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Life Sciences

Special Report

A roundup of IEEE's activities in this growing area

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REGION NEWS

REGION 1 NORTHEASTERN UNITED STATES

■ **New York Section** forms IEEE Systems, Man, and Cybernetics Society chapter.

REGION 3 SOUTHEASTERN UNITED STATES

■ Student branch formed at **Valencia College, Orlando, Fla.**

■ Student branch at **Florida Institute of Technology, Melbourne,** forms IEEE Aerospace and Electronic Systems Society chapter.

REGION 5 SOUTHWESTERN UNITED STATES

■ Student branch at **University of Texas, Dallas,** forms IEEE Engineering in Medicine and Biology Society chapter.

REGION 6 WESTERN UNITED STATES

■ **Coastal Los Angeles Section** forms IEEE Electromagnetic Compatibility Society chapter.

■ **Metropolitan Los Angeles Section** forms IEEE Industry Applications Society chapter.

REGION 7 CANADA

■ **Quebec Section** forms IEEE Graduates of the Last Decade affinity group.

REGION 8 EUROPE, MIDDLE EAST, AND AFRICA

■ **United Arab Emirates Section** forms IEEE Education Society chapter.

■ Student branch formed at **Abu Dhabi University, United Arab Emirates.**

■ Student branch formed at **Akanu Ibiam Federal Polytechnic, Unwana, Nigeria.**

■ **Benelux Section** forms IEEE Robotics and Automation Society chapter.

■ Student branch at **University of Split, Croatia,** forms IEEE Computer Society chapter.

■ Student branch formed at **Pamukkale University, Denizli, Turkey.**

■ Student branch formed at **University of Ioannina, Greece.**

■ Student branch at **University of Central Greece, Lamia,** forms IEEE Women in Engineering (WIE) affinity group.

■ Student branch at **Université Mentouri Constantine, Algeria,** forms IEEE Magnetics Society chapter.

■ Student branch formed at **ISCTE University Institute of Lisbon.**

■ Student branch formed at **Suez Canal University, Ismailia, Egypt.**

■ Student branch at **University of Manchester, England,** forms IEEE Electron Devices Society chapter.

■ **Jordan Section** forms IEEE Robotics and Automation Society chapter.

■ The **National School of Engineers of Sfax, in Tunisia,** forms IEEE Council on Electronic Design Automation chapter.

REGION 9 LATIN AMERICA

■ **Student branch** formed at **Instituto Tecnológico de León, Mexico.**

■ Student branch at **Instituto Tecnológico y de Estudios Superiores de Occidente, Guadalajara, Mexico,** forms IEEE Robotics and Automation Society chapter.

■ Student branch formed at **Universidad Adolfo Ibáñez, Peñalolén, Chile.**

■ Student branch at **Universidade Estadual de Campinas, Brazil,** forms IEEE Computational Intelligence Society chapter.

■ **Rio de Janeiro Section** forms WIE affinity group.

■ Student branch at **Universidad de San Buenaventura Cali, Colombia,** forms IEEE Engineering in Medicine and Biology Society chapter.

■ Student branch formed at **Universidad Don Bosco, San Salvador.**

■ Student branch at **Universidad Nacional del Callao, Bellavista, Peru,** forms WIE affinity group.

REGION 10 ASIA AND PACIFIC

■ Student branches formed in India at **IES College of Technology, MLR Institute of Technology, Sai Vidya Institute of Technology, Annamacharya Institute of Technology and Science, Laqshya Institute of Technology and Sciences, Sri Venkatesa Perumal College of Engineering and Technology, Velammal Institute of Technology, Surya School of Engineering and Technology, Sri Aurobindo Institute of Technology,** and **Atmiya Institute of Technology and Science.**

■ Student branches in India at **GMR Institute of Technology, Rajam,** and **St. Xavier's Catholic College of Engineering, Tamil Nadu,** form IEEE Education Society chapters.

■ Student branches in India at **MVGR College of Engineering, Vizianagaram,** and **Thiagarajar College of Engineering, Madurai,** form IEEE Computer Society chapters.

■ Student branches in India at **MEA Engineering College, Perinthalmanna,** and **Knowledge Institute of Technology, Kakapalayam,** form WIE affinity groups.

■ Student branch at **GITAM University, Visakhapatnam, India,** forms IEEE Computational Intelligence Society chapter.

