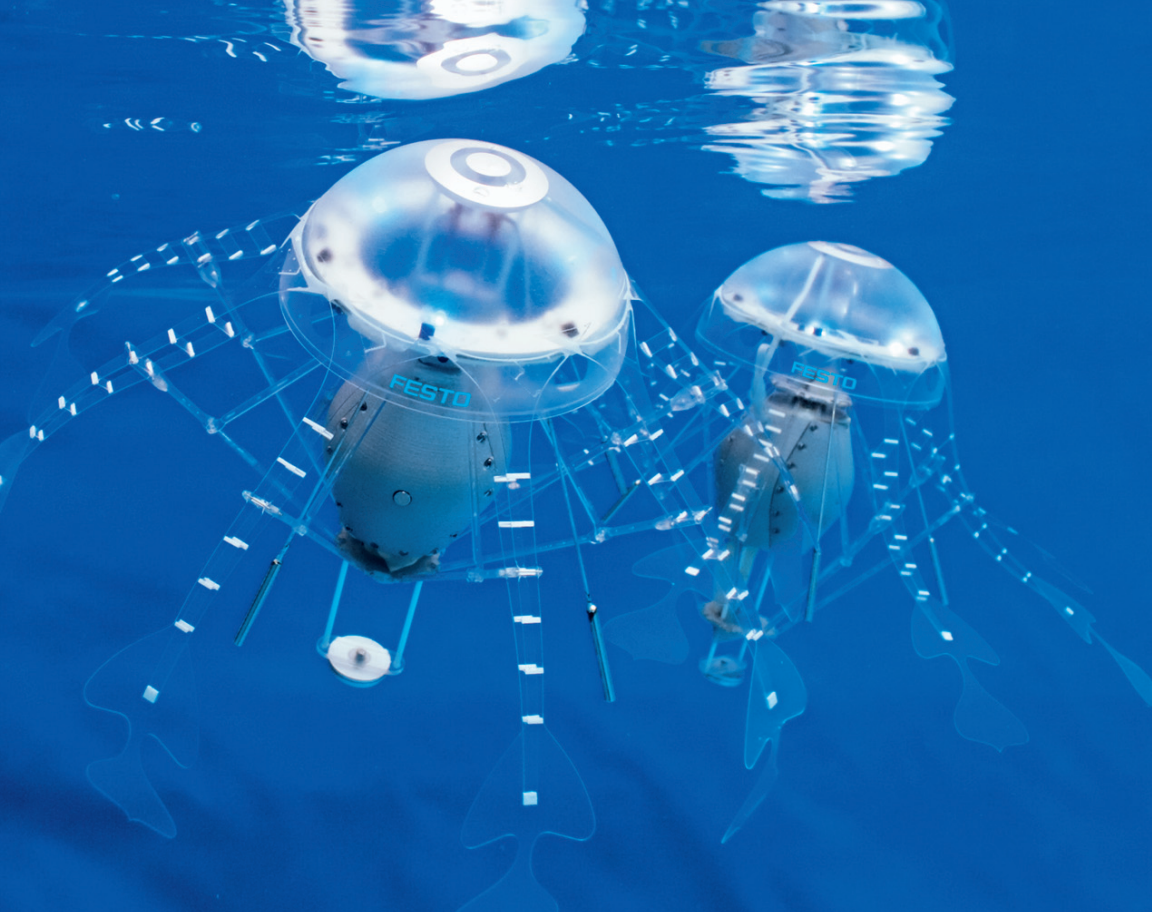

Handbook of COLLECTIVE ROBOTICS

Fundamentals and Challenges

Edited by **Serge Kernbach**

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Preface

Collective robotics may be considered an interdisciplinary effort, which deals with technological, scientific, and social problems in artificial and mixed societies consisting of many interacting entities. *Handbook of Collective Robotics: Fundamentals and Challenges* is devoted to mechatronic, chemical, biological, and hybrid systems utilizing cooperative, networked, swarm, self-organizing, evolutionary, biomimetic, and bioinspired design principles and addressing underwater, ground, air, and space applications. In selecting the topics for this book, special attention was paid to covering current and future key technologies and involving leading research groups from the corresponding technological areas. This book is aimed at anyone who is interested in learning more about collective robotics, whether coming from research, education, business, or anywhere else. Its purpose is to help people learn what modern collective robotics is, what it may develop into, and what impact it might have on our society.

The idea of creating a book that would address the entire field of collective robotics was born within several large European projects and communicated to the community during conferences, such as ICRA, IROS, DARS, and ANTS. The preparation essentially arose from the workshops *Collective Adaptive Systems* and *Collective Robotics* organized by the *Future and Emerging Technology* and *Cognitive Systems and Robotics* units in the European Commission. Multiple discussions with Prof. Paul Levi, Prof. Hermann Haken, Prof. Alan Winfield, Dr. Thomas Schmickl, Dr. José Halloy, Prof. Gusz Eiben, Prof. Wei-Min Shen, Prof. Dario Floreano, Prof. Rolf Pfeifer, Prof. Steen Rasmussen, Prof. Jean-Louis Deneubourg, Prof. Karl Crailsheim, Prof. Heinz Wörn, and Prof. Kasper Stoy radically influenced the final selection of topics. Stanford Chong, director of Pan Stanford

Publishing, suggested extending the content to *Fundamentals* and *Challenges* and transforming it into a handbook. The book in its current form includes 22 chapters, divided thematically into *Middle-Sized and Networked Systems*, *Large-Scale and Swarm Systems*, and *Challenges*. Its creation involves 52 co-authors from 14 countries and describes more than 40 research projects and 70 robot platforms. Its 75 pages of references can be thought of as one of the most comprehensive overviews of the whole field of collective robotics. The chapters have received comments from 36 reviewers, and the whole effort took more than two years.

The editor prepared this volume in the conviction that future collective robotics will involve different synthetic systems; the selection of chapters reflects this vision.

The first chapter discusses a taxonomy for collective robotics and briefly introduces the content of other chapters. Chapters 13 and 21 are devoted to biochemical, Chapter 15 to biohybrid, Chapters 19 and 20 to micro- and nano-, and Chapter 22 to bacterial systems. Classical mechatronic technologies are represented by swarm (Chapter 2), networked (Chapter 3), reconfigurable (Chapter 7), and self-assembling (Chapters 8 and 14) systems. The chapters target different applications in service (Chapter 4), underwater (Chapter 16), aerial (Chapter 17), and space (Chapter 18) areas. Example of cooperating industrial robots should have been represented by the KUKA Robotics RoboTeam; unfortunately economic conditions made further preparation of this chapter impossible. I would like to thank Ken Stoddard and all those who were involved in the preparation of that work. The methodological part of the book covers self-organizing (Chapters 2 and 8), evolutionary (Chapters 5 and 12), biomimetic/bioinspired (Chapter 9), and developmental (Chapter 14) strategies and involves aspects such as reliability and fault tolerance (Chapter 5), scalability (Chapter 10), energy foraging (Chapter 11), self-replication (Chapter 13), and adaptivity (Chapters 12 and 14). Finally, diverse social aspects of collective robotics are treated in Chapters 9, 12, and 15.

I would like to thank all the co-authors who contributed to this book, the reviewers whose comments improved all the chapters, our research group, especially Prof. Paul Levi for his open and constant encouragement, and finally all those people who helped either with

computer infrastructure or with the technical preparation of this book. I would also like to thank my family for the support I received while preparing this book.

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Stuttgart