Closing the natural interaction loop with neuroscience-based robotics

In this talk, I will present an approach to social robotics that is based on objective methods of neuroscience in human-robot interaction research. I will provide an overview of studies in which we examined – with cognitive and social neuroscience methods – the human cognitive mechanisms evoked by interaction with humanoid robots. I will focus on the mechanisms of engagement, joint attention, attributions of intention and the methods of psychophysics, electroencephalography (EEG) and functional magnetic resonance (fMRI). Some of the studies have used "closed-loop" protocols, which feed into the robot behavioural, neural and physiological signals from the human, in order to induce bi-directional dynamical attunement. We would argue that "closing the loop" by using online human signals to improve the design; robot sensing capabilities and control of robot's functions will increase engagement between the interactive agents, and therefore the robots' social competence. Furthermore, such approach facilitates the transfer of findings from neuroscience to computational models, which can then be implemented on robot platforms in order to test whether the so-designed robots evoke social cognition processes in humans. Apart from fundamental research, our approach to social robotics allows for appropriate design of robot solutions for application purposes in healthcare and special needs areas. Here, of particular focus is augmenting humans with capabilities that have been impaired – for example through an EEG-based control of robotic exoskeletons, or through robot-assisted neuro-rehabilitation. Moreover, neuroscience-based closed-loop solutions that allow for inducing social engagement prove useful for training socially impaired individuals. In sum, we advocate that including neuroscience methods in research and application of robotics to societal needs has benefits over more traditional approaches.