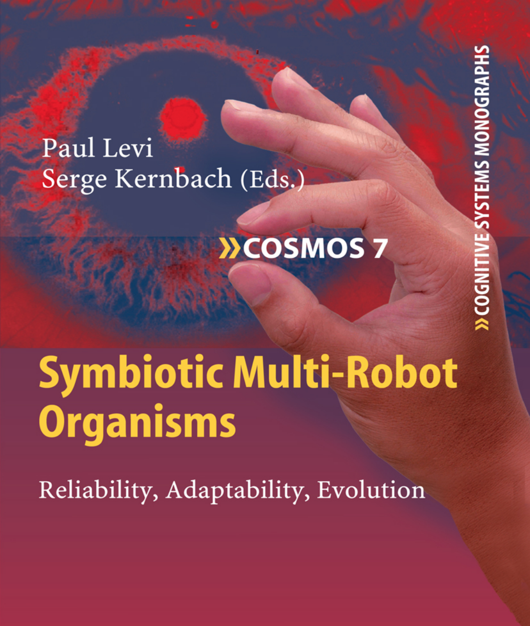

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Reliability, Adaptability, Evolution

Springer

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Foreword

It is our pleasure to contribute the foreword to this book on symbiotic multi-robot organisms, which is largely based on the scientific findings and explorations of two major EU research projects, Symbrion and Replicator, funded under the Seventh Framework Programme for Research and Technological development (FP7)[1]. FP7 emphasises consortia of European partners, transnational collaboration, open coordination, flexibility and excellence of research and plays a leading role in multidisciplinary research and cooperative activities in Europe and beyond. Its impact is major in terms of integrating and structuring research communities across national borders to achieve a critical mass, providing the leverage for high-potential fields to take off, and encouraging healthy competition at European level while avoiding unnecessary duplication of research capacities. Research proposals are evaluated through a demanding peer-review process and only the best are selected to be funded by the European Commission (EC). The Information and Communication Technologies (ICT) theme has set out a number of challenges within this context, which cover topics such as cognitive systems, modular robotics, adaptive systems and societies of artefacts.

- **Symbrion** was selected following the Call "Pervasive Adaptation" of the "Future and Emerging Technologies (FET)" programme area[2]. It started on 1 February 2008 and will run for 5 years. FET Proactive addresses evolutionary and revolutionary approaches through multidisciplinary cooperation and investigates new future technology options in response to emerging societal and industrial needs and identifies new drivers for research.
- **Replicator** was selected under the "Cognitive Systems and Robotics" programme area[3]. It started on 1 March 2008 and will also run for 5 years.

[1] The views expressed in this foreword are the sole responsibility of the authors and in no way represent the view of the European Commission and its services.
[2] http://cordis.europa.eu/fp7/ict/fet-proactive/home_en.html
[3] http://www.cognitivesystems.eu

The "Cognitive Systems and Robotics" challenge supports research on the engineering of artificial cognitive systems and in particular endowing robots with cognitive and other advanced capabilities.

These projects address major challenges for the robotics of the future that were identified during intensive consultations with leading scientists. Robots will have to harness and interpret information (e.g., speech, images or sensor data), carry out useful tasks (e.g. manipulation and grasping, exploration and navigation, monitoring and control, situation assessment, communication and interaction) and pursue immediate or long-term goals, autonomously or in cooperation with people or other robots. Moreover future robots will have to be:

- **Reliable and robust**, able to operate in adverse conditions for a long period of time without frequent or major maintenance.
- **Learning**, able to improve their capabilities through individual or social interactions with their environment, people or other robots.
- **Adaptable**, able to operate autonomously in loosely-structured, unpredictable, highly-dynamic and open environments, technological and user contexts.
- **Modular**, able, on their own initiative, to operate as a larger system to tackle problems or carry out tasks they would not be able to tackle or carry out individually.
- **Collaborative and social**, able, on their own initiative, to collaborate in a natural way with people or other robots, and to adapt to each others and to changing needs.
- **Evolvable**, able to elaborate strategies operating at different speeds and time scales, from the short-term development of specific skills to the long-term evolution into different species.

To realise the potential of this exciting field, it is crucial to stimulate contributions from and to create synergies between different disciplines, including robotics, cognitive systems, adaptive systems, the social sciences and biology. Symbrion and Replicator are examples of such efforts. Both projects work towards individual robots that are capable of adapting, reconfiguring and self-assembling into large artificial organisms. They will develop novel principles underlying these robotic organisms, such as self-configuration, self-adjustment and self-learning. Furthermore, they share a common platform to avoid duplication in this area.

- **Replicator** aims at developing small, autonomous reliable, highly capable and sensor-rich (laser, camera, RFID, localisation) robots which are able to self-assemble into large artificial organisms on their own initiative. The bio-inspired evolutionary approach and evolvable hardware structure will enable the robotic organisms to emerge new functionalities, to develop their own cognitive and control structures and, finally, to work autonomously in uncertain situations within open-ended or even hazardous, environments.

- **Symbrion** focuses on evolutionary and bio-mimicking approaches to explore biological concepts with robot populations (e.g., artificial evolution, pervasive evolveability, artificial immunology, genetic self-reprogramming, virtual sexuality). It places more emphasis on the genomic framework and genetic learning based on feedback from the environment. Accordingly, it uses large computation resources on the platform and more emphasis is put on collective behaviours and on the assembly into organisms.

Considering both projects together and their respective funding, 5.4 M€ for Replicator and 5.3 M€ for Symbrion (with a 0.5 M€ extension under negotiation), this is one of the largest combined grants ever in collaborative and evolutionary robotics. In this context the research community, the European Commission and both consortia recognise the crucial importance of identifying key underlying scientific questions, deriving scientific and technological priorities from these goals and using them to obtain important and highly-visible outcomes. Apart from the scientific impact, it is likely that both projects will contribute to longer-term applications in various domains, such as surveillance and intervention, exploration and inspection, and search and rescue.

We hope that the readers will enjoy this book as much as we did, and wish both teams success in achieving their ambitious goals.

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The investigation of artificial multicellularity and the development of robot organisms was only possible by the support of the European Commission, Directorate-General Information Society & Media over several years within the 7th Framework Program in the field of “Cognitive Systems, Interaction, Robotics” and “Future and Emerging Technologies”. The Strategic Research Agenda, Vision and Challenges are discussed with many experts from robotics, biology, genetics, evolutionary computations, machine learning. Considerable amount of preparatory works has been done within the I-Swarm, Swarmrobot, GOLEM, NEW TIES, Artificial Culture, LEURRE, SuperBot, Swarm-bots, HYDRA, CEBOT projects as well as discussed within the coordinated actions PerAda (Pervasive Adaptation Research Network) and euCognition (EUCogII – European Network for the Advancement of Artificial Cognitive Systems, Interaction and Robotics), which finally defined the field and the road to implementation. Organizers of the special sections and workshops during CEC, IROS, ICRA, GECCO, ICT, FET and several IEEE conferences gave us a great opportunity to present the ideas to scientific community and to collect a valuable feedback. We are grateful to our multiple reviewers for very intensive and fruitful remarks and corrections as well as to project officers whose continuous support essentially contributed to advances and progress of the research and development.

Ideas, experiments and implementations, described in this book were also impossible without a huge amount of effort and time, invested by young and senior researchers of our consortiums. The work of the last few years was of great strength and we are thankful to the consortiums for readiness to contribute, continuous availability and excellent motivation. This finally allowed formulating the ambitious goals towards possible future ways of the collective robotics.

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