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UTAH**ENGINEERING**

Inside

THE UNIVERSITY OF UTAH

Reshaping Electronics

ARTIFICIAL SIGHT AND FLEXIBLE ANTENNAS

LEFT: Glanluca Lazzi, Chair of Electrical and Computer Engineering
RIGHT: A flexible antenna (middle) and artificial retina antenna (bottom). Penny is for scale.

After he graduated 16 years ago with a Doctor of Engineering degree in electrical engineering at the University of Rome in La Sapienza, Gianluca Lazzi attended a conference in Italy that changed the course of his career. There he met Professor Om Gandhi from the Department of Electrical and Computer Engineering, who offered Lazzi an opportunity to come to America and work in his lab as a research associate at the University of Utah. Lazzi agreed, but eventually decided to stay to finish a PhD even though he already had a doctoral degree. At the U, he met his wife who was also studying electrical engineering. He then worked briefly as an assistant research professor.

Eventually, Lazzi went on to North Carolina State University, where he was a professor of electrical and computer engineering, for several years before being recruited back to the U last fall as the newly appointed chair of the ECE Department.

"It's remarkable what Utah has been doing in the past few years in terms of recruiting top faculty and students," he says. "We want the U to be recognized among the best on a national and international level. One of our main tasks is to be known for our scholarship. If we have recognition for having some of the finest faculty and the finest research, we can attract the finest students." >>

The flexible antenna can bend, twist or stretch and still return to its original shape. The antenna consists of a liquid metal alloy injected into thin microchannel tubes housed inside a stretchy silicone-based polymer.

Lazzi says the antenna may also be used one day in the artificial retina to wirelessly transmit images from the camera to the device.

An Artificial Retina for the Blind

In addition to his new appointment, Lazzi has been gaining national recognition for his research. Lazzi is part of a team developing an artificial retina device to treat age-related macular degeneration and inherited retinal disorders such as retinitis pigmentosa. Currently in the second phase of clinical trials, the device was recognized as the top technology innovation of 2009 by R&D Magazine.

A patient wears a pair of glasses fitted with a small video camera. The video signal from the camera is sent through a processor that digitizes the image and relays it to an implant on the eye, which in turn communicates with an electrode array attached to the retina. The electrodes send signals to the brain that allow sight.

"Right now, there are only 60 electrodes on the array, which gives the patient only rudimentary vision," he says. "Our goal is to eventually get to 1,000 electrodes, which studies show is necessary for facial recognition."

Because the device is wireless, it may be susceptible to overheating. Lazzi is working on thermal issues to predict what metals work best without overheating and how to limit radiation. He also looks at placement of the array to better mimic the photoreceptors in the eye, so the patient can get the best visual perception.

Lazzi began working on this project while at NC State. Developers of the artificial vision system include five national labs, four universities and several groups in private industry.

Stretchable, Bendable Antennas

Another of Lazzi's projects is a flexible antenna made from liquid metal. The quest for such an antenna began last summer when Lazzi was approached by a chemical engineering colleague at NC State about a liquid metal he had created. The metal alloy is liquid at room temperature, but unlike mercury that beads up, the alloy is spreadable. It is also nontoxic and reacts with oxygen to form a skin that won't leak.

Lazzi decided that the metal's properties may work in flexible antennas. He injected the alloy into thin microchannel tubes inside a silicone-based polymer to create an antenna that could stretch, bend, or twist but still go back to its original shape.

"We found that the material works just as well as any other antenna metal," he says. "And the alloy will conform to any surface. By stretching it, it can be tuned to any frequency without danger of leaking."

Lazzi says the flexible, tunable antenna could be used in a variety of applications, such as flexible electronics, military equipment that can be rolled up and easily transported, or as sensors to monitor structural integrity in bridges or other building structures.

