PROBLEMS OF PROCESSING OF THE INFORMATION IN TRANSPORT TELEMATICS SYSTEMS

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The globalisation of markets in conditions of different cultures derivate rather complex information problems. The sciences about complexity - fractal geometry and theory of the determined chaos, - offer new tools of the analysis of open systems. By more formal consideration this new paradigm appears by generalization of existing methods of processing of the information and allows solve some problems of transport telematics. The new complex models combine fractals, chaos and non-linear methods. This new sight reduces opportunities of the control in quickly varying situations, increases uncertainty and, at the same time, offers a general picture, how the world market works.

Key words: telematics, self-organization, information, open system, fractal, chaos

Introduction

The globalisation is an objective evolutionary process of formation of corporations of a new type. The self-organizing of the global market without borders results in open system, in which goods, the people, capital and information should freely move. The decision of problems of interdependence of transportation, selling, communications and economic networks of the different countries is possible with the help of systems transport telematics. Let's call an integrated system of data transmission and processing keeping elements of intelligent control of transport flows as a transport telematics system (Fig.1).

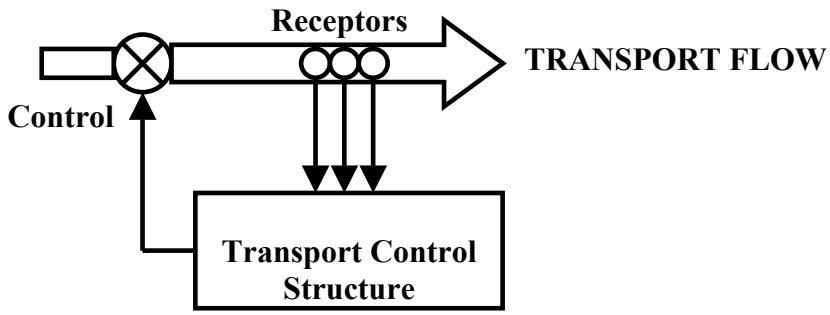

FIG.1. *A diagrammatic representation of a transport telematics system*

The information accepted by receptors (sensors), is a subject to processing for the analysis of a current situation and development of the conforming control action. More often this information is submitted by dynamic time series depending on many factors and outwardly not keeping in of tags,

of not keeping in, kind of regularity. Such time series often meet in problems of the forecast of different economical parameters, such as, for example, daily currency exchange (Fig. 2).

Usually for the analysis and forecast of such processes the statistical methods, founded on the concept of an equilibrium system and theories of random works will be used. Such approach and the applied packages founded on it have shown the full disability of the forecast of an actual economical situation. The experts have calculated, that, since the 70-th years, prognosists enabled severe errors in each of turning points of economical development, and, all together. The most correct predictions mirrored an actuality only in very short temporary intervals. In outcome, today economical forecasts often are object of jeers. Wall Street and corporate America is dismissed with analytical departments, because their predictions «demonstrate entertainment and fabrication, but not so are useful» [1]. Therefore the modern financiers estimate problem of the economical forecast in the same way, as attempt to invent a perpetuo mobile – for the physicians.

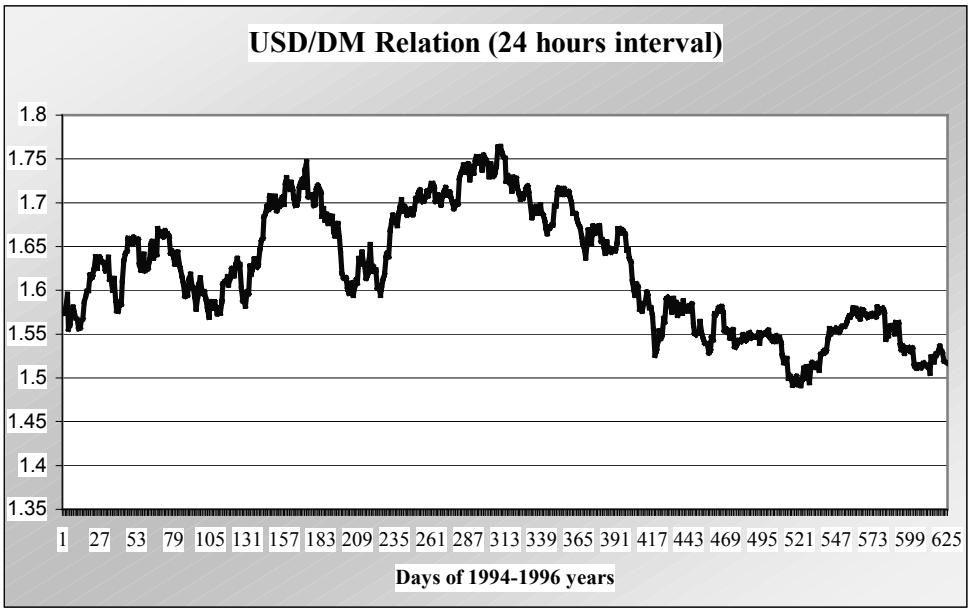

FIG.2. *Time series of relation of exchange USD/DM for 1994-1996 (interval - 1 day)*

