Replication and Self-assembly Concatenation Control in the Nanoprocesses

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***Short Abstract* — In the paper the interaction of the concurrently running objects replication processes, and concurrently running replication and self-assembly processes observed in the multi-stage molecular product synthesis, has been analyzed and discussed. Analysis of the interdependent replication processes and also, the mutual replication and self-assembly processes based on the growth functions, provides facilities for determination of the control of these processes in the sense of process stabilization, process extinguishing, and avalanche proliferation. In the paper, the numerical examples have been presented.**

***Keywords* — concurrent processes, concatenation, molecular simulation, self-assembly, replication.**

I. INTRODUCTION

IT is possible to create the technical nanosystems of informatics which will be realizing like in the case of biological systems the sets of technological operations which material products are coming into existence and so will be taken to manufacturing objects and products on the basis of the molecular nanotechnology. It leads to the two problems connected with the realization of creating the technical nanosystems of informatics of the direct product fabrication: the replication and the self-assembly processes [5, 7], and their mutual interactions enabling the control of complex processes.

II. CONCATENATION OF THE REPLICATION PROCESSES

Let us consider e.g. two replication processes determined by the step growth function [4] $\int S(.)$ and $\int T(.)$. Introducing a parameter α (control parameter) receiving values from the interval (0; 1), the concatenation of the concurrent replications processes can be described by the Definition 1.

Definition 1

The growth function $\int R(k_i)$, caused by concatenation of the growth processes $\int S(k_i)$ and $\int T(k_i)$, is defined on the set of discrete argument k_i in the form:

$$\int R(k_{i+1}) = \int F_1\left[\int S(k_i), k_i\right] + \int F_2\left[\int T(k_i), k_i\right],$$

$$\int S(k_{i+1}) = Ent\left[\alpha \cdot \int R(k_{i+1})\right],$$

$$\int T(k_{i+1}) = \int R(k_{i+1}) - \int S(k_{i+1}),$$

for initial condition:

$$R(k_0) = A \quad (A \text{ integer}),$$

$$S(k_0) = Ent\left[\alpha \cdot R(k_0)\right],\; T(k_0) = R(k_0) - S(k_0),$$

$$k_{i+1} = k_i + 1 \quad \text{for} \quad i = 0,\ 1,\ 2,\ 3,\ \ldots \quad \text{and} \quad k_0 = 0. \ \blacksquare$$

III. CONCATENATION OF REPLICATION AND SELF-ASSEMBLY

Let us consider two processes: replication with the growth function $\int S(.)$ and self-assembly with the growth function $\int U(.)$, described accordingly with the following dependencies for the time interval sequences (replication events k_i and assembly events m_i respectively):

$$k_{i+1} = k_i + A \quad \text{for} \quad i = 0,\ 1,\ 2,\ 3,\ \ldots,\ k_0 = 0, \quad \text{and}$$

$$m_{i+1} = m_i + \int \varphi\left[\int U(m_i), i\right], \quad i = 0,\ 1,\ 2,\ 3,\ \ldots,\ m_0 = 0.$$

Function $\int \varphi(.)$ enables to modulate the length of the step of self-assembly, dependent on the number of free elements existing in the process (created by initial conditions and replication) leading to control realization of the growing, extinction, and stabilization in the concatenation of replication and self-assembly processes.

IV. CONCLUSION

In case of the concatenation of *two replication processes*, the resulting process is characterized by the growth function which is determined by the control value α (faster growth then slower and slower growth then faster replication).

In case of the concatenation of *replication and self-assembly*, the resulting process can be controlled leading to three possible states: the number of elements is growing up, decreasing till to termination of the replication and a stable state i.e. the number of elements arising is equal to the number of elements snatched in the self-assembly process.

The results of the concatenation of replication and self-assembly processes can be used in the investigation of a connective replication of object with the internal molecular program, linking of such a processes, and also in analysis of processes where the very complex nanostructures appear e.g. in the processes of molecular biology [1, 2, 3, 6].

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