Working with the New Robots

Oussama Khatib
Artificial Intelligence Laboratory
Department of Computer Science
Stanford University

Abstract

Exploring, working, and interacting with humans, the new generation of robots being developed will increasingly touch people and their lives, in homes and workplaces, in challenging field domains and new production systems. These emerging robots will provide support in services, health care, manufacturing, entertainment, education, assistance, and intervention. While full autonomy for the performance of advanced tasks in complex environments remains challenging, the simple intervention of a human would tremendously facilitate reliable real-time robot operations. Two basic modalities of haptically mediated interaction and direct physical contact are being conceived. Human-robot interaction greatly benefits from combining the experience and cognitive abilities of the human with the strength, dependability, competence, reach, and endurance of robots. Moving beyond conventional teleoperation, the new paradigm places the human at the highest level of task abstraction, relying on highly skilled robots with the requisite competence for advanced task behavior capabilities. The discussion focuses on robot design concepts, robot perception and control architectures, and task strategies that bring human modeling, motion, and skill understanding to the development of safe, easy to use, and competent robotic systems. The presentation will include live hands-on illustrative instance of human-robot interactions in various robotic applications. In particular, it will highlight interactions with a novel underwater robot, being developed jointly in collaboration between Stanford, Meka Robotics, and KAUST. The motivation for this robot is to help marine biologists to safely explore the Red Sea's fragile and previously inaccessible underwater environment. Live interactions will illustrate how bimanual haptic devices can be used to interact with the entire robot. A 3D graphic and haptic interface allows non-expert users to intuitively operate the robot while feeling contact forces when performing dexterous tasks. While the operator can fully focus on the robot's task, the robot controller autonomously handles constraints, multiple contacts, disturbances, obstacles, and robot posture, so that the robot task can be optimally performed in the deep sea. This robot illustrates the new emerging paradigm in other challenging areas of underwater robotics, such as archeology, inspection, and maintenance of pipelines and other structures. Connecting humans to increasingly competent robots will certainly fuel a wide range of new robotic applications in challenging environments.

Biography of Oussama Khatib

Oussama Khatib received his Doctorate degree in Electrical Engineering from Sup'Aero, Toulouse, France, in 1980. He is Professor of Computer Science at Stanford University. His work on advanced robotics focuses on methodologies and technologies in human-centered robotics including humanoid control architectures, human motion synthesis, interactive dynamic simulation, haptics, and human-friendly robot design. He is Co-Editor of the Springer Tracts in Advanced Robotics series, and has served on the Editorial Boards of several journals as well as the Chair or Co-Chair of numerous international conferences. He co-edited the Springer Handbook of Robotics, which received the PROSE Award. He is a Fellow of IEEE and has served as a Distinguished Lecturer. He is the President of the International Foundation of Robotics Research (IFRR). Professor Khatib is a recipient of the Japan Robot Association (JARA) Award in Research and Development. In 2010 he received the IEEE RAS Pioneer Award in Robotics and Automation for his fundamental pioneering contributions in robotics research, visionary leadership, and life-long commitment to the field. Professor Khatib received the 2013 IEEE RAS Distinguished Service Award in recognition of his vision and leadership for the Robotics and Automation Society, in establishing and sustaining conferences in robotics and related areas, publishing influential monographs and handbooks and training and mentoring the next generation of leaders in robotics education and research. In 2014, Professor Khatib received the 2014 IEEE RAS George Saridis Leadership Award in Robotics and Automation.