

Lecture Notes  
in Control and Information Sciences

309

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Editors: M. Thoma · M. Morari

# Lecture Notes in Control and Information Sciences

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# Cooperative Control

**A Post-Workshop Volume  
2003 Block Island Workshop  
on Cooperative Control**

With 105 Figures

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## Preface

In recent years, there has been a growing interest in understanding on the one hand, how various animal aggregations such as fish schools, bird flocks, deer herds, etc. coordinate their collective motions to perform useful tasks and on the other, how groups of mobile autonomous agents such as AUV schools, UAV flocks, etc., might be instructed to cooperate in a similar manner. In ecology and evolutionary biology, for example, it is of great interest to understand how natural groupings coordinate themselves and move so flawlessly, often without an apparent leader or any form of centralized control. What kinds of signaling must they use? What role if any, does the physical medium, environmental context, currents, vortices, or other local environmental disturbances play in this process? Are there universal principles of coordinated group motion and if so what might they be? Could such principles be used in a robotic context to help enable a large group of autonomously functioning vehicles in the air, on land or sea or underwater, to collectively accomplish, in a safe and coordinated manner, useful tasks such as distributed, adaptive scientific data gathering, search and rescue, and reconnaissance?

Because of rapidly growing interest in issues such as these and because researchers from so many different fields have been working to provide answers, it seemed timely a year ago to hold a cross-disciplinary specialist workshop aimed at identifying and defining a range of research objectives. In response, a workshop on *Cooperative Control* was organized and held on Block Island, Rhode Island from June 9 to June 11, 2003. The primary objective of the workshop was to bring together a small number of individuals from animal biology, robotics, automatic control, communications and sensor networks, artificial intelligence, dynamical systems, algorithms, etc. with interests in group coordination and cooperative control – not primarily to present their current work, but rather to delineate common ground and to identify fundamental unresolved problems in the rapidly evolving, cross-disciplinary field of cooperative control of natural and man-made groups. The workshop was attended by more than 60 participants including representatives from industry, government, and the academic world. The workshop was centered around ap-

proximately twenty-four invited presentations organized into four sequential sessions. Each session consisted of a lead-off talk followed by invited panel member talks, followed by panel discussions. Participants were asked to prepare short position papers highlighting issues for discussion. These papers as well as other information about the workshop can be found at the website <http://www.cis.upenn.edu/~kumar/wcc/>.

This volume is an outgrowth of the workshop. It consists of fifteen contributed research papers, which encompass not only much of what transpired on Block Island, but also a broad spectrum of related topics contributed by workshop participants.

## **Acknowledgements**

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*Vijay Kumar  
Naomi Leonard  
A. Stephen Morse*

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