■ Student branch formed at **Bina Nusantara University, Jakarta, Indonesia.**

■ Student branch formed at **Rachna College of Engineering and Technology, Gujranwala, Pakistan.**

SEND US YOUR NEWS

We publish announcements of new groups once they've been approved by IEEE Member and Geographic Activities. To send us local news, like student branch events and competitions, WIE or preuniversity outreach efforts, or other IEEE group activities, use our form on the Region News page at http://theinstitute.ieee.org/region-news.

COVER: SCIENCE PHOTO LIBRARY/GETTY IMAGES; THIS PAGE: ISTOCKPHOTO

Online

Available 7 December at theinstitute.ieee.org

SOCIETY SPOTLIGHTS
Three of the IEEE societies involved with life sciences

ACHIEVEMENTS
IEEE members are recognized for their work by other organizations

NEWS

IEEE to Launch Eight Journals

SEVERAL IEEE societies plan to add to their growing list of publications.

The IEEE Education Society is set to publish *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, a Spanish translation of its *IEEE Latin-American Learning Technologies Journal*, a quarterly that covers engineering education tools, methods, and materials.

IEEE Journal of the Electron Devices Society will be available online only. The open-access monthly will publish papers on the theory, modeling, design, performance, and reliability of electron- and ion-integrated semiconductors, quantum-effect structures, vacuum devices, and more.

Another open-access journal, *IEEE Transactions on Emerging Topics in Computing*, will focus on new aspects of computer science, technology, and computing applications not currently covered by other IEEE Computer Society transactions. It will be published twice per year.

The quarterly *IEEE Journal of Emerging and Selected Topics in Power Electronics* will keep readers up to date on technologies for power converters and drives, local grid connections, cogeneration, and solid-state energy conversion. The IEEE Power Electronics and IEEE Industry Applications societies are cosponsoring the journal.

IEEE Geoscience and Remote Sensing Magazine, another quarterly, will cover international developments in the field, new satellite missions, and educational activities. The IEEE Geoscience and Remote Sensing Society is sponsoring the journal.

Can't get enough of the cloud? *IEEE Transactions on Cloud Computing* will feature articles on innovative research and applications, performance analyses, and more. To be published twice a year, the journal is sponsored by the IEEE Computer, Communications, Consumer Electronics, and Power & Energy societies, along with the IEEE Systems Council.

China Communications Magazine, to be published monthly in English by the IEEE Communications Society, will cover communications theory and techniques, systems, networks, regulatory policies, standards, and more.

IEEE Journal of Translational Engineering in Health and Medicine is designed to bridge the gap between engineering and clinical medicine. Published quarterly by the IEEE Engineering in Medicine and Biology Society, the open-access journal will cover a wide range of biomedical topics, including medical devices, health care delivery systems, global health care initiatives, and health care management technology.

—Amanda Davis

IEEE Spectrum Unveils Robot App

ROBOT ENTHUSIASTS rejoice: the *IEEE Spectrum* Robots for iPad app is now available from the Apple iTunes store. At US $4.99, the app features videos of 126 robots from around the world, 360-degree photos, descriptions, technical specs, and more. The app works on all generations of the iPad.

The app is the brainchild of Erico Guizzo, a senior associate editor of *IEEE Spectrum*, who is also editor of Automaton, the magazine's robotics blog, and *Spectrum's* photo and multimedia editor, Randi Klett.

Different types of bots are in the mix, including humanoids, toys, and those used in health care, research, and space. *—A.D.*

CALENDAR

December

4 1913: Birth date of **Robert Adler,** who pioneered the development of the TV remote control.

13 1994: **First meeting of the World Wide Web Consortium**, founded to promote common protocols on the Web, takes place at MIT.

22 1905: Birth date of **Thomas Harold Flowers**, designer of Colossus, the world's first programmable electronic computer, used by British code breakers to help decipher encrypted German messages during World War II.

25 1969: Seiko, a manufacturer of electronics in Tokyo, introduces its Quartz-Astron 35SQ—the **first quartz wristwatch sold to the public**.

22 1984: Apple Computer advertises its first **Macintosh**.

25–27 **Region 4 Meeting in Chicago.**

28 1886: Birth date of **Hidetsugu Yagi**, codeveloper of the directional shortwave antenna.

January

8 1918: U.S. president Woodrow Wilson's **"14 Points" address to Congress is transmitted to Europe** via the Marconi wireless station in New Brunswick, N.J.

20 1775: Birth date of **André-Marie Ampère**, pioneer of electromagnetism, for whom the SI unit of electric current is named.

February

2 1897: Birth date of **Gertrude Blanch**, a mathematician who made major advances in numerical analysis.

5 1952: New York City installs the first electric **Walk/Don't Walk** sign, in Manhattan.

