Springer Tracts in Advanced Robotics

Volume 19

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Tine Lefebvre · Herman Bruyninckx · Joris De Schutter

Nonlinear Kalman Filtering for Force-Controlled Robot Tasks

With 86 Figures and 10 Tables

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Foreword

At the dawn of the new millennium, robotics is undergoing a major transformation in scope and dimension. From a largely dominant industrial focus, robotics is rapidly expanding into the challenges of unstructured environments. Interacting with, assisting, serving, and exploring with humans, the emerging robots will increasingly touch people and their lives.

The goal of the new series of Springer Tracts in Advanced Robotics (STAR) is to bring, in a timely fashion, the latest advances and developments in robotics on the basis of their significance and quality. It is our hope that the wider dissemination of research developments will stimulate more exchanges and collaborations among the research community and contribute to further advancement of this rapidly growing field.

The monograph written by Tine Lefebvre, Herman Bruyninckx and Joris De Schutter is focused on how to achieve more robot autonomy by means of reliable processing skills. The latest developments in the areas of contact modelling, nonlinear parameter estimation and task plan optimisation for improved estimation accuracy are discussed. Kalman filtering techniques are applied to identify the contact state based on force sensing between a grasped object and the environment. The potential of the work is to be found not only for industrial robot operation in space, sub-sea or nuclear scenarios, but also for service robots operating in unstructured environments co-habited by humans where autonomous compliant tasks require active sensing.

Remarkably, the doctoral thesis at the basis of this monograph was a finalist for the Fourth EURON Georges Giralt PhD Award devoted to the best PhD thesis in Robotics in Europe. A fine addition to the series!

Naples, Italy,
June 2005

Bruno Siciliano
STAR Editor

Preface

During the last decades, a number of "smart machines" entered our homes: washing machines, vacuum cleaners, entertainment pet robots, ... This makes us dream about the next generation of service robots which take over household chores. However, several major difficulties have yet to be overcome before this dream can come true. One of these difficulties is to make contact in a safe and controlled way with inaccurately positioned objects.

More robot autonomy can only be achieved by reliable sensor processing skills. This book describes the latest developments in the areas of contact modelling, nonlinear parameter estimation and task plan optimisation for improved estimation accuracy. The obtained autonomy is indispensable for the execution of tasks with inaccurately known objects and for tasks in environments that do not allow a precise positioning of the objects. Application areas include industrial robot operation in space, sub-sea or nuclear environments. The same research is relevant for service robots operating in environments that have been designed for humans and where even simple tasks require a lot of sensing.

Meise, Leuven, Belgium,
March 2005

Tine Lefebvre
Herman Bruyninckx
Joris De Schutter

No book, however small, is produced without the help of others. This monograph is the result of four years of PhD research at the Division of Production Engineering, Machine Design & Automation (PMA), Department of Mechanical Engineering, Katholieke Universiteit Leuven, Belgium. I am grateful to all people who contributed to this work. I would like to give a special word of thanks to my supervisors Joris De Schutter and Herman Bruyninckx for offering me support and guidance and at the same time giving me the freedom to choose my research niche. Also many thanks to the Fund for Scientific Research Flanders for providing a fellowship for this research. Last but not least, I am indebted to my parents who always encouraged and supported me to study something in which I was interested.

Meise, Belgium, *Tine Lefebvre*
March 2005

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