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METHOD FOR DETERMINING INFORMATION STABILITY IN INFORMATION TECHNOLOGIES AT TECHNICAL OBJECTS

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In information technologies used in technical objects, an important concept is the information stability, i.e. the ability of a system to obtain accurate information in changing conditions [1]. In such circumstances, the results of measuring the parameters of physical processes are described, as a rule, by non-stationary random processes. The report analyzes the stability of information about the surface deflections of the physical model of the bridge structure under the action of random loads, which were used as pedestrians. A fragment of one of the realizations of the non-stationary random process is shown in fig. 1.

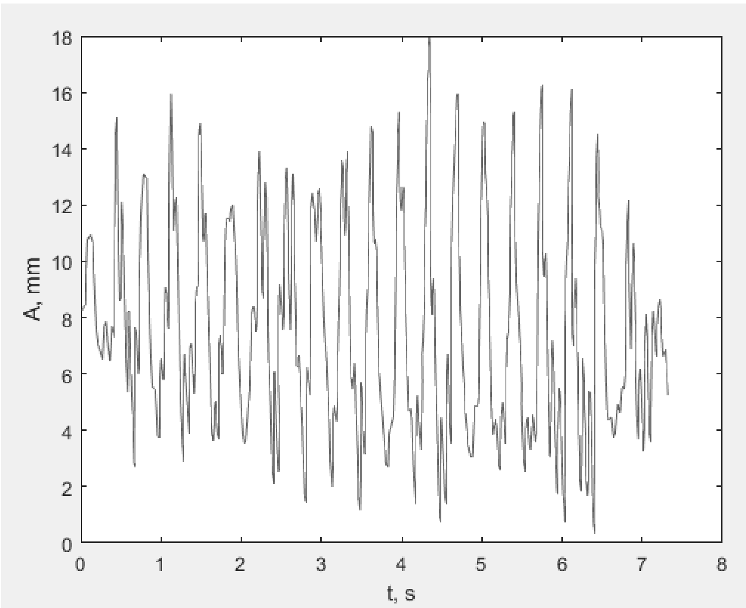

Figure 1 – The realization of a random process of the bridge deflection at one point

Since the variance of the deflections *x* of the non-stationary process $\xi(x)$ changes over time, the accuracy of the information is not described by a constant value. It is desirable for practice to calculate the stability of information by a simple formula

$$S = 1 - \frac{\Delta I}{I}, \tag{1}$$

where I is the quantity of information expressed through the entropy H_x [2] of a random process $\xi(x)$, and ΔI – the maximum change of information in non-stationary conditions. We believe that $\Delta I < I$, otherwise the physical meaning of stability is lost. If $\Delta I = 0$, then $S = 1$, i.e., the greatest value of information stability is reached. This is possible if the random process $\xi(x)$ was stationary and remained the same with a constant deflection variance σ_x^2. Let's denote by $p_s(x)$ – the probability density of a random variable x for a stationary process, and $p_{ns}(x)$ – for a nonstationary one, when the analysis of a random process $\xi(x)$ is performed at intervals of deflections x stationarity, where the variance σ_x^2 is greatest. Then the information stability (1) is determined as follows

$$S = 1 - \frac{\Delta I}{I} = 1 - \left| \frac{\int_{-\infty}^{\infty} p_{ns}(x)\log_2 p_{ns}(x)dx - \int_{-\infty}^{\infty} p_s(x)\log_2 p_s(x)dx}{\int_{-\infty}^{\infty} p_{ns}(x)\log_2 p_{ns}(x)dx} \right| \tag{2}$$

Probability densities $p_s(x)$ and $p_{ns}(x)$ in relation (2) were distributed according to the normal law. From relation (2) it follows that when the variance of random deflections changes, the information stability also changes. To reduce the effect of variance changes on the information stability for nonstationary signals, the report proposes the use of Hilbert-Huang transformation modes instead of the realization of nonstationary process, as the authors previously demonstrated in [3]. Now, together with the space of realizations of random deflection processes, subspaces of realizations of Hilbert-Huang modes should be used, which are most often the realizations of stationary deflection signals, and this, in turn, leads to a decrease in the range of changing the variance of each mode and to an increase in the measurement information stability. If for non-stationary processes under study the information stability fluctuates within very wide ranges, then for Hilbert-Huang modes it lies within 0.9… 1.0 (fig. 2).

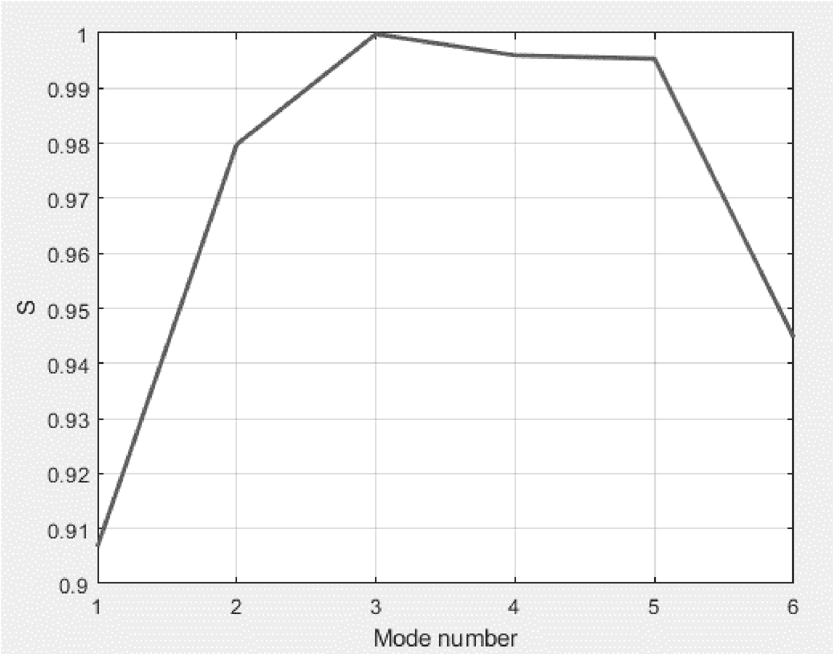

Figure 2 – Distribution of information stability about the deflections of the bridge structure using Hilbert-Huang modes for the non-stationary process realization shown in fig. 1

Therefore, the use of information about the deflections of bridges received from the Gilbert-Huang modes, can significantly increase its stability.

References

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[2] C. E. Shannon. A mathematical theory of communication. - Bell System Technical Journal, 27, 1948, pp. 379 - 423 p.

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