Quality Evaluating of the Simulated System Based on the Keep Law of Integrity

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***Abstract*— An approach is proposed that relates the aim of the simulated system to the processes taking place in the system. This article aim is to substantiate the necessary and sufficient conditions for the existence of the result to be achieve by simulated system. This goal is achieved with applying the keep law of integrity. The proposed approach supposes that three independent components can be distinguished in the simulated system. Necessary and sufficient conditions are obtained by linking these components to each other with the help of the keep law of integrity.**

Keywords*— *the keep law of integrity; guaranteed achievement of result

I. INTRODUCTION

The most common and studied way to date for the synthesis of systems is built on the basis of analysis, that is, the system is "assembled" from possible elements and checked for compliance with the performance measure. If the result is not worse than required, then the system is considered good, otherwise the decision-making step is repeated until a satisfactory indicator is obtained. This approach is applicable to fairly simple systems. When it comes to complex systems, the number of options is huge. In this case, it is advisable to use a synthesis-based approach, that is, to find the basic laws and immediately obtain a ready system [1]. Examples of basic laws can be: Ohm's law for the linear part of electric circuits, the law of World gravitation for satellites, the Archimedes' law for ships, etc. Modern systems are so complex that they need to select many basic laws. When designing systems, questions arise: which basic laws are necessary? How are they coordinated between themselves? How do the system features influence on the system's achievement of the result? The answer to these and other questions can be obtained by using the keep law of integrity (KLoI) [2].

II. THE KEEP LAW OF INTEGRITY

The law conside that in any properly constructed system there is a stable recurring connection between the system and its actions, an indicator of efficiency (the system's purpose) and the environment:

$$I = F(Q, \Phi, \Psi, t),$$

where

I – indicator of efficiency;

Q – system model;

Φ – model of the system's actions in space-time;

Ψ – enviroment model;

t – time.

If the problem situation (problem) is affecting on the system, then it is formed ΔQ and/or $\Delta\Phi$, that entails ΔI. The task of system is reduced to leveling its deviations:

$$\Delta\Phi \to 0, \Delta Q \to 0 : \Delta I \to 0.$$

The particular form of the KLoI depends on the application system. Let us conside r one of the ways of obtaining a specific dependence

III. REPRESENTATION OF A SIMULATED SYSTEM

Suppose that the system runs in a manner analogous to man, and in it we can distinguish three mutually related processes [1]:

1) the problem appearance process;

2) the problem detection process;

3) the process of eliminating the problem.

Suppose that situations are possible:

1) the problem is manifested or not $B_1 \cup \overline{B_1}$;

2) the problem is detected or not $B_2 \cup \overline{B_2}$;

3) the problem is eliminated or not $B_3 \cup \overline{B_3}$.

Thus, we get a group of eight events. We encode a direct event with a unit, and the inverse event with a zero. We introduce the positional correspondence as follows: the senior category describes the appearance of the problem, the middle one is the detection of the problem, the lower one is the

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elimination of the problem. As a result, we get a binary code encoding all the states of the system:

000 (P_0) – there is no problem, it is not detected, not eliminated. The required state;

001 (P_1) – there is no problem, it is not detected, eliminated. This situation can describe the training of the system, then it does not participate in the examination;

010 (P_2) – there is no problem, it is detected, is not eliminated. A non-critical error of the system;

011 (P_3) – there is no problem, it is detected, it is eliminated. A non-critical error of the system;

100 (P_4) – there is a problem, it is not detected, not eliminated. The system ceases to exist;

101 (P_5) – there is a problem, it is not detected, it is eliminated. There are errors in the detection of the problem, but it does not affect on the efficiency index. Acceptable condition;

110 (P_6) – the problem is, it is detected, is not eliminated. The system ceases to exist;

111 (P_7) – there is a problem, it is detected, it is eliminated. Acceptable condition.

As the indicator of efficiency we take $P_0 \geq P^*$, where P^* – the required value of the efficiency indicator.

The described states and transitions between them are shown in Fig. 1.

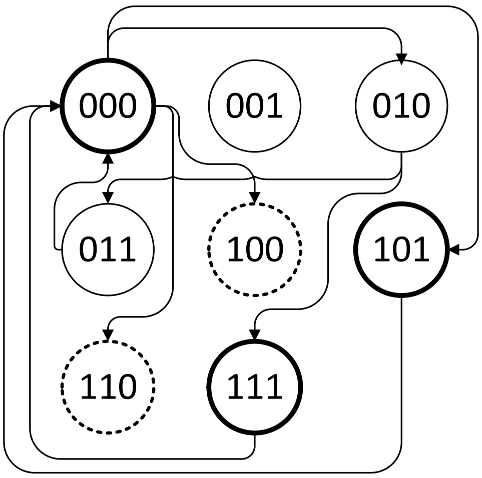

Fig. 1. The system states

IV. THE LINK OF SYSTEM PROPERTIES WITH ITS QUALITY

Suppose that the appearance, detection, and elimination processes of a problem are Poisson flows. In this case, we can find the form of the KLoI analytically using the Kolmogorov-Chapman differential equations:

$$
\begin{aligned}
&P_0 = 1 - P_2 - P_3 - P_4 - P_5 - P_6 - P_7 \\
&\frac{dP_2}{dt} = \lambda_{02}P_0 - (\lambda_{23} + \lambda_{27})P_2 \\
&\frac{dP_3}{dt} = \lambda_{23}P_2 - \lambda_{30}P_3 \\
&\frac{dP_4}{dt} = \lambda_{04}P_4 \\
&\frac{dP_5}{dt} = \lambda_{05}P_0 - \lambda_{50}P_5 \\
&\frac{dP_6}{dt} = \lambda_{06}P_0 \\
&\frac{dP_7}{dt} = \lambda_{27}P_2 - \lambda_{70}P_7
\end{aligned}
,
$$

where λ_{ij} – the transition intensity the from i to state j.

The system of equations can be solved analytically manually, or, for example, by the Matlab system.

The dependence found (P_0) links the indicator of the effectiveness of the system to its properties.

Analyzing the expression describing P_0, we can conclude that the presented system should have a margin of safety (the number of unresolved problems). If there is a need to extend the system life, you should add the training modes and include the state 001 to system of equations.

V. PROSPECTS FOR APPLYING THE APPROACH

A particular dependence of the KLoI can be represented both in the form of a continuous function, and in the form of a discrete one, or as an algorithm. It seems that use of the fuzzy functions and linguistic variables will get especial interest.

The KLoI application for hierarchical systems was considered in [3].

VI. CONCLUSION

An approach is proposed to the synthesis of systems, which, unlike the approaches based on analysis, immediately obtain the desired state of the system. The approach is based on the use of the KLoI. Before using KLoI for the synthesis of the system, it is necessary to find and formalize the basic law of the system, on the basis of which to determine the specific type of KLoI. An example is given of obtaining the basic law for a system described by Markov processes.

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