

## **RECURRENCE ANALYSIS OF HYDROELECTRIC POWER STATION FORCE EQUIPMENT VIBRATION SIGNALS**

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The basic tasks at operation of hydroelectric power station are support of ecologically safe, economically effective and technically of reliable serviceability of its force equipment. The efficiency of these parameters directly depends from performance of conditions on maintenance of trouble-free operation of the equipment, one of the basic parameters of which technical condition is its vibration.

The control and diagnostics of a technical condition of the force equipment of hydroelectric power station is accompanied by the capture, processing and representation of large capacity of the vibrating measuring information. The analysis of parameters of vibration is made by the account of specificity of working regimes, from of influence of hydraulic, mechanical and electromagnetic revolting forces and moments. The acceptance of the decision by results of these researches requires judgement and estimation of large content of the measuring, normative and technological information. The presence of expert system in structure of the measuring equipment allows to generalize and collected knowledge during service of the equipment and to increase efficiency of prospect researches [1]. The greater increase of efficiency and reliability of procedure of vibrating measuring experiments can achieve by realization recurrence analysis of the assembled data.

Recurrence analysis is based on fundamental properties of the dynamic systems marked French mathematics of Poincare and formulated as the theorem of recurrency. The practical applications of this theorem as recurrence plots was offered by Eckmann and others [2].

Realization recurrence analysis for disquisition of dynamic systems it is not required of presence of the large capacity of data, there is enough short observation of one measuring experiment. At construction recurrence plots it is necessary to choose norm. The choice of norm depends on specificity of applied use of the constructed diagram.

Recurrence plots constructed during realization recurrence analysis of time series have in the basis the geometrical structures. The basic diagonal on рекуррентной to the diagram looks like a black diagonal line - line of identity.

The separate points on the diagram do not carry any information, however, together they reconstruct properties of researched process. For the analysis of researched processes by recurrence plots two classes of structure are used: topology and texture of the images. The topology represented by large-scale structures gives general representation about character of process on four classes: homogeneous, periodic, drift and white areas. Texture is characterizes small-scale structure of the diagram and consists of separate points, of diagonal, horizontal and vertical lines [2-4].

Let's consider results of realization the recurrence analysis for processing real vibrating signals. In figures 1-4 as examples are submitted the recurrence plots and the distance plots (norm) of vibrating processes fixed on the paddle of the directing device at turbine and pump regimes of operations of the hydro unit.

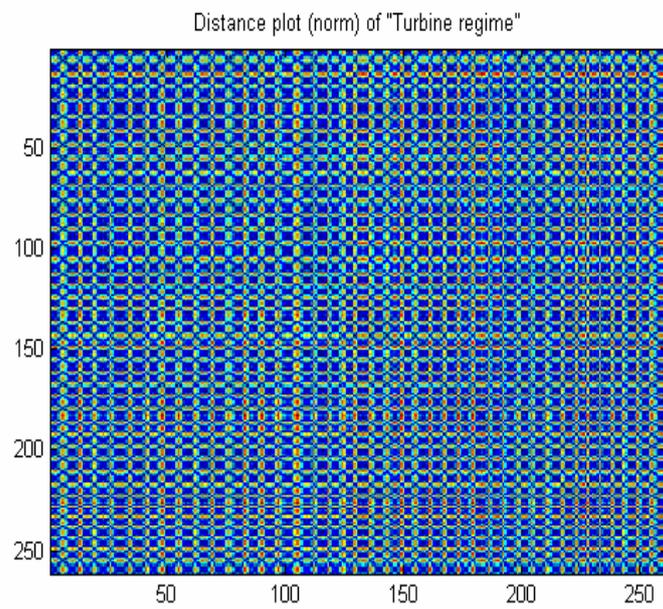


Figure 1.

