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Applying Filtering in Digital Signal Processing for Improved Accuracy

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Abstract

In the theoretical plan, the primary optimization of the cost of exchange processes (which has methods, transformations, transmissions, processing and representations) that measure data in information and measurement systems, in order to improve, first and foremost, the metrological quality of measurement results. With regard to information and measurement systems, the solution of optimization problems is associated with significant difficulties, which in most cases are related to the lack of information about the properties and characteristics of the automation object, measured dimensions, mixing coefficients, intermediate and final results.

Keywords

Digital Signal, Mathematical Expressions, Non-sinusoidal Signal, Noise and Interference, Digital Measurement, Discrete Averaging, Measurement Systems

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1. Introduction

In the context of the ever growing demand for information and measurement systems, the diversity of their characteristics and areas with growing demands on the quality and efficiency indicators of existing and newly created systems, the problem of the development and development of theoretical, methodological and practical aspects. Particularly the creation of highly efficient information and measurement systems.

2. Formulation of the Problem

The solution of the main system functions and tasks, as well as the functional nodes of the measuring and computing subsystems. In the synthesis of optimal information-measuring systems and their subsystems operating in a dynamic mode, the problem of overcoming uncertainty becomes even more acute. Now, when high-precision dynamic measurements become massive, this problem is of interest for the further development of information and measurement technology in general [1, 2].

Currently, in connection with the special importance of the role of electric vehicles in the energy system, the solution of major technical problems and responsible technological processes, the creation of effective methods and tools is becoming increasingly important for their practice. Diagnostics of these data is one of the main issues of general technical problems of increasing the reliability of these cars. The analysis of emergencies on technical objects shows that the occurrence of serious malfunctions is always accompanied by restrained malfunctions arising from certain micro and mini changes in the form of cracks, bends, vibrations, shocks, etc. Their preliminary detection allows predicting the change in the state of the object under study, which can be used to prevent and prevent serious failures.

The aim of the work is to control and improve the efficiency

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of managing the objects of generation and consumption of electric energy through the conversion and digital processing of non-sinusoidal electrical signals, the development and application of methods and tools to improve the accuracy of digital processing. In any case, the process of developing your own software is important for simplifying, reducing time and direct financial costs for its development. At present, in connection with the development of computer technology, algorithmic methods of increasing the accuracy of measurements are widely used. They are based on obtaining additional information in the operation of information and measurement systems, which makes it possible to exclude the influence of errors on the measurement result. Additional information can be obtained due to the presence of structural, temporal or structural-temporal redundancy of information and measuring systems. A distinctive feature of the use of algorithmic methods is the possibility of improving the accuracy of measurement results without improving the metrological characteristics of the initial measuring instruments and systems.

Any measuring device can be represented in the form of a series of measuring transducers, the functions of which are the conversion of the quantity fed to their input. In general, the measuring device measures the input quantity, which is a random function of time and a series of parameters. In general, the parameters of the actual transformation functions of the measuring device are non-stationary random functions of time. In this connection, the error of the measuring device will also be a non-stationary random function of time [3]. When drilling oil wells, certain parameters are measured, such as temperature, pressure, density, etc. In addition, all these parameters are processed to obtain certain information. Since the results of the experimental measurement data obtained from the wells are wedged, it is necessary to filter these data before processing them. Filtering should be both high-frequency and low frequency [4, 5].

The negative effect of nonsinusoidality on the operation of networks, electrical equipment and electrical receivers is as follows: additional losses occur in electrical machines, transformers and networks, as well as additional voltage deviations; reduces the life of electrical machines and equipment; the work of means of automation, telemechanics and communications is deteriorating.

As is known [6], diagnostics of electric motors in the oil and gas industry can be carried out by measuring and processing values of currents and powers in idle and short circuit modes. Reliability of control and diagnostics depends on how accurately the measurements of these parameters are performed. In the process of measuring current and voltage, the useful harmonic signal turns out to be noisy, as a result of this measurement; high-frequency noise (interference) is superimposed on it. As a result, the pure harmonic signal is not harmonious. In addition, in real circuits, the presence of additional harmonics determines the non-sinusoidality of the measurement signals $u(t)$ and $i(t)$ themselves. The causes of non-sinusoidal voltages and currents in the electrical network are the presence of gate-transformers and electrical receivers with a nonlinear volt-ampere characteristic. The main influence is made by blocking converters. Sources of non-sinusoidality in power systems can also be generators or transformers, when they operate on the nonlinear part of the magnetization curve.

3. Resolving the Problem

The instantaneous values of the continuous signal are most useful, but not always predictable. Therefore, to manage and analyze controlled processes and objects is of great importance in determining the parameters of an integral signal in real time. The latter characterize the total amount of material and energy that must be produced and obtained in production over a certain period of time, the operating mode and characteristics, is the average of the measured values, etc. Determination of specificity The digital methods and tools of ISP must perform discrete averaging (DA) or discrete integration (DI), continuously changing in time.

Any functional intersection or processing operator used in the metering information exchange meter in the information-measuring system has this and other filtering properties [7]. Therefore, these properties should be analyzed and analyzed efficiently as a metrological resource during research and development of those tracts. If these resources do not allow to meet the requirements for the efficiency and quality of the information-measuring system, then additional methods and tools for corrective filtering should be used.

Naturally, the main purpose of all the functional nodes included in the measuring-processing tract is to transmit measurable information x (t) in the output signal of the transmitter to the output with the least loss (distortion) as possible.

Constructive filtering is understood to mean the combination of useful signal and error signal (noise) for measuring the informative parameter (current price, function, or function) of the measuring signal as accurately as possible [8]. Therefore, the effectiveness of the filtered filtering result, measured by the criterion of the actual measurement of the signal's actual parameter value, is an indication of the level of accuracy that the information measuring system can provide. The accuracy is the most effective measure of the work of any measuring instrument.

