

Preface

The work presented in this monograph is the final result of the multidisciplinary project entitled COmponents for SPACe Robotics (COSPAR), developed in the period 2010–2012 within the context of the Alta Scuola Politecnica and in cooperation with the Istituto Italiano di Tecnologia (IIT). The project team was constituted by M.Sc. students selected among the most talented ones of both Politecnico di Torino and Politecnico di Milano, in particular:

- *Eleonora Marina Botta*, Space Engineering, Politecnico di Milano.
- *Pierluigi Freni*, Materials Engineering, Politecnico di Torino.
- *Ippazio Martella*, Computer Engineering, Politecnico di Torino.
- *Federico Radici*, Biomedical Engineering, Politecnico di Milano.
- *Luca Randazzo*, Mechatronics Engineering, Politecnico di Torino.
- *Roberto Rossi*, Mechanical Engineering, Politecnico di Milano.

All the components of the team gave their personal and fundamental contribution to the present work and those who are not cited among the authors are indicated at the beginning of the chapter they contributed the most.

The Alta Scuola Politecnica

The Alta Scuola Politecnica (ASP) is a school for young talents founded by Politecnico di Torino and Politecnico di Milano in 2004. The ASP program is profoundly multidisciplinary and is focused on innovation. 150 students per year are chosen for this advanced program, which runs parallel to their M.Sc. courses. During courses, they enrich their knowledge of innovation processes and the socioeconomic context. In their multidisciplinary projects, they learn to develop a whole project working in a diverse team cooperating with industries, research, and governmental institutions.

COmponents for SPace Robotics

The Components for Space Robotics (COSPAR) project aims at developing new technologies that could support space exploration missions. In the next decades, planetary exploration will play an important role in directing the global technological development and will provide at the same time an extensive application and testing field for many innovative technologies. In support of exploration missions, new space systems shall be developed requiring research on many new technologies involving robotics, automation, bioengineering, artificial intelligence, and nanotechnology skills.

One of the main problems during Extra-Vehicular Activities (EVA) is the astronaut's hand fatigue: the pressurized suit limits the astronaut's mobility and, in particular, the hands' dexterity, force and endurance. Astronauts would benefit from a device able to mitigate hand fatigue during EVAs without hindering any movement, allowing them to accomplish their tasks more comfortably and for a longer time. In this project, the team's approach was to research a possible preliminary technological solution for a lightweight hand exoskeleton to be embedded in the astronaut's glove. The difficulty of the project was increased by the complexity of the human hand, in terms of degrees of freedom and working space, and by the extreme environment in which the exoskeleton will be employed. The team focused on highly innovative and high-risk solutions designed from scratch for a glove based on soft robotics concepts, employing Electroactive Polymers (EAPs). The design solution is an innovative response that makes it possible to foresee the subsequent stages of prototyping and development.

Acknowledgments

We are glad to express our gratitude to all the people and institutions involved in the COSPAR project, that made this experience possible for us, gave us their support and enabled the results attainment. We would like to thank the ASP board for offering us the opportunity to work on this project, within a highly specialized context, and for the continuous support both on organization and content aspects. A very special thank you goes to Paolo Ariano of IIT, for his continuous help and collaboration along the whole project development and for the several precious inputs and ideas he shared with us.

We want also express sincere gratitude to Paolo Nespoli for offering us an irreplaceable occasion to understand the astronauts' needs and the problems they have to face during EVAs, which brought us to a much higher level of awareness and led us to the final concept design able to meet the final users' priorities.

Special thanks go to Loredana Bessone for giving us the possibility to participate in a visit to the European Astronauts Center, to Riccardo Bosca for the guided tour of EAC's facilities and to Herve Stevenin for sharing precious information about astronauts' training.

Sincere thanks are due to Emanuele Tracino, Project Manager of Thales Alenia Space, with whom we had extremely constructive confrontations and who particularly helped us in the understanding of radiation hazards in EVAs.

Conflict of interest. The authors report no conflict of interest.

Innovative Hand Exoskeleton Design for Extravehicular
Activities in Space

Freni, P.; Botta, E.M.; Randazzo, L.; Ariano, P.

2014, XII, 89 p. 46 illus., 2 illus. in color., Softcover

ISBN: 978-3-319-03957-2