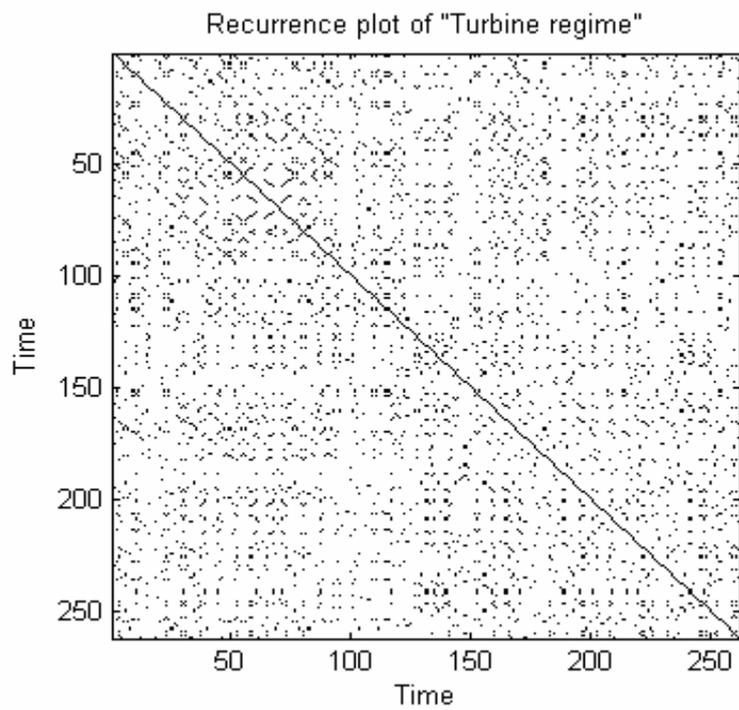


Figure 2.

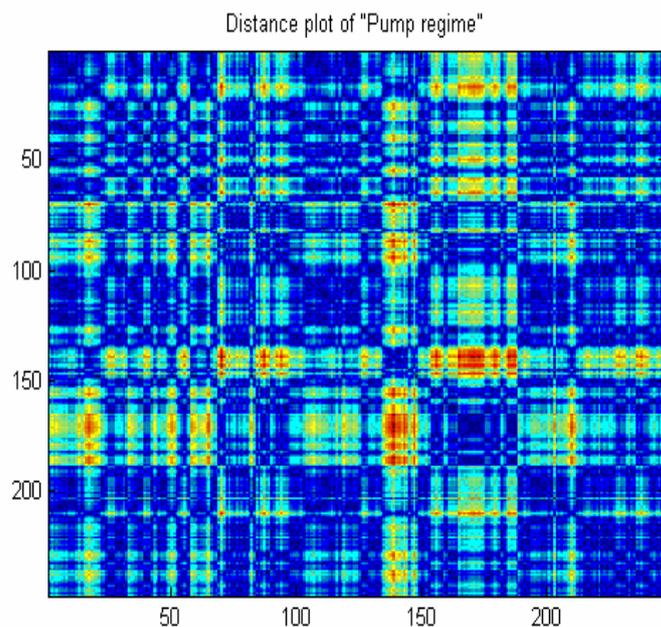


Figure 3.

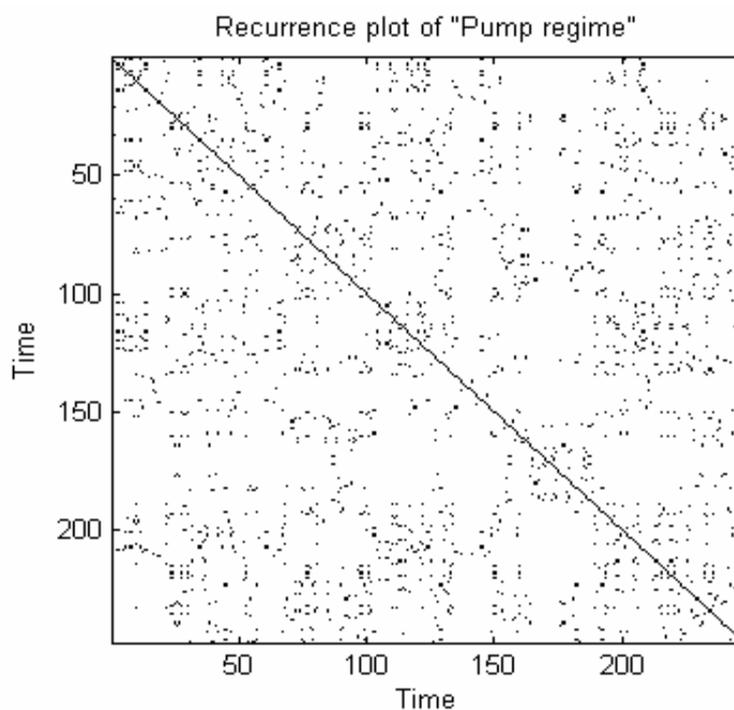


Figure 4.

The graphic images recurrence plots and the diagrams of distances (norms) of a signal « Turbine regime » speak about obviously expressed harmonic component of a signal, on which are looked through noise distortion. The character of a structure of this diagram allows to judge presence of some established mode, on which the casual revolting signals are imposed. The graphic images of a signal « Pump regime », are strongly deformed by casual components with a wide frequency spectrum. Such diagram speaks about presence of the unsteady mode and wide frequency spectrum of a signal.

The practical value of application of the recurrence analysis and use recurrence plots consists that in comparison with comprehension of large capacity of the measuring information, the visual control allows faster to understand and to estimate essence of proceeding processes, to predict change of their condition and to accept the decision on anticipation of negative consequences.

### **References**

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