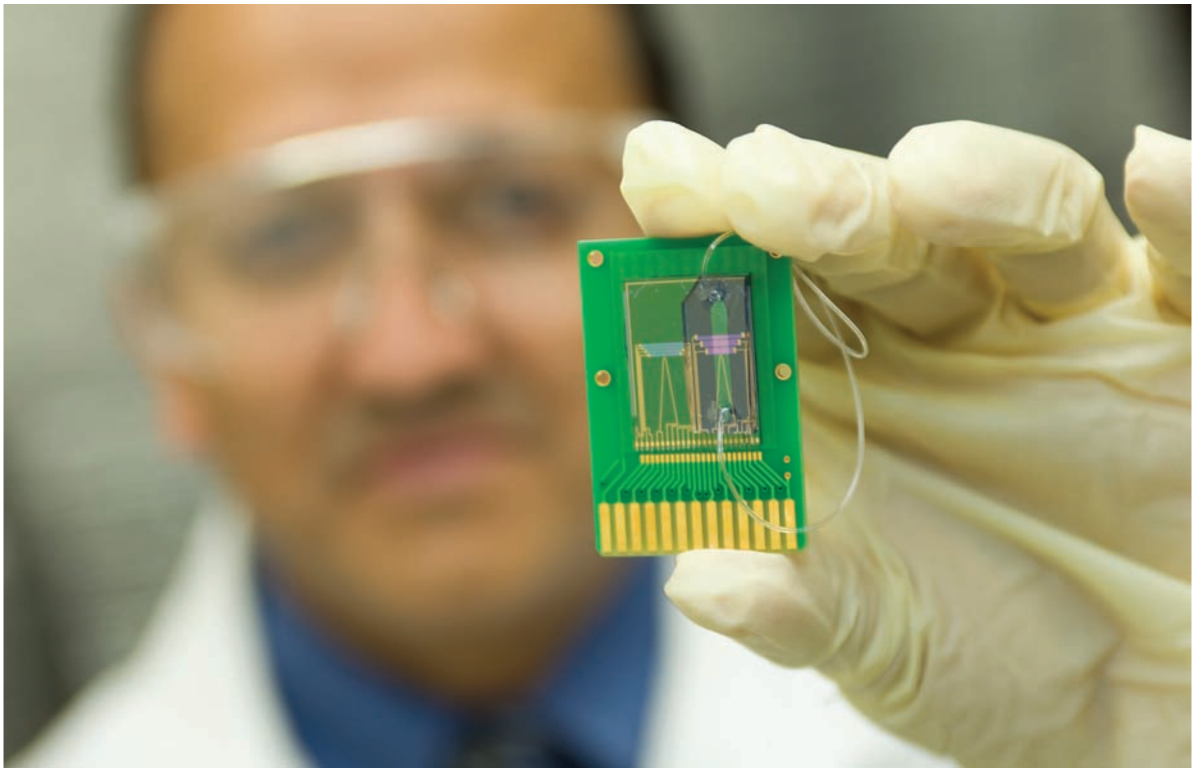
10 1902: Birth date of **Walter Houser Brattain**, coinventor of the transistor.

13–18 **IEEE Meeting Series in Austin, Texas.**

17 1907: Donald J. Bell and Albert S. Howell form **Bell & Howell Co.**, which became a leader in film projectors, cameras, and optical equipment, in Wheeling, Ill.

Historical events provided by the IEEE History Center. IEEE events indicated in red.

CLOCKWISE FROM LEFT: ZENITH ELECTRONICS/AP PHOTO; SHEILA TERRY/PHOTO RESEARCHERS; MACIEJ MAKSYMOWICZ/ISTOCKPHOTO; BETTMANN/CORBIS/AP PHOTO; GEORGE ROSE/GETTY IMAGES; BETTMANN/CORBIS/AP PHOTO; BRIDGET COLLINS



TECH TOPIC: LIFE SCIENCES

Engineering Meets Biology

Advances in nanobiotechnology and surgical robots

BY **KATHY PRETZ**

FEW PEOPLE ARE aware of what a major player IEEE is in the field of life sciences, not least because its activities are scattered across 29 of the organization's societies, technical councils, and committees. The life sciences encompass nanobiotechnology, genomics, health informatics, and surgical robots, as well as ways to improve health care and lower medical costs.

To raise awareness of its involvement, the IEEE Board of Directors last year established the Life Sciences New Initiative (LSNI) project. With the help of the LSNI committee, this special life sciences issue of *The Institute* showcases IEEE's offerings, describes what a career in life sciences could be like, and spotlights the work of several leaders in the field.

