Preface

Smart electromechanical systems (SEMS) are used in cyber physical systems (CPS). The term “cyber physical systems” was proposed in 2006 by Helen Gill in order to emphasize the distinctive feature of the seminar NSF CPS Workshop she organized. At that time, she was a director of Integrated and Hybrid Systems at the National Science Foundation. Organizers of the seminar were trying to redefine the role of embedded systems, and they succeeded; they caught the general trend, and after a couple of years, the rapid development of CPS began. Progress in this class of systems has been recognized as one of the most important technological developments in the USA and later in Europe. CPS show the ability to integrate computing, communication and storage of information, and monitoring and control over the objects of the physical world. The main tasks in the field of theory and practice of CPS are to ensure the efficiency, reliability, and safety of functioning in real time.

CPS relate to a new scientific field, i.e., cybernetic physics, which is identified by the author of this trend Alexandr Fradkov, the head of the laboratory, IPME RAS of the Academy of Sciences (St. Petersburg, Russia) in his book “Cybernetic Physics” is aimed at the study of physical systems through cybernetic methods. Although some selected publications, using the idea of control theory, started to appear in physics journals a long time ago, an independent branch of science at the intersection of physics and control theory began to take shape only in the 1990s due to the rapid growth in areas such as control of chaos and control over quantum systems, and a number of publications are now estimated at several thousands.

SEMS have been widely employed since 2000 in parallel robots, or so-called parallel kinematic machines. They provide good opportunities in terms of accuracy, rigidity, and ability to manipulate heavy loads. Currently, SEMS are widely used not only in intelligent robots, but also in astronomy, machine tools, medicine, and other fields.

The objective of the publication of this collection of articles is to introduce the latest achievements of the scientists of the Russian Academy of Sciences in the field
of theory and practice of SEMS. At the same time, a lot of attention here is given to methods of designing and modeling of SEMS based on the principles of adaptability, intelligence, biomorphism of parallel kinematics, and parallelism in information processing and control computation. The most complete are the following points of interest:

– methods of design of SEMS modules and intelligent robots based on them;
– synthesis of neural systems of automatic control over SEMS modules;
– mathematical and computer modeling of SEMS modules and CPS based on them;
– vitality control and reliability analysis based on logic and probabilistic and logic and linguistic forecasting;
– methods of optimization of SEMS control systems based on mathematical programming methods in ordinal scale and generalized mathematical programming;
– information-measuring software of SEMS modules and CPS based on them.

This book is intended for students, scientists, and engineers specializing in the field of SEMS and robotics, and includes many scientific domains such as kinematics, dynamics, and control theory.

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