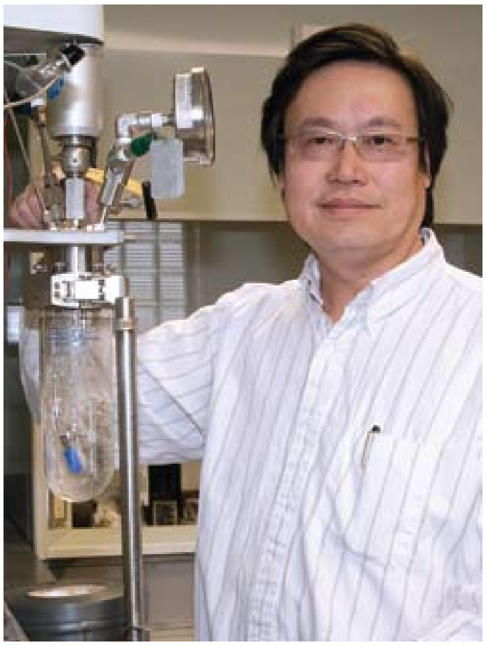
The antenna might also be used in the artificial retina, where the electrode array would receive wireless signals from the camera.

"The antenna could definitely have biomedical applications," says Lazzi. "It could be implantable. Anywhere you might need an antenna, this device could go."

Tiny Bubbles Target Oil

NEW METHOD CLEANS OIL SHEEN, OTHER POLLUTANTS FROM WATER

By Lee J. Siegel



LEFT: Andy Hong used a chemical reactor to develop and test a new method for removing pollutants such as oil sheen from water.

RIGHT: Microbubbles in a chemical reactor are crucial to a new method for cleaning up oil sheen and other pollutants. Microscopic bubbles are more effective than larger bubbles at removing oil.

Small amounts of oil leave a fluorescent sheen on polluted water. Oil sheen is hard to remove, even when the water is aerated with ozone or filtered through sand. Now, Andy Hong, professor of civil and environmental engineering at the University of Utah, has developed an inexpensive new method to remove oil sheen by repeatedly pressurizing and depressurizing ozone gas, creating microscopic bubbles that attack the oil so it can be removed by sand filters.

"We are not trying to treat the entire oil content in the water—to turn it into carbon dioxide and water—but we are converting it into a form that can be retained by sand filtration, which is a conventional and economical process," says Hong.

In laboratory experiments, Hong demonstrated that pressure-assisted ozonation and sand filtration effectively removes oil droplets dispersed in water, indicating it could be used to prevent oil sheen from wastewater discharged into coastal waters. The method also could be used to clean a variety of pollutants in water and even soil, including "produced water" from oil and gas drilling sites on land, water from mining of tar sands and oil shale, groundwater contaminated by the gasoline additive MTBE, and wastewater polluted with medications, among others.

Hong's method uses two existing technologies—ozone aeration and sand filtration—and adds a big change to the former. Instead of just bubbling ozone through polluted water, Hong uses repeated cycles of pressurization of ozone and dirty water so the ozone saturates the water, followed by depressurization so the ozone expands into numerous microbubbles in the polluted water, similar to the way a carbonated beverage foams and overflows if opened quickly.

The tiny bubbles provide much more surface area—compared to larger bubbles from normal ozone aeration—for the oxygen in ozone to react chemically with oil. Pollutants tend to accumulate on the bubbles because they are not very water-soluble. The ozone in the bubble attacks certain pollutants because it is a strong oxidant.

The reactions convert most of the dispersed oil droplets into acids and chemicals known as aldehydes and ketones that, in turn, help the remaining oil droplets clump together so they can be removed by conventional sand filtration.

Hong conducted his experiments using a tabletop chemical reactor. He found oily water was cleaned most effectively by pressurizing and depressurizing it with ozone gas 10 times, then filtering it through sand, then putting the water through 20 more pressurized ozone cycles, and then filtering it again through sand. The procedure removed 99 percent of the turbidity—leaving the water almost as clear as drinking water—and removed 83 percent of the oil, converting the rest to dissolved organic acids removable by biodegradation. With success in the laboratory, Hong now plans for larger-scale pilot tests. "It is economical and it can be scaled up," he says.

