Special Issue: Virtual Reality and Sports
Guest Editors’ Introduction

This special issue of Presence: Teleoperators and Virtual Environments presents selected research contributions in the use of immersive systems for serious applications in sports and physical exercise.

These papers address a general question: How can training in immersive systems help individuals to acquire motor and perceptual skills that can be applied to real situations? Understanding how humans develop the skills needed to perform complex motor tasks in sports is a multidisciplinary and challenging issue. It involves addressing complex and complementary aspects of performance, including perception, motor control, decision-making, cognition, and social behaviors.

Sport is an example of an extreme human activity, in which human capabilities can be pushed to their limits. For example, almost all sports involve dealing with complex perception-action coupling, assuming that people act to perceive and perceive to act. For sports scientists, this coupling is addressed by designing highly controlled scientific protocols. These protocols are very far from the real situations and make it difficult to use the resulting scientific knowledge in designing training programs.

Virtual reality (VR) has been widely used to train people in driving or repairing complex systems. It has also been successfully applied to treat people who have psychological diseases and phobias. In the same way, VR is a very promising investigative tool for sports training, as it tries to preserve the real-world naturalness of a situation while ensuring its strict control, which is not typically achievable in the real world. Once identified, the parameters correlated with a good performance can be trained in virtual environments. Further, additional meaningful information can be conveyed to the user in the virtual scenario during training.

In addition to these fundamental questions, using VR in sports raises new technological challenges, such as (but not limited to) simulating realistic virtual opponents, ensuring multisensory feedback, and designing specific immersive platforms. One key point in developing new technologies is that many of the likely users are experts in their sport and are very demanding regarding the possible transfer of skills acquired in the virtual environment to their real practice. Complementary to this type of expert training, recent developments of video games (such as Nintendo Wii or Microsoft Kinect) have demonstrated interest on the part of people of various ages and training levels in practicing virtual sports.

Considerable scientific work is needed to determine how virtual sports practice can actually enhance health and performance. Some of the papers in this special issue address the question of whether and how VR can be viewed as a new way to improve health and quality of life by motivating people to move.

The seven papers included in this issue were submitted from multidisciplinary teams in computer science, sports science, VR, and human-machine interface design. Most of the papers in this issue deal with the influence of various forms of sensory feedback on the motivation and performance of motor tasks performed in immersive environments.

The first paper, “Does virtual reality enhance exercise performance, enjoyment, and dissociation? An exploratory study on a stationary bike apparatus,” by Daniel R. Mestre, Christophe Maïano, Virginie Dagonneau, and Charles-Symphorien Mercier, evaluates the influence of different sensory inputs, such as video and music, on the performance of people in a VR cycling situation. Similarly, the contribution by Roland Sigrist, Jürg Schellenberg, Georg Rauter, Simon Broggi, Robert Riener, and Peter Wolf, “Visual and auditory augmented concurrent feedback in a complex motor task,” compares different auditory and visual concurrent feedback designs for rowing-type movements by analyzing the variability of movements for different feedback configurations.
Emanuele Ruffaldi, Alessandro Filippeschi, Carlo Alberto Avizzano, Benoit Bardy, Daniel Gopher, and Massimo Bergamasco, in their paper entitled “Feedback, affordances, and accelerators for training sports in virtual environments,” also use the rowing simulation as the platform for reviewing the role of various types of sensory feedback in virtual environments. Using a different virtual task, “Car racing in a simulator: Validation and assessment of brake pedal stiffness,” by S. de Groot, J. C. F. de Winter, M. Mulder, and P. A. Wieringa, focuses on the effects of brake pedal stiffness when driving in a car simulator.

One of the main questions arising in developing immersive systems for training motor skills is determining the type of feedback that will have the strongest impact on learning real-world motor skills. The paper by Daniel L. Eaves, Gavin Breslin, Paul van Schaik, Emma Robinson, and Iain R. Spears, “The short-term effects of real-time virtual reality feedback on motor learning in dance,” addresses this type of problem for three kinds of feedback for the specific case of dance motions.

A major advantage of immersive systems is associated with the motivation of people to act in virtual worlds. The paper “Astrojumper: Motivating exercise with an immersive virtual reality exergame,” by Samantha Finkelstein, Andrea Nickel, Zachary Lipps, Tiffany Barnes, Zachary Wartell, and Evan A. Suma, demonstrates that an immersive exergame enhances the motivation of young and elderly people to perform full-body exercise.

In this study, the participants experienced a significant increase in heart rate after gameplay.

Immersive systems can also provide a standardized situation for studying the perception-action coupling in complex motor tasks. The paper “Virtual reality as a tool for the study of perception-action: The case of running to catch fly balls,” by Frank T. J. M. Zaal and Reinoud J. Bootsma, evaluates the pros and cons of using virtual environments as a tool for research on perception and action, featuring the well-studied task of fly ball catching as an example. The authors briefly summarize the relevant research on fly ball catching, and identify some of the strengths and weaknesses of using VR in this context.

As a group, these papers clearly demonstrate the value of virtual environment implementations of complex task performance, both as a testbed for evaluating skill acquisition and as an aid in facilitating the transfer of these skills to real-world scenarios.

The guest editors—on behalf of all of the authors—gratefully acknowledge the constructive and extremely valuable comments made by the reviewers during the review process for this special issue.

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