Research Statement

Emanuele Ruffaldi

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Research Background

My research career started in the domain of virtual environments with focus on Haptic Rendering techniques. During the PhD I have investigated multi-rate haptic rendering techniques related to the manipulation of objects, spending a period as researcher in the BioRobotics laboratory of Stanford University with Prof. Salisbury and Prof. Barbagli. In 2007 I became Assistant Professor at PERCRO laboratory working in the area of multimodal feedback for skill learning and transfer addressing aspects of human-robot interaction, machine learning for human skill training and design of interaction modalities. This activity has been performed in the context of the European Project SKILLS in which I acted as Work Package leader managing one of the demonstrator resulting in the development and testing of the SPRINT system. The interest on human understanding and feedback continued and brought me to creating, in 2010, the Group Sensing, Modeling and Learning for Human inside PERCRO. with which I am investigating technologies and methods for human-system interaction spanning from human-robot interaction to interaction in virtual environments, as supported by European and Local grants.

Two related research lines are described below.

Training in Virtual Environments

The first area of interest is in the one of technologies and methods for human training using multimodal virtual environments. A specific contribution is the design and development of a rowing training platform that combines feedback design, biomechanical modeling, integrated sensing, skills modeling and machine learning. This research platform, called SPRINT and developed in the context of SKILLS project, has been tested in several settings (Israel at TECHNION with Prof. D. Gopher and France at University of Montpellier 1 with Prof. B. Bardy). This line of research has produced a number of publications (7 journal papers plus conference ones) and interdisciplinary contacts (invited talk at European Congress of Psychology 2015).

This research line has brought me to interest in machine learning based analysis of human action and the selection of the optimal feedback for training purposes. A recent unpublished result within my group is the use of Deep Learning techniques for the estimation of fatigue from gait as captured by Kinect sensors. This approach has been designed in particular for the RAMCIP assistive robot.

Mixed Reality for HRI

My interest in robotics has been focused on the adoption of Mixed Reality technologies for HRI both in situation of tele-presence and in co-presence. Co-location, visual augmentation and haptic interaction are integrated in a way to improve quality of interaction (e.g. 3DUI 2015, VRST 2015). In a recent work under review I have explored the role of different types of visual feedback for controlling a robot via tele-presence.

In the case of co-presence I have started to evaluate both the use of AR glasses (AVR 2016) and robotic spatial augmented reality in the form of a projector and camera combined to form the head of a service robot.

Future Directions

The above research lines can be found in the grant proposals that I have under review:

- Coordinator of FET Open proposal on investigation of Human-Robot embodiment with neuroscience methods (15th January 2017 call)
- Coordinator of a H2020 Personalized Medicine RIA on Virtual Coach for aging people with interaction design methods (31st January 2017 call)
- Partner of a Italian Ministry of Health proposal for AR/VR manipulation of cardiac models (July 2016 call)

In a longer term I am interested in exploring Mixed-Reality mediated Human Centered Robotics, that is the confluence of robotic systems and wearable technologies for providing more personalized and contextual interaction. This investigation involves aspects of cognitive robotics, human-robot interaction, virtual environments and machine learning.

Three long-term questions can be formulated

- How wearable technologies can convey information shared with a robotic system?
- How human mental models of tasks and teams change whether a teammate is human, or an advanced automated system?
- How computer modeling can lead to shared mental models being instantiated and used in robots?

This longer term goal can impact different areas of HRI and domains. In particular the domain of reconnaissance robotics and humanitarian robotics, but also, in general, the area of field robotics in which the interaction and orchestration with different robots requires prompt and precise interaction.