Lee J. Siegel, *science news specialist, University of Utah Public Relations*

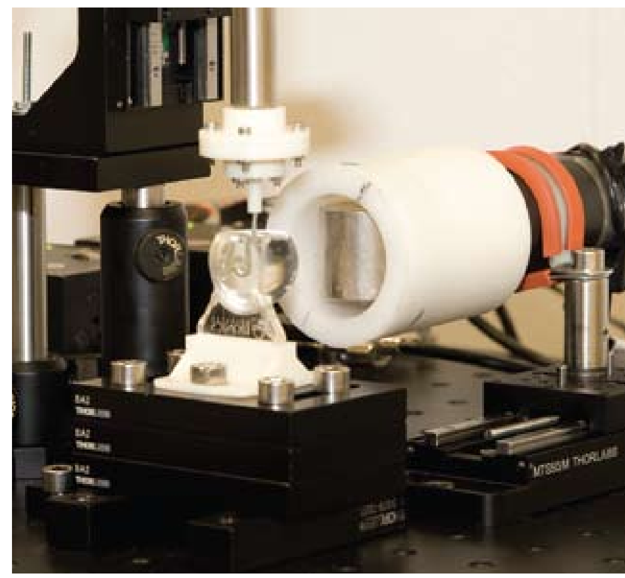
Robotics in Medicine

Little robotic tools may be the future of medicine. Tiny bots, called "microrobots," have the potential to make surgery and cancer therapies much less invasive. These wireless devices may one day provide better access to remote areas of the body, such as inside the brain or heart, through insertion with just the poke of a needle.

LEFT: Jake Abbott, assistant professor of mechanical engineering

BELOW: A prototype robotic cochlear-implant (CI) insertion system. One stage inserts the CI into a life-size phantom cochlea, while another stage rotates the magnet that steers the CI into place.

Jake Abbott, assistant professor of mechanical engineering, is developing various microrobots that are controlled and moved by magnetic fields. He is designing models of external magnetic fields that wirelessly power and remotely navigate the microrobot inside the body. Abbott is director of the Telerobotics Lab at the University of Utah.

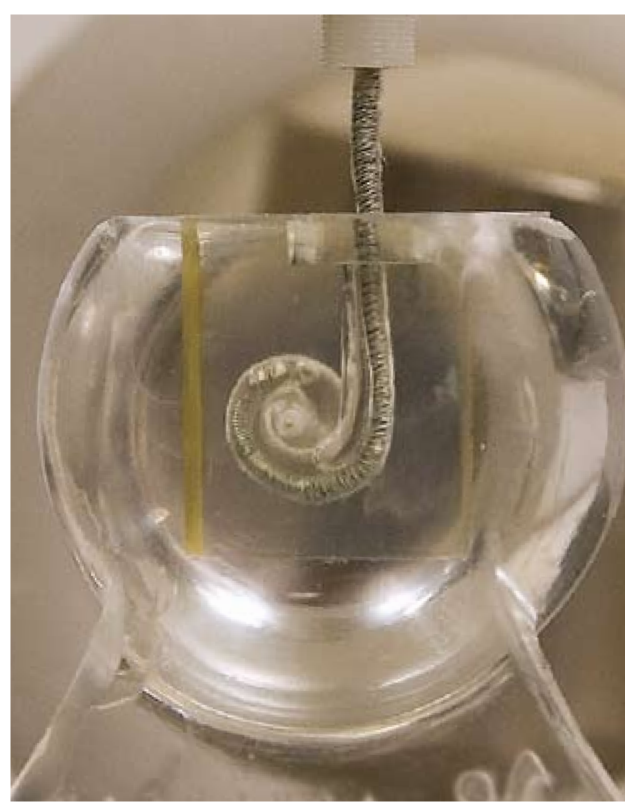


One type of microrobot is a tiny wireless device less than a millimeter in size. It is intended for small organs, such as the eye or prostate, and is remotely propelled by magnetic fields that steer the free-floating device through delicate structures to the problem area. For example, the device might be inserted into an eye through a small needle and magnetically moved to a blood clot at the back of the eye.

"The microrobot would carry a clot-busting drug to break up the clot and then be removed without the need for a suture," says Abbott. "That is truly minimally invasive."

Abbott is also making tethered microrobots consisting of a long, thin wire for other medical uses, such as heart ablations. The wire would be snaked into the body through a small catheter and then be deployed and guided magnetically. The end of the wire may have a set of microforceps (or "grippers") or an electrode array, depending on the medical procedure.

"The tools could clean arteries or remove kidney stones," says Abbott. "The electrodes could be used to measure electrical signals deep in the brain, or in cochlear implants to stimulate hearing."



