

Preface

Neuromechanics is a new, quickly growing field of neuroscience research that merges neurophysiology, biomechanics and motor control and aims at understanding motor behavior of living systems through interactions between their neural and mechanical dynamic properties. Although research in Neuromechanics is not limited by computational approaches, neuromechanical modeling is a powerful tool that allows for integration of massive knowledge gained in the past several decades of organization of motion related brain and spinal cord activity, various body sensors and reflex pathways, muscle mechanical and physiological properties and detailed quantitative morphology of musculoskeletal systems. Recent work in neuromechanical modeling, featured in this book, has demonstrated advantages of such an integrative approach and led to discoveries of new emergent properties of neuromechanical systems.

This book is largely based on the presentations at the workshop Neuromechanical Modeling of Posture and Locomotion, which was a part of the Computational Neuroscience Symposium in Atlanta and Decatur, Georgia, USA in July 2012. The goals of this workshop were to bring together neuromechanics researchers, discuss new developments in the field of neuromechanical modeling and inform computational neuroscience community of this new and exciting area of research. The goals of this book are similar. This book is the first to present a comprehensive and diverse collection of neuromechanical modeling studies of posture and locomotion.

It seems natural that neuromechanical modeling sprang from studies of neural control of posture and locomotion. Over the last 100 years, increasingly more sophisticated experimental paradigms, animal preparations and recording methods have been developed to obtain quantitative information about the mechanical, morphological and physiological properties of the musculoskeletal system, on the one hand, and about the biophysics and physiology of neurons, neuronal networks, reflex pathways and neural pattern generating circuits that control the musculoskeletal system, on the other hand. Neuromechanical modeling appears to be a very useful tool for integrating this massive body of information in models that recreate complex motor behaviors and reveal the mechanisms by which these behaviors emerge.

This book has several unique features. It is the first book on the topic of neuromechanics in general and on neuromechanical modeling of posture and locomotion

specifically. The majority of research groups working in the area of neuromechanical modeling contributed chapters to the book. The book covers a wide range of topics from theoretical studies linking the organization of reflex pathways and central pattern generating circuits with morphology and mechanics of the musculoskeletal system (Nichols et al., Chap. 3; Burkholder, Chap. 4 and Shevtsova et al., Chap. 5) to detailed neuromechanical models of postural and locomotor control (Bunderson and Bingham, Chap. 1; Markin et al., Chap. 2 and Aoi, Chap. 8). Furthermore, diverse modeling approaches are presented in the book including theoretical analyses of muscle non-linear transformations of neural signals (Burkholder, Chap. 4; Hooper et al., Chap. 6; Peterka, Chap. 9), detailed neuromechanical modelling incorporating multi-joint musculoskeletal models with afferent feedback signals and central pattern generating networks (Bunderson and Bingham, Chap. 1 and Markin et al., Chap. 2), theoretical and computational dynamic analyses of activity regime transitions in a multistable half-center oscillator (Bondy et al., Chap. 12), and others.

We hope this book will be a useful contribution to the field, inform the computational neuroscience community of this relatively new area of research and help attracting new talented students and researchers.

Neuromechanical Modeling of Posture and Locomotion

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