IEEE and its members have contributed to the field with new applications, standards for medical device communications, conferences, periodicals, and books.

IEEE Fellows Rashid Bashir and Guang-Zhong Yang [see "The Next Generation," p. 6] spoke with *The Institute* about their work in nanobiotechnology, which uses microscopic materials and devices to study and solve large biological and medical problems, and surgical robots. They were speakers at the IEEE Life Sciences Grand Challenges Conference, held in October in Washington, D.C.

Bashir, a professor of electrical and computer and bioengineering at the University of Illinois at Urbana-Champaign (UIUC), is director of the university's Micro and Nanotechnology Lab, a campus facility for nanofabrication and nanobiotechnology. Yang is director and cofounder of the Hamlyn Centre for Robotic Surgery and deputy chairman of the Institute of Global Health Innovation, both at Imperial College London.

SMALL SENSORS, BIG WORK

Bashir is an expert in applying micro- and nanotechnology to biotechnology and medicine. He and his team of researchers in Illinois are using nanobiotechnology to develop chip-based sensors (such as the one pictured above, held by Bashir) that can detect molecules related to cancer earlier than traditional methods can. Cancer mortality rates can be reduced if cases are detected and treated early.

Lab-on-chip sensors could allow doctors to detect small concentrations of a cancer biomarker—in some cases with just a few molecules—right in their offices, in patients' homes, or in remote villages. Known as point-of-care (POC) diagnostic devices, the sensors make do with small samples of tissue or blood, so procedures are less invasive.

Bashir is working on POC devices for cancer detection, which can be advanced by developing new label-free sensing components—based on a silicon field-effect sensor, the same device used in computer memory chips. Actually, the nanobiosensors are built around silicon nanowire FETs that can detect microRNA, short strands of ribonucleic acid molecules.

Promoting interference with the right RNA plays an important role in defending cells against cancer. MicroRNAs bind to messenger RNAs, causing repression of undesirable proteins, gene silencing, and expression of proteins that are typically altered in several forms of cancer.

"The expression of microRNA at various stages has become important in cancer detection and for monitoring the state of the disease," Bashir says. "Previous research has shown a difference in the expression of microRNA molecules in cancer cells and even in blood serum samples from cancer patients."

Bashir's devices would detect those microRNA molecules in intracellular products from small biopsy samples.

Bringing the testing closer to the patient also eliminates the time and cost of visiting a laboratory. Such devices would not completely replace a lab, Bashir says, but they would make accurate testing faster and cheaper and could revolutionize cancer treatment.

SENSING CELL GROWTH

Bashir's group is also at work on a related project involving a different type of microsensor. It determines the relationship between a cell's mass and growth rate. For nearly 50 years biologists have been studying whether cells grow at a fixed rate or whether growth accelerates as mass increases.

The researchers developed a unique array of microelectromechanical (MEM) resonant mass sensors suspended on the platform of a chip. The tiny weighing scales consist of platforms that are 50 micrometers wide, about half the diameter of a human hair. They were able to culture cancer

RASHID BASHIR/UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN cells on the chip—similar to the way scientists grow cells in a petri dish—allowing them to collect data from many cells at once while still being able to record individual cell measurements.

The suspended scale vibrates at a particular frequency, which changes with mass. As a cell's mass increases, the sensor's resonant frequency decreases. Being able to measure the mass and growth rate of cancer cells can shed light on cancer biology and potentially discriminate between cancer and noncancer cells.

The microsensors were used to measure individual colon cancer cells' masses and growth rates. Previous studies used an aggregate population of cells, making it impossible to determine patterns of individual cell growth. The researchers found the cells' growth rates increased as the cell masses became larger, with the average rate increasing linearly with cell mass. Documenting the processes could help identify whether cancer is present and help develop drugs or diagnostic tools to slow or stop cancer cell growth.

"We believe our measurement system can be used for studying various cellular processes, such as cell growth, cell cycle progression, and differentiation," Bashir says.

Both sensor projects are in their early stages of development. The first project is funded by the Midwest Cancer Nanotechnology Training Center, a regional hub at UIUC for the National Cancer Institute Alliance for Nanotechnology in Cancer, of which Bashir is a coprincipal investigator. The second project is funded by the National Science Foundation's Cellular and Molecular Mechanics and Bionanotechnology Integrative Graduate Education and Research Traineeship, which Bashir also coleads.

He sees a great need for IEEE and its members to get involved in developing instrumentation not only for better diagnostic tools but also to reduce the cost of health care.