ABOVE: Close-up of cochlea model

Abbott is now building a prototype of a cochlear implant (an electronic device that stimulates hearing). The device is surgically inserted into the inner ear as it is magnetically guided into place inside the cochlea. An electrode array running along the length of the implant stimulates the nerves to provide hearing to a person who is deaf. "This is a novel, minimally invasive way to implant cochlear devices unlike anything that has ever existed," he says.

Microrobots may also deliver targeted drug therapies to the precise area where a cancer growth is, and they may even be used to diagnose disease by taking measurements inside organs. "For decades we have been imagining the day when we could perform minimally invasive medical procedures from inside the body," he says. "We're actually getting there."

ELECTED A FELLOW OF AICHE

Professor JoAnn Lighty, chair of the Department of Chemical Engineering, has been elected a fellow of the American Institute of Chemical Engineers, the world's leading organization for chemical engineering professionals. One of nine fellows recently elected, Lighty was nominated by Presidential Professor Jost Wendt, who is also an AIChE fellow. Lighty was recognized for her outstanding professional accomplishments and contributions as a senior member of chemical engineering.

NSF CAREER AWARD

Suresh Venkatasubramanian, assistant professor in the School of Computing, was recently honored with a National Science Foundation CAREER Award in computational geometry for $486,000. Venkatasubramanian will use the grant to develop a systematic, global algorithmic framework for manipulating concrete geometric notions. The framework will provide the foundation for efficient and accurate data analysis of spaces of distributions and lead to deeper insights into analysis problems across a wide range of applications.

INTERNATIONAL COMMISSION FOR OPTICS 2009 PRIZE

USTAR Assistant Professor Rajesh Menon in the Department of Electrical and Computer Engineering was recently awarded the 2009 prize from the International Commission for Optics. The honor was for his achievements in nanolithography, particularly "for his invention and development of the absorbance modulation method for a wider range of nanophotonic applications."

University of Utah
RANKS AS WORLD-CLASS

The University of Utah has landed a ranking of 80 on the 2009 Academic Ranking of World Universities, compiled by the Center for World-Class Universities of Shanghai Jiao Tong University. Among other programs ranked at the U, computer science and engineering/technology placed in the top 100. Since the ARWU was first released in June 2003, the University of Utah has been named among the top 100 offering one of the best educational values by a public institution in the country.

Scholarship Drive a Success

Faced with tuition increases and an uncertain economy, engineering students will have a new source of help and encouragement this year. Thanks to an overwhelming response from alumni and industry friends to the special matching scholarship campaign, students will benefit from an additional $94,000 in scholarship donations this year. A grant from the state provided $68,000 for engineering scholarships. The College challenged alumni to match the funds with donations of $1,000 or more. So far, 51 alumni and industry friends responded to the appeal and will be recognized among the named scholarships available in the college and departments.

Students are encouraged to apply at both the college and individual departments. They will have the opportunity to meet and thank their scholarship donors at the awards banquet in the fall. Most important, students will get the message that the engineering community cares enough to reach out to help them at this difficult time.

In addition to the special matching campaign, engineering donors contributed more than $533,000 in new scholarship dollars in 2009, including several extraordinary gifts from individuals like Bob and Mary Jane Engman, among others. We are profoundly grateful for such support. *A limited number of matching dollars is still available. Contact Marilyn Davies at 801-581-7194 for more information, or email mdavies@coe.utah.edu.*

Many thanks to the following donors who responded to the matching scholarship campaign.

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ELECTRICAL AND COMPUTER ENGINEERING PROJECT

FROM LEFT: ECE research engineer Bryan Stenquist; seniors Logan Rawl Tsinigine, Donald Mackay, Talmage Daley, Lichung Chu, and Steve Olsen; and Professor Faisal Khan

Households may one day power their own homes, at least in part. A group of electrical and computer engineering students working on their senior project was tapped by Rocky Mountain Power to design a wind generator-solar panel system that integrates both utility power and renewable energy sources. The system produces about as much power as a typical household uses, and monitors the flow of power to and from the grid.

"The unique thing is they're designing software to monitor the power flowing in and out of the power-generating

Lifetime
ACHIEVEMENT AWARD

Mark Fuller, who graduated with a B.S. degree in Civil Engineering, was recently awarded a lifetime achievement award from the Themed Entertainment Association. Fuller is CEO and chair of WET (Water Entertainment Technologies) Design, the Los Angeles-based world leader in water feature design and technology. Fuller's firm has pioneered advances in the design and engineering of water features, holding more than 50 patents on water control, lighting and air compression devices, and laminar stream technology.