However, by paying attention on ecology of the alive pattern, it is possible to draw a conclusion, that the nature, to the contrary, avoids equilibrium, and reaches stable states far from an equilibrium state. Such systems, essentially non-linear and hierarchic, are described by the theory of the determined chaos [2]. Determined random (pseudo-random) process is outwardly similar to random, but having rigid control law, process.

Research of random and deterministic processes

Let's consider for an example two very similar temporary series (Fig. 3), one of which is submitted to the so-called «logistics» mapping

$$x_{k+1} = r \cdot x_k \cdot (1 - x_k), \quad \text{where } 0 < r < 4 \text{ and } \quad 0 < x_0 < 1. \qquad (1)$$

Parameter r is selected equal to 3.99, which corresponds to a mode of «deep» chaos [3]. Another time series is a stochastic process with a normal distribution law taken from the generator of random numbers. These both processes are very similar to each other in temporary and spectral areas (Fig. 4).

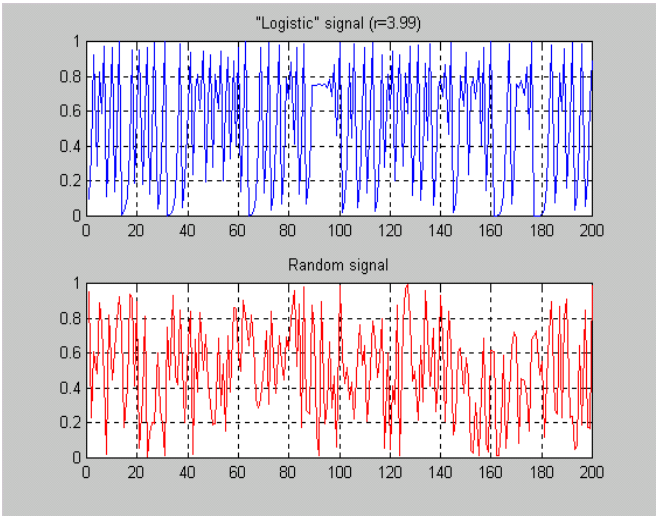

FIG.3. *Time series calculated by "logistics" mapping (above) and random series (below)*

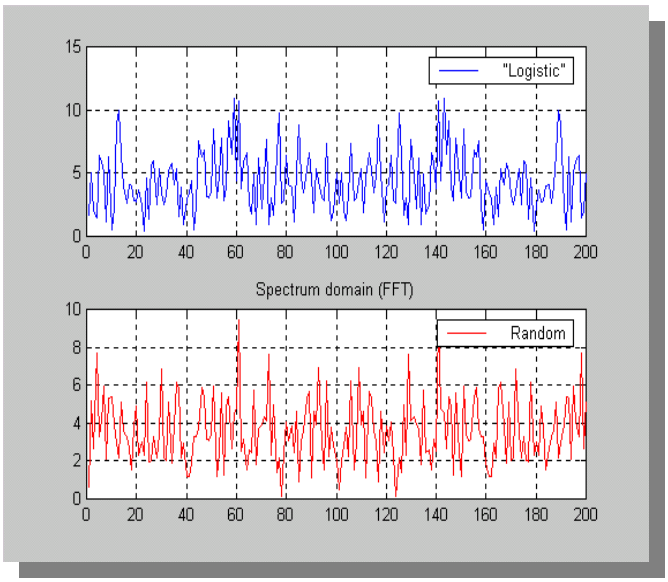

FIG.4. *A module of a spectrum of power of "logistics" mapping (above) and random time series (below)*

The classic characteristic of stochastic processes is a function of autocorrelation [4] also makes these series practically indiscernible (Fig. 5). Thus, the separation of the random and determined signal in temporary, spectral and auto-correlated areas appears practically impracticable. However, these processes uniquely are categorized in a pseudo-phase space [3], where the random and determined nature of processes becomes apparent (Fig. 6).

The theory of chaos allows returning to construction of the determined models of composite systems for the solution of a problem of a prediction of dynamic process again. Such approach was utilised for the analysis of a competition in insurance business [5].

