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Fundamentals of event-continuous systems simulation theory

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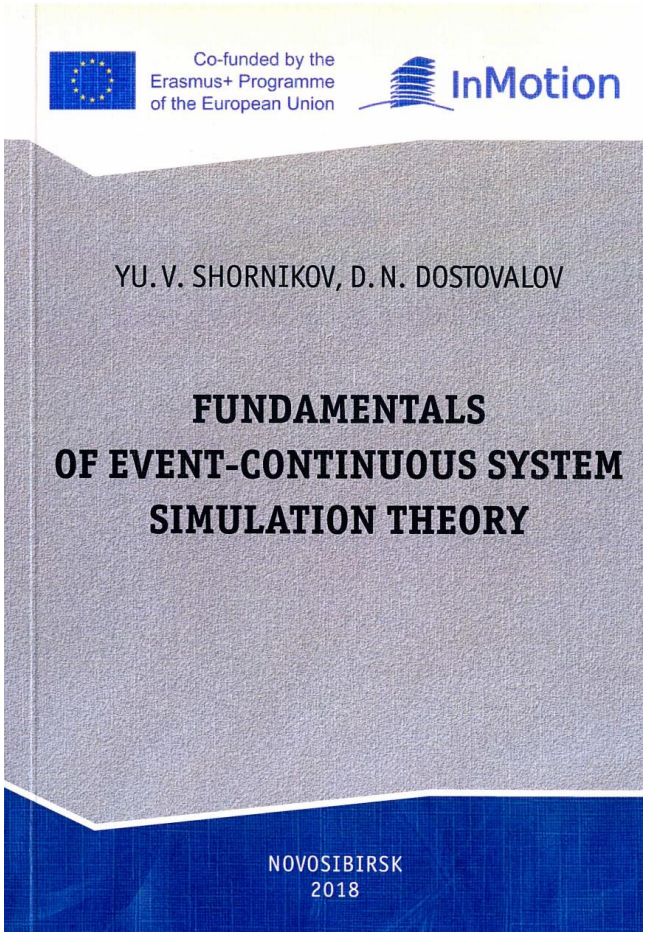
Textbook abstract



Physical systems interacting with software applications (so-called event-continuous systems) can be effectively modeled as heterogeneous systems including subsystems with continuous time and subsystems interacting with discrete events. Initially, the terminology of discrete-continuous systems based on concrete mathematical concepts was developed, although it was limited in the dimensionality of systems analyzed due to using an analogue approach. Usually, the continuous components of a system are modeled as differential equations, whereas its discrete events are modeled with the aid of a finite automaton. The most important theoretical and practical contribution to the field of event-continuous systems is the development of systems theory, control theory, computer-aided analysis software, et cetera. In order to ease the usage of different analytical approaches, numerous software applications (Charon, HyVisual, HyTech, etc.) and tools for effective numerical analysis and data processing were developed. The important

features of new software tools are surveyed in the papers of J.M. Esposito. Prof. Esposito, in particular, suggested new paradigms such as event functions. It led to the creation of new approaches of numerical analysis of discrete-continuous phenomena. A new methodology of studying event-continuous systems was developed.

At the same time, there appeared the need of development of new event-driven multipurpose software architecture dealing with such situations that at the same time there might occur a few events, which would normally lead to a nontrivial modeling problem. The new methodology allowed to solve high-dimensional problems, but now there is the problem of stiff modes. And here, by the way, Professor E.A. Novikov received major scientific results, considering completely different fundamental problems. And whereas, in the papers of Dr. Esposito, when simulating event-continuous systems, the integration step is controlled only by the tolerance conditions and the requirements to detect unilateral events, we add the stability conditions, taking into account the stiffness, and consider the dynamical behavior of event functions, which speeds the detection algorithm up.

It should be noted that event-driven systems are of more and more use in different totally not related areas. The examples are heterogeneous modeling and simulation of living systems, large electrical power systems, mechanical engineering, chemical kinetics systems, chemical industry, and many other applications.

The book is written in a simple for understanding manner, includes necessary theoretical concepts and practical examples, and can help one to study complex event-continuous phenomena.

The textbook written by Yu. V. Shornikov, D. N. Dostovalov (NSTU).