

Preface

The addition of haptic feedback to virtual environments has enhanced users' virtual experience dramatically. It has enabled users to experience physical characteristics of objects such as weight, temperature, roughness and compliance, which was previously impossible with only visual and auditory feedback. Moreover, haptic feedback has the potential of greatly enhancing the experience of social interactions within virtual environments.

This book summarizes results achieved in the IMMERSENCE research project funded by the 6th Framework Programme of the European Union, FET—Presence Initiative. In addition, it includes selected chapters of other researchers in the field who were not part of the Immersence consortium. Different aspects of haptic interaction are explored based on three different scenarios: Person-Object (PO), Person-Object-Person (POP) and Person-Person (PP) interaction. While the PO scenario focuses on multimodal information processing, manipulative aspects of haptic interaction, and subliminal perception, the POP scenario explores examples of joint action in virtual environments, such as collaborative lifting. Finally, the PP scenario uses paradigms of handshaking and dancing to investigate direct contact between a human and an agent located in virtual reality.

The book is an example of interdisciplinary research directed towards the realization of multimodal immersive virtual environments with particular focus on haptic interaction. Recent results of psychophysical and behavioral studies are reported along with new technological developments for haptic displays and novel haptic rendering techniques.

The book is organized in two parts: I. Psychophysical and Behavioral Basis and II. Technology and Rendering. Chapters in part I report studies investigating important aspects of individual and collaborative object manipulation. Studies exploring the PO scenario investigate conditions affecting tactile sensitivity during manipulation. Other studies evaluate the effectiveness of multipoint contact haptic interfaces in simulating weight during unimanual and bimanual manipulation of virtual objects and examine the role of grip forces and cutaneous feedback on weight perception. Studies on multisensory enhancement, emotional factors and subliminal cues on performance in virtual environments are also reported. The POP studies are focusing on

experiments investigating human-human and human-robot collaborative lifting and suggest control algorithms describing this type of collaborative behaviour. The part also includes a chapter on issues related to the use of psychological experiments to evaluate artificial haptic interaction partners.

Part II reports on advanced rendering techniques for data-driven visuo-haptic rendering of deformable objects, haptic rendering for multiple contact points, as well as the rendering of cutaneous cues for the PO scenario. For the PP scenario rendering of social haptic interaction partners is investigated and a new MR compatible sensing glove to analyze dyadic interactions using fMRI is developed. Finally, the realization of advanced human-computer collaboration schemes involving haptic role exchange and negotiation mechanisms are investigated for the POP scenario.

Although the two parts of the book are virtually separated, they are not in practice: both of them benefit from each other and many overlappings between the two parts exist. Novel devices and rendering techniques cannot be developed without the knowledge of psychophysical and behavioral findings, while new experiments cannot be performed without sophisticated devices and rendering techniques. Consequently, the two parts are highly complementary and many of the synergies between them are highlighted in the single chapters.

Finally, we would like to thank all the authors for their valuable contribution to this book.

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