Nano World: Finger-sensitive sensor films

June 13 2006

Devices comparable in sensitivity to human fingers, enabled by a novel film embedded with nanoparticles, could offer the first step toward giving robotics hands the delicacy of the human touch, experts told UPI's Nano World.

Robotic hands with a delicate touch could help enhance the next generation of minimally invasive surgeries by enabling doctors to feel the presence of cancerous or abnormal tissue inside a patient's body. "This would allow a surgeon to, for example, find out right away if he or she has taken out all the bad tissue during a procedure, something a pathological test would take at least two days," said researcher Ravi Saraf, a chemical engineer at the University of Nebraska at Lincoln.

Current state of the art sensors for touch anywhere near the size of a fingertip -- say, a square centimeter large -- are sensitive enough only to detect features roughly two millimeters in diameter, while the human finger can detect features some 40 microns or millionths of a meter wide and two microns high. The sensor Saraf and his colleague Vivek Maheshwari manufactured after three years of research, a square inch in size, can now also detect features some 40 microns wide and five or so microns high.

The film, only 100 nanometers or billionths of a meter thick, is composed of alternating self-assembling layers of gold and semiconducting cadmium sulfide nanoparticles separated by insulating sheets of organic compounds. When a voltage is applied through the film, it converts force applied onto it to light.

This electroluminescent response is due to electrons tunneling from the gold nanoparticle layers through the insulating sheets in response to the applied force into the cadmium sulfide nanoparticle layers, which glow as a result. The nanometer sizes of the particles allow them to glimmer after only a few electrons pass through them. Saraf and Maheshwari reported their findings in the June 9 issue of the journal Science.

The researchers captured this light using a CCD image sensor, the same kind found in digital cameras. The film can produce images of a U.S. penny detailed enough to show the wrinkles of President Abraham Lincoln's clothing and the letters "TY" in "LIBERTY." "We did not expect the light intensity to be so large that it could be imaged on a CCD camera, because the light falling on each pixel of the CCD is from just few tens of nanoparticles," Saraf said.

"This could be quite worthwhile in robotics," said Richard Crowder, a robotics researcher from the University of Southampton in Britain. "The advantage it has is resolution. If applied in the right way, it could give us the kind of resolution you find in your fingertips."

The self-assembling nature of the films suggest they "can be made cheaply," Saraf said. Future touch sensors for robots based off the work of Saraf and his colleagues will likely not rely on light signals, but rather electrical impulses, he added.