Electrical & Computer ENGINEERING

SEMINAR

Thursday
September 4, 2003
Scaife Hall Auditorium
4:00 p.m.
Refreshments - 3:30 p.m.

Metin Sitti, PhD
CMU Department of Mechanical Engineering and The Robotics Institute

Metin Sitti received the BSc and MSc degrees in electrical and electronics engineering from Bogazici University, Istanbul, Turkey, in 1992 and 1994 respectively, and the PhD degree in electrical engineering from the University of Tokyo, Tokyo, Japan, in 1999. He was a recipient of the Monbusho Research Fellowship from the Japanese Ministry of Education during his study in Japan. He was a research scientist and lecturer in the Department of Electrical Engineering and Computer Sciences, University of California at Berkeley during 1999-2002, working in micromechanical flying insects and gecko foot-hair nanostructures projects, and teaching the graduate level Micro/Nano-Robotics course. He is currently an assistant professor in the Mechanical Engineering Department and the Robotics Institute at the Carnegie Mellon University. His research interests include micro/nano-robotics, nano-manufacturing, MEMS/NEMS, bio- nanotechnology, and tele-robotics. He received the best paper award (1998) in the IEEE/RSJ International Conference on Intelligent Robots and Systems, and the best video award (2002), the best student paper nomination (2001), and the best paper nomination (2000) in the IEEE Robotics and Automation Conference. He is the chair of the Nanorobotics and Nanomanufacturing technical committee in the IEEE Nanotechnology Council.

For more information:
James Hoe, jhoe@ece.cmu.edu
http://amp.ece.cmu.edu/ECESeminar/

High Volume Micro/Nano-Manufacturing of Synthetic Gecko Foot-Fibers

Geckos can climb and run on wet or dry and molecularly smooth or very rough surfaces with very high maneuverability and power efficiency. They have compliant micro- and nanoscale high aspect-ratio beta-keratin hairs at their feet to adhere to any surface with a pressure controlled contact area. Being inspired from these hairs, this presentation will focus on manufacturing synthetic gecko foot-hairs as novel polymer dry adhesives.

Three fabrication techniques are proposed. The first approach is nanorobotic, and it uses atomic force microscope probes to indent soft surfaces precisely to manufacture molding templates.

The second approach uses self-organized nanopore membranes as the template. Both templates are molded with liquid polymers under vacuum, and, after curing, cured polymers are peeled off or templates are etched away. 1:300 aspect ratio (200nm diameter) and 1:2, 4, 9 aspect ratios (5, 2, 0.6 ?m diameters, respectively) silicone rubber (PDMS) and polyurethane micro- and nano-fibers are fabricated and characterized. Preliminary synthetic hair prototypes showed adhesion close to the predicted values for natural specimens (around 100nN each).

As the final method, a directed self-assembly manufacturing technique is proposed. Here, a thin liquid polymer film is coated on a flat conductive substrate, and a closely spaced another metal plate is used to apply a DC electric field on the polymer film. Then, regular micro/nano-pillars grow due to the instability of the liquid film. These pillars would be utilized as synthetic fibers.

By these techniques, large areas of different aspect ratio micro- and nanoscale hairs are manufactured at very low costs and high volume. As applications of these synthetic adhesives, at first, WaalBots which are revolutionary small space robots that exploit these adhesives for inspection and repair on spacecraft and orbiting facilities would be reported. Finally, endoscopic micro-capsule robots which can transmit high resolution real-time images of the digestive system using wireless communication and powering would be proposed. These capsules could be clamped and steered using synthetic fibers in such unstructured environments inside the body.