Micron Scale Mobile Robotic

Abstract:
Miniature mobile robots have the unique capability of accessing to small spaces and scales directly. Due to their small size and small-scale physics and dynamics, they could be agile and portable, and could be inexpensive and in large numbers if they are mass-produced. Miniature robots would have potential future applications in health-care, mobile sensor networks, desktop micro-manufacturing, environmental monitoring, and inspection. In this presentation, miniature mobile robots with tens or hundreds of micrometer overall sizes and various locomotion capabilities are presented. Going down to tens or hundreds of micron scale robots, significant challenges are on-board actuation and power sources. Two alternative approaches are proposed in this talk to solve this challenge. First, external powering and actuation methods are used to move permanent magnet micro-robotic bodies using a stick-slip dynamics, spinning or rolling based surface locomotion on planar surfaces in air or in liquid in 2-D. Vision-based automatic control schemes can individually control single- or teams of micro-robots and these robots can manipulate and assemble micro-parts with or without contact in liquid. Controlled assembly and disassembly of such multiple magnetic micro-robots are also investigated and demonstrated towards reconfigurable micro-robotic systems in 2-D. As the next approach, a hybrid (biotic/abiotic) actuation principle is used to propel micron scale robotic bodies in liquid by harvesting the flagellar propulsion of attached bacteria and the chemical energy in the environment. Highly stochastic swimming locomotion of these S. marcescens bacteria attached micro-objects can be stopped and resumed repeatedly using chemical switching. Their 3-D motion can be steered using controlled chemical gradients in the liquid medium. Stochastic dynamics and control of such bacteria propelled micro-objects are demonstrated by simulations and experiments.

Short Bio:
Metin Sitti received the PhD degree in electrical engineering from University of Tokyo, Japan, in 1999. He was a research scientist at University of California at Berkeley during 1999-2002. He is currently a professor in the Department of Mechanical Engineering and Robotics Institute at Carnegie Mellon. His research interests include micro/nano-robotics, bio-inspired miniature robots and materials, and micro/nano-manipulation. He received the SPIE Nanoengineering Pioneer Award in 2011. He was nominated for the World Technology Award related to health care and medicine in 2009. He has been appointed as the Adamson Career Faculty Fellow in 2007. He received the National Science Foundation CAREER award in 2005. He was elected as the Distinguished Lecturer of the IEEE Robotics and Automation Socety for 2006-2008. He received the Best Paper Award in the IEEE/RSJ International Conference on Intelligent Robots and Systems in 2009 and 1998, the second prize in the World RoboCup Nanogram Demonstration League in 2010 and 2007, the Best Biomimetics Paper Award in the IEEE Robotics and Biomimetics Conference in 2004, and the Best Video Award in the IEEE Robotics and Automation Conference in 2002. He was the Vice President of the Technical Activities in the IEEE Nanotechnology Council for 2008-2010, and he is the co-editor-in-chief of Journal of Micro/Nano-Mechatronics and an associate editor for the IEEE Trans. on Robotics and ACS Applied Materials and Interfaces.