"Soft Robotics" - the next generation of intelligent machines

Rolf Pfeifer

Abstract

Researchers from robotics and artificial intelligence increasingly agree that ideas from biology and self-organization can strongly benefit the design of autonomous robots. Biological organisms which are for the better part built from soft materials, have evolved to perform and survive in a world characterized by rapid changes, high uncertainty, indefinite richness, and limited availability of information. The term "Soft Robotics" designates a new generation of robots capable of functioning in the real world by capitalizing on "soft" designs at various levels: surface (skin), movement mechanisms (muscles, tendons), and interaction with other agents (smooth, friendly interaction). Industrial robots, in contrast, operate in highly controlled environments with no or very little uncertainty. By "outsourcing" functionality to morphological and material characteristics - e.g. to the elasticity of the muscle-tendon system - the distinction between control and controlled, which is at the heart of manufacturing and control theory, breaks down and entirely new concepts will be required. In this lecture I will argue that the next generation of intelligent machines – robots – will be of the “soft” kind and I will explore the theoretical and practical implications, whose importance can hardly be over-estimated. I will be showing many examples and case studies from biology and engineering. In particular I will be introducing the tendon-driven “soft” robot “Roboy” and conclude with some “lessons learned” and trends in robotics. Finally, I will present a vision of the future, the ROBOLOUNGE project.

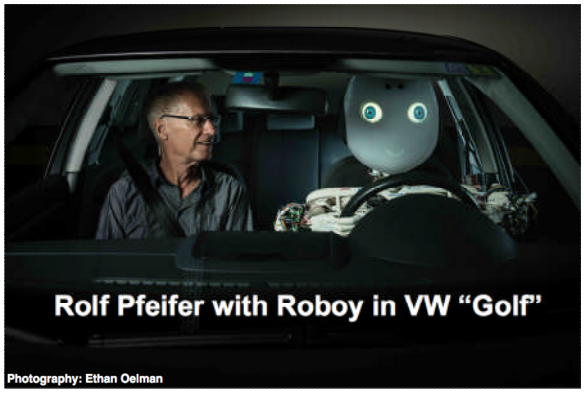
Short Bio

Rolf Pfeifer, Prof. em. University of Zurich, Switzerland, is currently a “Specially Appointed Professor” at the Institute for Academic Initiatives, Osaka University, Japan, and a visiting professor, at Shanghai Jiao Tong University, China. He is a member of the board of several Artifical Intelligence and Robotics companies and co-founder of the National Competence Center Robotics, Switzerland.

He has a master’s degree in physics and mathematics and a Ph.D. in computer science (1979) from the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. From 1987-2014 he was professor of computer science at the University of Zurich and director of the Artificial Intelligence Laboratory. He was a visiting professor and research fellow at the Free University of Brussels, the MIT Artificial Intelligence Laboratory in Cambridge, Mass. (US), the Neurosciences Institute (NSI) in San Diego, the Beijing Open Laboratory for Cognitive Science, the Ludwig-Maximilians-University, Munich, the University of São Paolo, Brasil, and the Sony Computer Science Laboratory in Paris. In 2004 he was elected "21st Century COE Professor, Information Science and Technology, Strategic Core" at the University of Tokyo. In 2009 he was a visiting professor at the Scuola Superiore Sant'Anna in Pisa, and at Shanghai Jiao Tong University in China and was appointed "Fellow of the School of Engineering" at the University of Tokyo.

He is a pioneer of the fields of “embodied intelligence” and “soft robotics” which are now rapidly gaining importance and have already had a decisive impact on the field of artificial intelligence and robotics. His book “How the body shapes the way we think” has been published in English, Japanese, Chinese, Arabic, and French. He developed the humanoid Roboy, which has attracted world-wide media attention, and he is currently pursuing the “Robolounge” project, where robots will take care of the well-being of the customers, to be launched in an Asian metropolis in 2016/2017.

Shanghai, 23 March 2015, Rolf Pfeifer


Rolf Pfeifer with Roboy in VW “Golf”
Photography: Ethan Oelman