, *o*, *y*, *u*, but sounds *э*, *ы* are located in the neighborhood of the resulting figure. We obtained figures based on the analysis of female and male voices, which show that with a decreasing voice (male) the quadrangle shifted to the origin and with an increasing voice (female) – away from the origin. However, the relative position of the sounds does not change. If the voice is hoarse, the location of the quadrilateral changes, but the relative position of the phonemes does not change. Quads vowels with different ratios of signal/noise were built. Figure 2 shows the change in the dependence of formants F_1 and F_2 for phonemes spoken by a female voice.

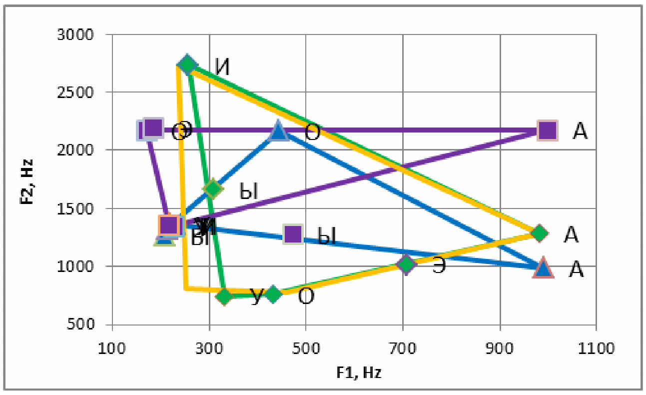

Fig. 2. The change of the location of phonemes under the influence of noise

According to the research it can be concluded that formant F_1 for phoneme *a* is most resistant to noise. And as the relative position of the sound remains, we recognize the voice. Thus, by changing the location of the formants and relative displacement of the vertices we can assess the magnitude of the distortion of the speech signal. And a shift of formants F_1 allows us to assess the intelligibility of a particular phoneme. Figure 3 also shows the stability of formants phonemes to interference.

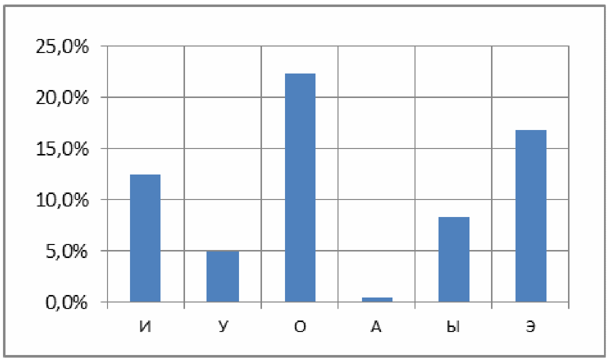

Fig. 3. Noise immunity of phonemes

As a result, the research proposed to use a combination of methods to assess primary features of the speech signal: AFC for frequency of the main tone and cepstral for the determination of the main formants (just the first two formants). This approach will allow determining the presence of speech in noise and assessing the magnitude of the distortion of the signal.

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VARIANTS OPTIMIZATION ALGORITHMS FOR SOLVING SYSTEMS OF LINEAR EQUATIONS

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This article describes options for increasing the rate of convergence of algorithms for solving systems of linear equations and considers the relaxation method for solving systems of linear equations

The subject of my report intersects with my master's thesis "Optimization algorithm for calculating the stationary gas networks". At this point a calculation algorithm based on the method of simple iteration, which is applied to the numerical methods and can be called the method of successive approximations, is developed in our university.

The idea of the simple iteration method is that the equation $f(x) = 0$ results in an equivalent equation $x = \varphi(x)$ so that the mapping $\varphi(x)$ was contracting. If it succeeds, then the sequence of iterates $x_{i+1} = \varphi(x_i)$ converges. This conversion can be done in different ways. In particular, the roots of the equation are retained in the form $x = x - \lambda(x) f(x)$, if $\lambda(x) \neq 0$ on the investigated interval.

The iteration method is the easiest to implement, however, this method is not very effective, due to the slow convergence.

Let us consider some ways to optimize the algorithms:
1) reducing the accuracy of the calculations;
2) the distribution of computing power;
3) the replacement of the basic algorithm for solving linear equations.

The first and third methods refer to software, and the second - to hardware. Let's dwell on each of them closely.

Reducing the precision of calculations is quite an effective way to increase the performance of algorithms for solving linear equations, as it reduces the required number of iterations to achieve the final result by several times, but if the algorithm is used in industry, this process is irrelevant as it usually requires less accuracy and is not specified in the condition. Therefore, this method can't be used in the context of the topic of my dissertation.

This hardware method implies partial transfer calculations to other computers or hardware of the local computer, which is not currently engaged in calculations. For example, we have two independent systems of equations, which ultimately influence the final decision. Having two computers, we can parallelize the solutions of these systems, and then put the final data together. The method is quite effective, but entails additional risks:
1) incorrect data transmission;
2) incorrect receive in processed data;
3) failure of network hardware;
4) inability to local use.

In this case, a replacement of the basic algorithm means changing the program used for solving systems of linear equations. Replacement of the basic algorithm, in our case, complicates the implementation, but at the same time, increases the efficiency of the algorithm as a simple iteration method has the slow speed of convergence. The methods for solving systems of linear equations are direct and iterative. Well-known iterative methods are:
1) Jacobi method (simple iteration);
2) Gauss – Seidel method;
3) The method of relaxation;
4) Multigrid method;
5) MethodMontante;
6) Abramov method;