Controlling Physical Human-Robot Interaction

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ABSTRACT

Rapid advances in social robotics, humanoids, autonomy and deep learning over the past decade suggest that robot assistants are within reach. However, robots are still unable to effectively collaborate with humans in everyday physical tasks. In this talk, I will describe our research on how to allow robots to physically interact with humans. An application that motivates this work are robot assistants for the elderly, where the robot needs to actively involve the human in Activities of Daily Living (ADLs). I will discuss challenges in obtaining measurements of physical interaction and introduce the ELDERLY-AT-HOME corpus of annotated human-human collaborative multimodal interactions; the corpus is instrumental for understanding how humans perform collaborative tasks and can be used for learning by demonstration. I will then highlight our results on human-robot collaborative manipulation and on robot-human handover, two tasks that frequently occur in ADLs. In both cases, the focus will be on how to control the robot to replicate and possibly improve on how a human helper acts during physical interaction. For collaborative manipulation, I will discuss how to compute the interaction force – thought to be responsible for coordination – and how this force can be used to quantify and in turn control the cooperation. For robot-human handover, I will introduce a novel model that explicitly includes a slipping mode; in turn, the model is used to design a robust controller that makes the handover smooth, yet safe.

Miloš Žefran completed his undergraduate studies in Electrical Engineering and Mathematics at the University of Ljubljana, Slovenia, where he also received a M.Sc. degree in Electrical Engineering. He received a M.Sc. degree in Mechanical Engineering and a Ph.D. degree in Computer and Information Science in 1995 and 1996, respectively, from the University of Pennsylvania. From 1997 to 1999 he was a NSF Postdoctoral Scholar at the California Institute of Technology. He then joined Rensselaer Polytechnic Institute. Since 1999 he has been with the Department of Electrical and Computer Engineering at the University of Illinois at Chicago where he is a Professor and the Director of Graduate Studies. In 2008 he was a visiting researcher at the University of Pisa. His research interests are in robotics and control with applications to human-robot interaction, cyber-physical systems, and robot networks. Dr. Žefran's research has been supported by a National Science Foundation (NSF) Career Award (2000) and a number of subsequent NSF awards. He has published over 100 journal and conference papers, and is the associate editor for the IEEE Transactions on Control Systems Technology.