COMING OF AGE IN ROBOTICS

MAJA J MATARIĆ

University of Southern California, mataric@usc.edu, http://robotics.usc.edu/~maja

Happy 20th anniversary! I am happy to share this special milestone with the Zurich Artificial Intelligence Lab, because this year marks my own 20 years of being involved with AI and robotics as I started my graduate study at MIT in 1987. We can be proud to have come of age; we might even call ourselves adults, actual grownups. People say growing up is hard to do, because we now have to face some really hard problems.

My own growing up in AI and robotics has been a wonderful trip that has taken me from working on representation for behavior-based systems (where I met a memorable and memory-capable robot Toto), to exploring cooperative robot teams (where I worked with an unruly Nerd Herd and a series of less appealing but more robust 1st generation robots), to digging into the mechanisms for learning by imitation (where I started to collaborate with neuroscientists and psychophysicists, and experiment with not just robots but also people), to helping to develop ways to make humanoid robots move (where I enjoyed teaching Adonis how to dance).

As the Zurich AI Lab and I celebrate our 20th anniversary, the field of robotics has just celebrated its 50th anniversary and its own coming of age. Five decades into its development, the field is finally at the brink of entering our daily lives. While simple robot vacuum cleaners are already in over a million homes, robotics researchers are developing much more complex robots that will work with and for people in hospitals, elder care centers, schools, and homes. What happens when intelligent robots and people share an environment and goals? This question is at the heart of human-robot interaction (HRI), an interdisciplinary research endeavor that brings together engineering and social science, cognitive science, neuroscience, ethics, and health care and education. HRI is as much a study of people as it is of robots; it requires us to gain insight into a new and dynamically changing relationship between humans and intelligent machines.

My research work is now focused on *socially assistive robotics (SAR)*, whose challenge is to aid people through social interaction rather than through physical contact. SAR brings together HRI and assistive robotics, which has demonstrated successes in hands-on rehabilitation through the use of high-precision but low-autonomy and low-interactivity systems. Thus, SAR presents an entirely new set of challenges, as we strive to understand how robots can effectively and measurably help in the difficult processes of convalescence, rehabilitation, socialization, training, and education. Our research aims to develop a novel robot-assisted research paradigm with two goals: 1) to gain insight into human behavior and cognition; and 2) to develop technologies that elicit sustained productive goal-driven behavior as part of the diagnostic, therapeutic, or educational process. The physical *embodiment* of the robot is a critical means of eliciting the user's response. The properties of that embodiment, such as how the robot looks, behaves, and relates to its niche, all present open avenues for research.

Figure: Left: a stroke patient interacting with our socially assistive robot. Right: our child-sized humanoid robot interacting with a child.

Situated at the interplay of science and technology, SAR is aimed at impacting major societal challenges, focusing specifically on the growing ageing population, rising costs of medical care and education, and shortages of social programs for education and training of children and adults with disabilities. To aid people in need, robots will need to perform in both structured/controlled environments (hospitals, elder care facilities, and schools) and unstructured settings (homes, cities, roadways, rubble piles). They will need to remain engaging and effective over long time-periods: months in stroke rehabilitation, years in special education, or, potentially, life-long. This presents an entirely novel and compelling challenge for both robotics and AI.

Embarking on assistive robotics involves facing complex scientific and technological challenges in messy, noisy, and sensitive real-world domains that involve interactions with vulnerable users. Our research that has so far placed simple robots with stroke patients, cardiac patients, and children in special education classrooms has already demonstrated positive and promising results, and has pointed toward a plethora of fascinating research questions. The rich potential of SAR for gaining novel insights into human cognition and social behavior, and for improving human quality of life for populations where it most needs improving, represents one of the most exciting and uniquely compelling topics in the field of modern robotics. This is a great time to come of age and celebrate, then get to work!