CLASSIFICATION OF TWO TYPES OF RANDOM PROCESS CORRELATION FUNCTION

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I. INTRODUCTION

Processing telemetry information brings us different tasks: a task of anomalous measurement screening; a task of approximation of correlation function; a task of smoothing of the obtained realization; etc. Different characteristics are calculated in the process of realization of the algorithms for solving these tasks. Particularly, the filters should be adjusted correspondingly for optimal operation of the algorithm of anomalous measurement screening. A type of correlation function is one of the characteristics of the filters. Hence, it is necessary to learn how to estimate and classify correlation function. It should be noted that estimation of the correlation function is made at small shifts that is specified by limitation for response time of the system (real-time mode).

II. TWO TYPES OF CORRELATION FUNCTION

Industrial control systems contain standard spectral distributions, to which correlation functions conform to. Under specified limitations they reduce into two types [2]:

$$R_x(\tau) = e^{-|\tau|/T_0} \qquad (1)$$

$$R_x(\tau) = (1+\frac{|\tau|}{T_0})e^{-|\tau|/T_0} \qquad (2)$$

The problem is that realization being processed has two components: information component and so called noise component.

Noise component is specified for example by sensor bounce and represents random process, which is attributed to one of the presented types.

III. CLASSIFICATION METHOD DESCRIPTION

Main characteristic to be used to classify correlation function is Z-coefficient, which represents a measure of process oscillativity [2]:

$$Z = \frac{D_2}{2\times D_1} \qquad (3)$$

where:

$$D_1 = (n-1)\times\frac{1}{\pi}\arccos(p_1);$$
$$D_2 = (n-1)\times\frac{1}{\pi}\arccos(\frac{2\times p_1 - p_2 - 1}{2-2\times p_1}); \qquad (4)$$

$\rho_1, \rho_2 -$ values of correlation function;

In other words, we introduce a structured metric where Z-coefficient solves a recognition task. Finite differences of the first and second orders (4), values of which correspond to the number of crossovers of the zero level and number of extremums correspondingly, are used for calculation of the Z-coefficient. [3]

As it is possible to see from (4) it is sufficient to calculate a value of the correlation function for two shifts (p0 and p1). p1 and p2 is easy to obtain from the abovementioned expressions (1) and (2) for two types:

Type 1:

$$\rho_1 = e^{(\frac{-2\pi\times Fc}{F_d})};$$
$$\rho_2 = e^{(\frac{-4\pi\times Fc}{F_d})}; \qquad (5)$$

Type 2:

$$\rho_1 = 1+\frac{(2\pi\times Fc)}{F_d}\times e^{(\frac{-2\pi\times Fc}{F_d})};$$
$$\rho_2 = 1+\frac{(4\pi\times Fc)}{F_d}\times e^{(\frac{-4\pi\times Fc}{F_d})}; \qquad (6)$$

where: Fc – process frequency; Fd – sampling frequency;

As we can see, a value of Z depends on process frequency and sampling frequency; hence it is possible to make summary tables of values of Z depending on process frequency (fig. 1).

Coming from the shape of the graph it is easy to calculate an average value of Z and to formulate a decision rule of recognition. As it is shown on fig. 2, sector locating above this value is attributed to the first type while everything below is attributed to the second one. Sampling frequency equal to 200 Hz, 100 Hz and 50 Hz have been considered.

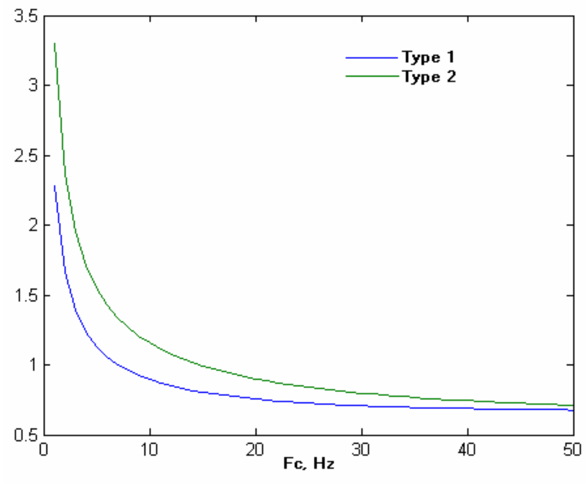

Fig. 1.Graph of Z-coefficient for two types (sampling frequency 100Hz).

So, it is sufficient to compute a process frequency at the interval, to determine a value of Z-coefficient and compare it with tabulated value. The result is presented by a set of intervals of realization corresponding to the first or second type of the correlation function.

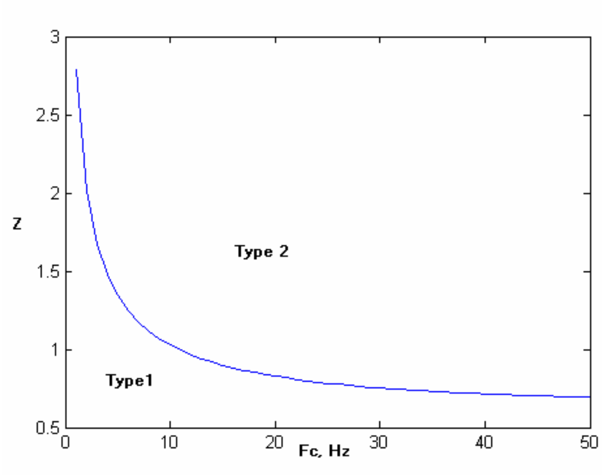

Fig 2.Graph of average values of Z- coefficient (sampling frequency 100Hz).

IV. CONCLUSION

A decision rule, which allows separating two types of Correlation Function, has been found. We can use it when processing real-time telemetry information.

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