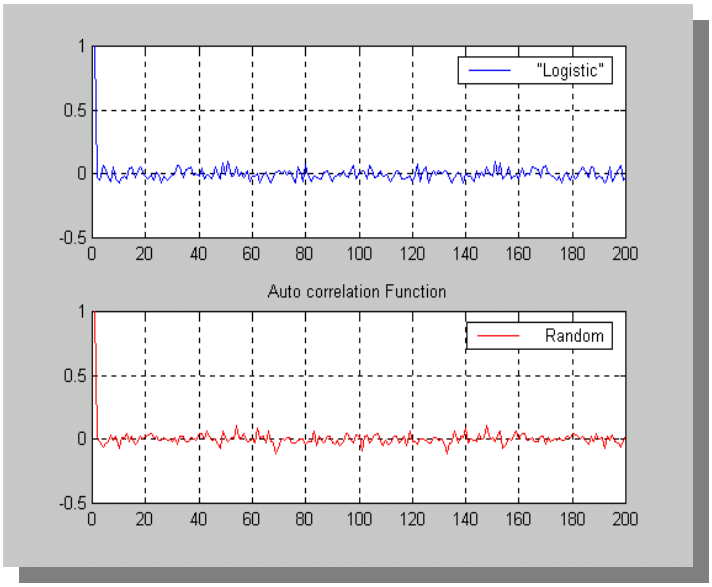

FIG.5. *A function of autocorrelation of "logistics" mapping (above) and random time series (below)*

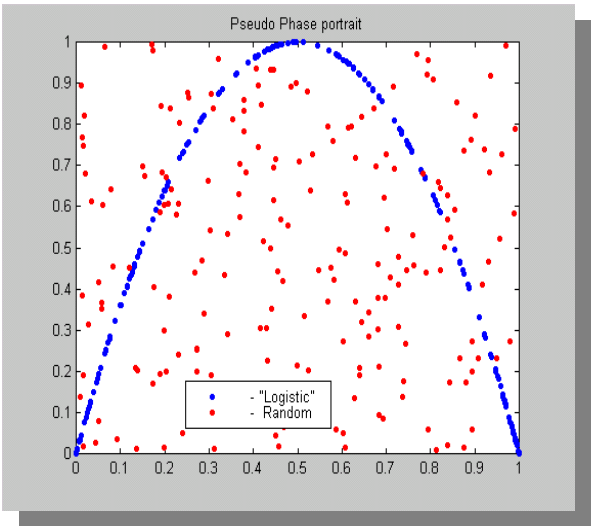

FIG.6. Separation of time series in the field of pseudo-phase space

The competition is described by the system of non-linear differential equations:

$$\begin{cases} \dfrac{dx_1}{dt} = a_1 \cdot x_1 - a_{11} \cdot x_1^{\,2} - a_{12} \cdot x_1 \cdot x_2 - a_{13} \cdot x_1 \cdot x_3 \,, \\ \dfrac{dx_2}{dt} = a_2 \cdot x_2 - a_{22} \cdot x_2^{\,2} - a_{21} \cdot x_2 \cdot x_1 - a_{23} \cdot x_2 \cdot x_3 \,, \\ \dfrac{dx_3}{dt} = a_3 \cdot x_3 - a_{33} \cdot x_3^{\,2} - a_{31} \cdot x_3 \cdot x_1 - a_{32} \cdot x_3 \cdot x_2 \,. \end{cases} \qquad (2)$$

where a_i - factor of "birth rate" of *i*-th "population" (or "kind"),

a_{ii} - its factor of "death rate",

a_{ij} - level of suppression of *i*-th "kind" by *j*-th "kind".

Such model does not look too simplified. Unconditionally, participants of competition could be more, but thus the order of a system, so, and complexity of its analysis is augmented. On the other hand, with allowance for amalgamations and monopolization of the subjects of economical activity, it is substantial that in one terrain (region, city, area, locale) in selected sector of the market there cannot be more than 2-5 competitors. Therefore examples of a situation conforming models (2), are rather representative.

The solution of a system (2) gives dynamics of process of a competition (Fig.7a). The advantage of the deterministic approach is encompass bayed volume, that allows to decide a return problem - for real input dates (Fig.7b) to determine parameters of model and to forecast outcomes of competition for three Latvian insurers (AAS) in the field of insurance of automobiles (Fig.8). If the outcomes of the forecast for one of the competitors look depressing, it does not mean at all a full crash. On following period of time, due to own operations or due to errors of other competitors, the situation can change cardinally, that will be exhibited in the change of a positional relationship of new input data and factors of the competition equations. Therefore, the suggested technology of the forecast can be used permanently in a mode of monitoring of a current situation, receiving an impartial estimation of quality of own economical policy and administrative (technological, organizational, price etc.) solutions.

