University of Bremen
Institute of Automation
Otto-Hahn-Allee NW1
D-28359 Bremen

BRAINROBOT
Methods and Applications for Brain Computer Interfaces

Axel Gräser
Ivan Volosyak (Eds.)

Shaker Verlag
Aachen 2010

Publication Series of the Institute of Automation
University of Bremen

Series 5-Nr.2

Axel Gräser,
Ivan Volosyak (Eds.)

BRAINROBOT

Methods and Applications for Brain Computer Interfaces

Shaker Verlag
Aachen 2010

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Publication Series of the INSTITUTE OF AUTOMATION, UNIVERSITY OF BREMEN:

1 Colloquium of Automation, Salzhausen
2 Automation
3 Robotics
4 Control Theory
5 Brain Computer Interface
6 Virtual and Augmented Reality
7 Image Processing

Printed in Germany.

ISBN 978-3-8322-8201-1
ISSN 1861-5457

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen
Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9
Internet: www.shaker.de • e-mail: info@shaker.de

Preface

This booklet contains the results of the EU-Marie-Curie-Transfer of Knowledge (TOK) project BRAINROBOT MTKD-CT-2004-014211. The different chapters contain mainly enlarged versions of already published papers. The collection should give the reader a complete overview about the project and the different approaches which have been taken into account. The overall goal of BRAINROBOT was the transfer of knowledge by research in the fast growing field of Brain Computer Interfaces (BCI). The TOK aimed to provide a fast BCI to be used as an input device for high-level control of the care-giving robot FRIEND. The necessary interdisciplinary research required a close cooperation between experts from different areas such as Cognitive Neurosciences and Robotics. The research project was funded by the EU Marie Curie Transfer of Knowledge (TOK) funding scheme, which is unique in the form of financing it, provides funds for the transfer of knowledge between institutions with quite different backgrounds and experiences. The host institute and project coordinator of the BRAINROBOT project, the Institute of Automation (IAT) at the University of Bremen in Germany, has many years of experience in robotics, especially in the field of care-providing robots. The partners in the project consortium were Professor Dr. Pfurtscheller and Professor Dr. Neuper, Institute for Knowledge Discovery, Graz University of Technology, Graz, Austria; Professor Dr. Niels Birbaumer, University of Tubingen, Tübingen, Germany; Dr. Alexa Riehle, Institute de Neurosciences Cognitives de la Méditerranée, CNRS Marseille, France; Prof. Dr. Ken Hunt and Dr. Henrik Gollee, Department of Mechanical Engineering, Centre for Systems and Control, University of Glasgow, Glasgow, UK. The experience of the partners was, among others, in Cognitive Neuroscience, Brain-Computer Interface and Functional Electrical Stimulation (FES). Incoming and outgoing experienced and incoming senior researchers were also involved in the project. In total 108 person months were financed by the project. The person months financed were distributed as follows: 81 person months for incoming experienced scientists, 21 person months for outgoing scientists from the IAT who spent time at the partner institutes and 6 person months for senior researchers. The TOK was carried out in several research projects which led to a considerable number of publications. IAT realized control of the care-giving robot FRIEND with a BCI-system and demonstrated that even BCI-inexperienced users were able to control the robot by brain signals. The BCI-robot control was successfully presented at the International Conference on Rehabilitation Robotics ICORR in 2007 and the international fairs CEBIT and RehaCare in 2008. The participation in CEBIT 2008 and RehaCare 2008 enabled a field test of IAT's BCI with users of different ages, including disabled users.

Even in the early stages of the BRAINROBOT research project, it became obvious that the delay time of BCIs and the low information transfer rate are very big obstacles for the use of BCI for robot control. Several successor research projects resulted from this experience (BRAIN, sBCI) which have as goals, among others, increasing the information transfer rate and shortening the response time of BCIs. Due to the structure and funding opportunities of the EU Marie Curie Transfer of Knowledge scheme, the IAT was able to build strong knowledge base in BCI systems in a very short time. The IAT experienced researchers had the opportunity to visit several first class institutes where they gained knowledge about BCI and FES. The Marie Curie Transfer of Knowledge funding also enabled IAT to hire first class experienced researchers to carry out research at the IAT while transferring their knowledge to the IAT researchers and doctoral students. IAT was also able to invite, for short periods, senior researchers who are first class experts in their field of research to share and transfer their specific knowledge.

I would like to thank the EU for the creation of the TOK funding scheme. I would like especially to thank my colleagues Prof. Dr. Gert Pfurtscheller, Prof. Dr. Christa Neuper, Prof. Dr. Ken Hunt, Prof. Birbaumer and Dr. Alexa Riehle, for their support during the project proposal writing and for the generous hosting of Dr. Ivan Volosyak. I would also like to thank Prof. Dr. Petko Kiriazov, Dr. Piotr Durka, Dr. Maciej Pokora and Dr. Henrik Gollee for accepting the invitation to visit IAT and for sharing their knowledge with us. The experienced incoming scientists Dr. Ola Friman, Dr. Bernhard Graimann, Dr. Brendan Allison, Dr. Hubert Cecotti (ordered according to time of arrival at the IAT) as well as Dr. Ivan Volosyak, Dipl.-Ing. Diana Valbuena, Dipl.-Ing. Thorsten Lüth, M.Sc. Aavo Moltsaar and Dipl.-Ing. Amir Teymourian (all five from the IAT) also made important contributions to the success of the TOK project. I thank all of them for their dedication to BRAINROBOT. Last but not least I would like to thank the EU project officers Dr. Marcela Groholova and Laura Elena Apostol for their advice and support and the patient help to solve several organizational problems during the execution of the project.

Finally, I hope that the readers will enjoy reading the different chapters in this booklet.

Bremen, February 2010

Axel Gräser
Project Coordinator BRAINROBOT

Contents