Preface

Neurological and age-related diseases affect human mobility at different levels causing partial or total loss of such faculty. There is a significant need to improve safe and efficient ambulation of patients with gait impairments. In this context, walkers present important benefits for human mobility, improving balance and reducing the load on lower limbs. Most importantly, walkers induce the use of patient's residual mobility capacities in different environments. In the field of robotic technologies for gait assistance, a new category of walkers has emerged, integrating robotic technology, electronics, and mechanics. Such devices are known as "robotic walkers," "intelligent walker," or "smart walkers."

One of the specific and important common aspects to the field of assistive technologies and rehabilitation robotics is the intrinsic interaction between the human and the robot. In this book, the concept of human-robot interaction (HRI) for human locomotion assistance is explored. This interaction is composed of two interdependent components. On the one hand, the key role of a robot in a physical HRI (pHRI) is the generation of supplementary forces to empower human locomotion. This involves a net flux of power between both actors. On the other hand, one of the crucial roles of a cognitive HRI (cHRI) is to make the human aware of the possibilities of the robot while allowing him to maintain control of the robot at all times.

This book will also present a new multimodal human-robot interface for testing and validating control strategies applied to robotic walkers for assisting human mobility and gait rehabilitation. This interface extracts navigation intentions from a novel sensor fusion method that combines: (i) a laser range finder (LRF) sensor to estimate the users legs' kinematics, (ii) wearable inertial measurement Units (IMUs) to capture human and robot orientations, and (iii) two triaxial force sensors measure the physical interaction between the human's upper limbs and the robotic walker.

Two close control loops were developed to naturally adapt the walker position and to perform body-weight support strategies. First, a force interaction controller generates velocity outputs to the walker based on the upper-limbs physical interaction. Second, a inverse kinematic controller keeps the walker within a desired position to the human improving such interaction.

The proposed control strategies are suitable for natural human-robot interaction as shown during the experimental validation. Moreover, methods for sensor fusion for estimating control inputs were presented and validated. In the experimental studies, the parameters estimation was precise and unbiased. It also showed repeatability when speed changes and continuous turns were performed.

At the end, this book will focus on describing the upcoming research in the field of assisted locomotion which leads to the development of hybrid solutions based on the combination of smart walkers and biomechatronic exoskeletons. Additionally, new technological breakthroughs regarding human-robot interaction taking into account the environment are also defined. In this manner, the aim is to achieve a closer interaction between the robotic solution and the individual empowering the rehabilitation potential of such devices in clinical applications.

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