His career in creating special water effects began with his University of Utah honors undergraduate thesis on axisymmetric laminar fluid flow and its application in architectural-scale water features. After getting a master's degree in engineering and project design at Stanford University, Fuller worked in the special effects department of the Walt Disney Company for six years supervising the creation of more than 500 special effects and water projects for the Disney Parks. When he left Disney in 1984, Fuller co-founded WET Design. His firm's work can be seen all over the world, including the Fountains of Bellagio in Las Vegas and the Dubai Fountain in the United Arab Emirates. Some of his Salt Lake City projects include the cauldron for the 2002 Winter Olympic Games and the Olympic Snowflake Fountain at the Gateway. WET Design is currently working with Salt Lake City to develop fountains for the new City Creek Center.

Designing Seniors Devise Energy Innovation

units and the grid," says Assistant Professor Faisal Khan, faculty advisor to the group. "Therefore, this project would present the various components of the Smart Grid and explain how it works."

The power company wants to avoid operating expensive, inefficient "peak" plants during times of high demand. The hope is that this project will pave the way for consumers to generate part of their own power, reduce consumption, and sell unused power back to the grid to other consumers. "This is a win-win situation for both the consumer and the utility company," says Khan. "Demand continues to increase over time, so supplementary clean sources of renewable energy are needed."

The project also aims to demonstrate how the Automated Demand Response operation works—where consumers respond to dynamic pricing of electricity by managing consumption so they can avoid the penalty for using electricity during peak events.

Corporate sponsors use student talent "because in many cases there is a clear engineering need that our groups can fill," says Associate Professor Steven Blair, director of the engineering clinic program that matches seniors to corporate-sponsored projects. "Many sponsors are short-handed, and they find this to be an economical way to solve problems that are important to them while investing in engineering's future, increasing their own visibility, and recruiting new graduates."

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STUDENT LIFE

Engineering AN ALL-AMERICAN

As he prepares for the upcoming NFL draft in April, football player and mechanical engineering student Zane Beadles is grateful for his association with the University of Utah.

Beadles, who graduated from the U of U in December, has had an illustrious football career already. During his four-year college career as a starting offensive tackle, Beadles was a three-time all-Mountain West Conference selection. In his senior year he won 675 of his 770 total plays, and had 24 cuts and 13 pancake blocks. He was also part of a team that went undefeated in 2008 and won a conference championship, as well as the 2009 Sugar Bowl—a Bowl Championship Series (BCS) game. Plus, he won a host of postseason honors this year, including first-team Football Writers Association of America All-American, first-team College Football News All-American, and first-team Phil Steele All-American. In his junior year the NFL expressed interest in Beadles, but he decided that graduating was more important.

At an early age, Beadles wanted to study mechanical engineering. He had been watching a Discovery Channel program about military weapons of the future and one of the experts was a mechanical engineer. "I got it in my head that that's what I wanted to do," he says. "I came to the U with a football scholarship and knew the university had an outstanding mechanical engineering program, so it was a great fit for me."

One of his more memorable projects as a student involved building a robot from scratch. His team's robot competed against others' in his mechatronics class on a racing course, where robots had to detect and pick up objects and return them to home base. Beadles' team (pictured) beat most of the others, placing in the top eight among 35 teams in the class.

Another important experience was his senior design project that involved designing an inexpensive residential wheel chair lift that could be built with readily available materials.

"It's a continuation of a project that had been started a year before and is geared for flood-prone, low-income areas like New Orleans," says Beadles. "We want to get our design to volunteer organizations, so they can get parts from local retailers and build lifts in the communities that need them."

FROM LEFT: Mechanical engineering students Matt Ehlert, Charles Alvey, Zane Beadles, and Dan Hirst

Whatever happens in April, Beadles knows his future is bright. "If football doesn't work out, I've got a great future in the mechanical engineering field," he says. "I am very interested in earning a graduate degree but that is on hold for now. It depends on what happens with my playing career and how long that lasts. Then I can focus on continuing my education or working as an engineer."