The aspects that need to be addressed in solving the problematic filtering problem have been systematized in [9]:

a. The input signal of each of the altitudes of the information-measuring system can be regarded as an "additive" of the noise (error) with the measuring signal;

b. The most adequate model of error is a non-stationary process in the continuous time domain and non-stationary sequence in the discrete time domain;

c. Variability of working conditions of the "measuring-processing" tract, whereas due to the stochasticity of the processes (noise), useful information on alertness and noise is always incomplete;

d. Metrology, dynamics and operational efficiency of most components used in measuring-processing tractors due to the diversity and specificity of the measurement information processing and processing issues are limited;

e. The specified limitations and "irregularity" cause traversal, transformation and accumulation of various types of tracks;

f. Signal is the majority of digital processing operators, so they are vulnerable to both spp. Of the additive "signal + noise" mixture.

Because of the facts and factors listed above, the question of the corrective filtering has been found in the information-measuring system, rather than quasi-realism rather than optimism.

In this study, the interpretation characteristic (or, for example, the characteristic sensitivity) of any functional junction or processing operator to a useful measurement signal - X and noise (fault signal) - in order to analyze the effectiveness of the filtering effect in the "measurement-processing" Processing) operators and time and frequency regions.

It is natural that, given the appropriate limitations, the degree of usefulness for these operators should be sought for amplitude and phase noise for analytical or trivial measuring alert (where p is operative in time or frequency domain).

The question of measuring the measurement results in the measuring instruments has already become a classic issue (many authors call this issue "bug fixes") always in the spotlight of professionals working in this field. This is also natural because it is the "product" information of any information exchange system. Therefore, the effectiveness of the decisions taken directly depends on the credibility of the information.

Comparative analysis has been made in the method and means of measuring the measurement information [10]. The conventional filtering methods and means are divided into two main classes, depending on the nature of the measurement signals and the information exchange processes performed in the "measuring-processing" tracts: (analog, discrete and digital)

1. structure;

2. algorithmic.

Structural methods and tools are designed to increase the accuracy and stability of measuring instruments by incorporating lightweight elements and blocks into the structure of the junction (eg, the feedback device). Algorithmic methods are implemented by means of software, their implementation is oriented to classical and modern filtering algorithms (mostly digital filters) [11, 12].

On our side, imitation modeling of Matlab software package of corrective filtering has been conducted and a positive result has been achieved (Figure 1).

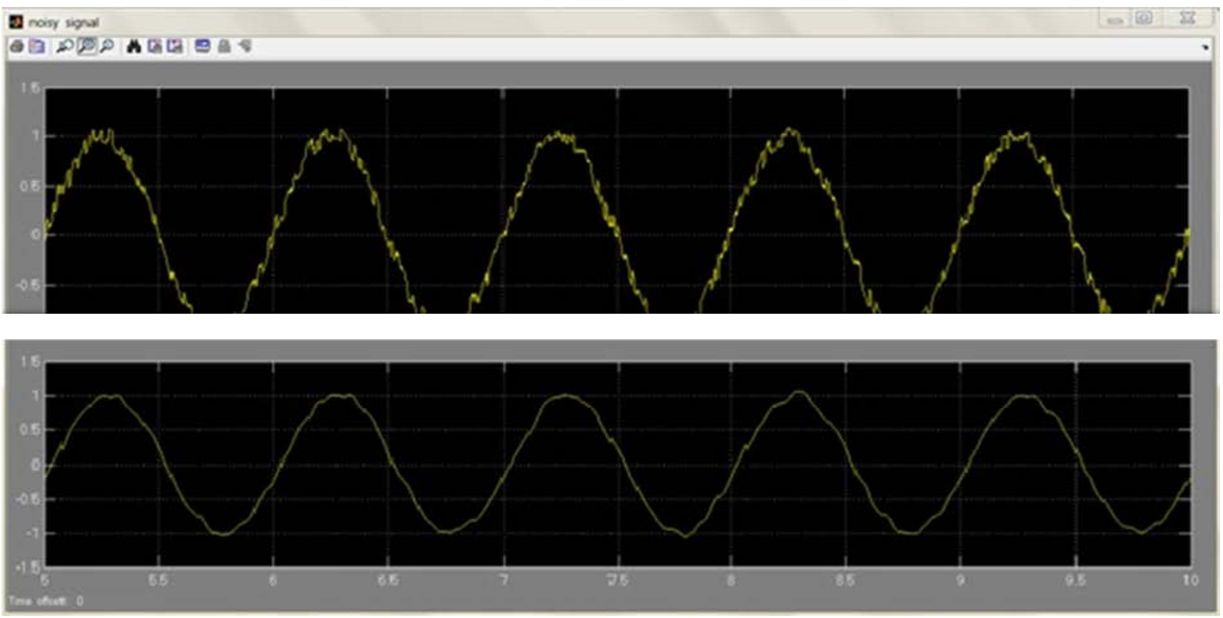

Figure 1. Results of simulation of non-sinusoidal signal.

4. Conclusion

The results of comparative analysis of the experiment with the random and systematic errors show that it is better suppressed bias. Therefore, discrete averaging operator, applied to both types of error is a correction with respect to all types of errors. This has been proven with simulations in Matlab program. That is why, one can say that the digital averaging operator applied to both types of error correction is to all kinds of errors. Thus, the proposed approach to the creation of information and measuring systems by design consists in the aggregate analysis of measurement processes and corrective filtering in order to achieve a balanced metrological, structural, algorithmic and functional efficiency of the developed tools.

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