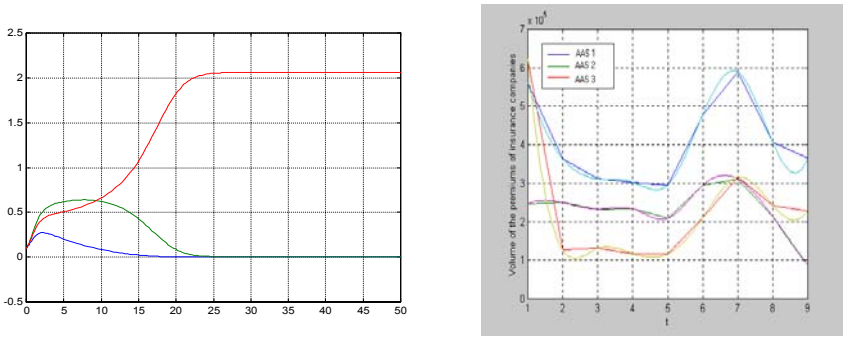

FIG.7. *(a) Outcomes of numerical experiment for a system (2),*
(b) Curves of change of the premiums of three insurance companies after interpolation

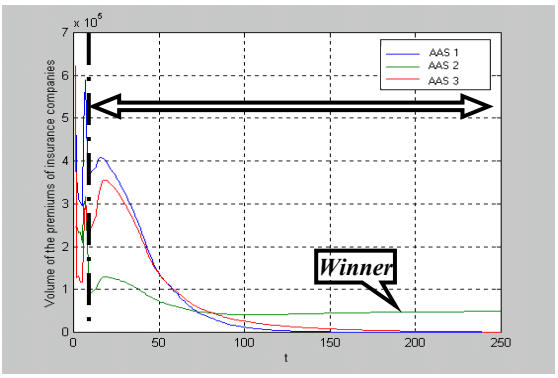

FIG.8. *Affiliation between initial and forecasting curves of a monthly volume premiums of the insurance companies in a time dependence*

Therefore, the tendered technology of the forecast can be used permanently in a mode of monitoring of a current situation, receiving an impartial assessment of quality of own economical policy and administrative (technological, organizational, price etc.) solutions.

The alternative version of research of time series (Fig. 2,3), founded on research of their fractal properties is possible also. Using technology of calculus of correlation fractal dimension [1, 3] - in

the basis the statistical method, but applied not to initial time series, and to its mapping in pseudo-phase spaces of the different order, the following outcomes were obtained (Fig. 9).

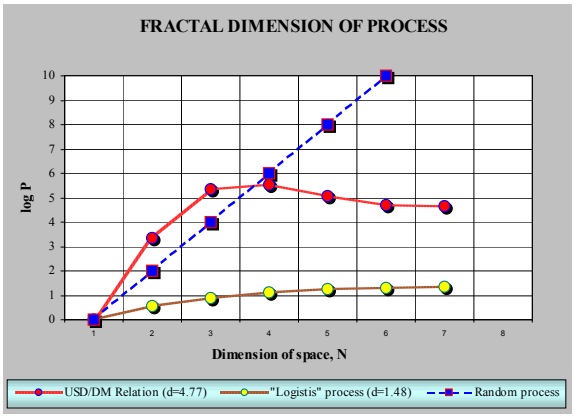

FIG.9. The computed fractal dimensions of time series

The fractal dimension of process characterizes it as determined random. In a phase space of the whole dimension nearest in the large party to fractal dimension, there is a control law by process. Really, the fractal dimension of "logistics" process (Fig.3) is equal to 1.48 and the control rule of this process is obviously seen in a phase space of the 2nd order - on a plane (Fig. 6). For stochastic process the curve on Fig.9 has no asymptotic, therefore fractal dimension and control law for it does not exist. At last, for time series of the courses of exchange the fractal dimension is equal to 4.77, that means availability of a control rule in space of the 5th order. If to see the bank reports of exchange, really, usually there are 5 basic currencies, for example, in relation to EUR - USD, GBP, DEM, FRF, JPY.

Conclusion

In summary, it is necessary to mark, the new outcomes of the theory of the determined chaos and non-linear dynamic systems can be used in problems of a prediction as economical time series, and at a data processing of transport telematics systems. Thus it is necessary to expect pseudo-random nature of process on short time frames (where the statistical processing techniques) and determined nature on large time frames is suitable.

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