"Cancer, cardiovascular disease, infectious diseases, HIV-AIDS, and other medical conditions are worldwide problems and a major cost challenge for many countries," he says. "Using technology to bring the diagnostics and management of diseases to the patient in a personalized way will bring down costs.

"We have to train the next generation of thought leaders in areas interfacing engineering and biology and make the public more aware of how these exciting interdisciplinary efforts are changing the world." ■

TECH TOPIC: SURGICAL ROBOTS

The Next Generation

Smaller, lighter, and less expensive robots

BY ANIA MONACO

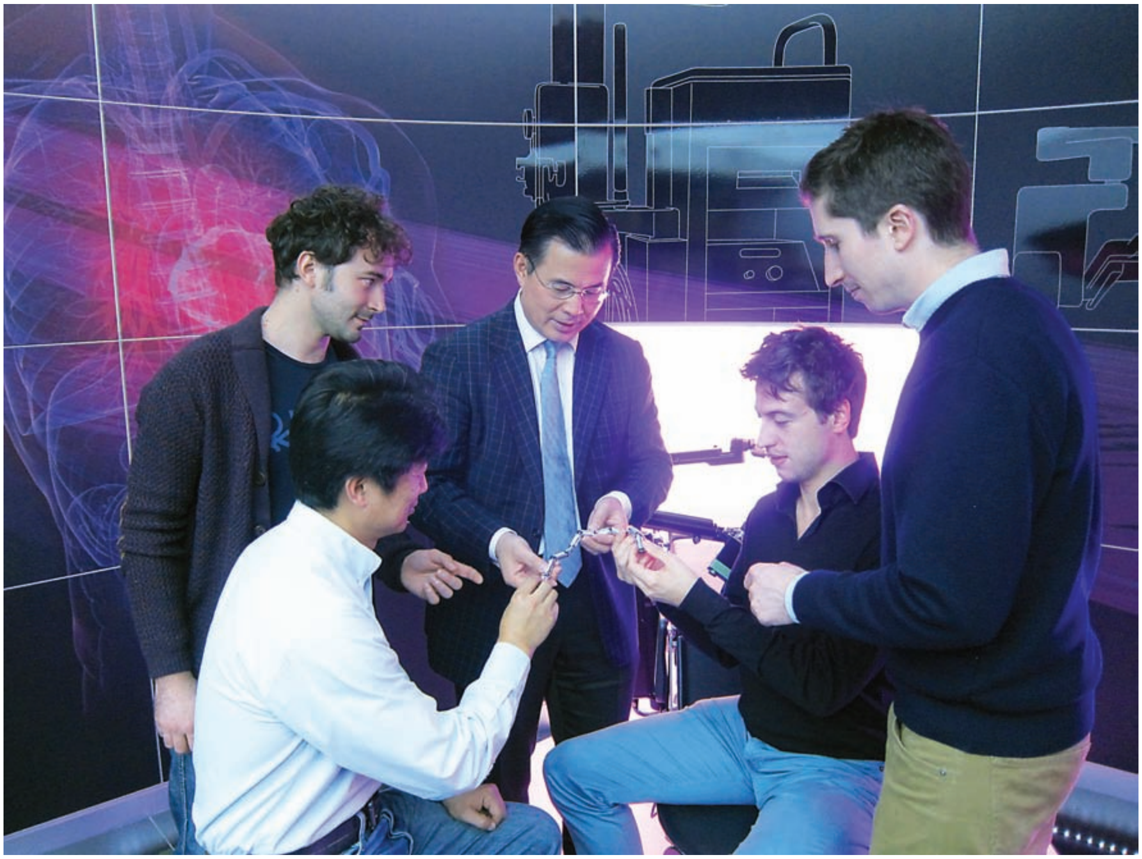
SURGERY CAN BE anything but stress free. Beyond the anxiety over the procedure's outcome, patients must often deal with complications, long recovery periods, and large, painful scars. Minimally invasive surgeries, which have become increasingly common, alleviate many problems. With their smaller incisions, they tend to result in faster healing and fewer post-op woes.

In a typical laparoscopy procedure, for example, a surgeon makes small cuts in the patient's skin through which small operating tools and a camera are inserted. The surgeon then views the operating site, usually on a monitor, while controlling the tools. But minimally invasive surgeries, used for such procedures as removing an ovarian cyst or a prostate gland, have their challenges. The rigid instruments used are typically more than 30 centimeters long—which can exaggerate a surgeon's normal hand tremor.

In addition, surgeons must deal with what's known as the fulcrum effect: When the hand moves to the right, the tip of the surgical instrument moves to the left. And because such surgery requires extensive operating skills and dexterity, surgeons face a difficult learning curve.

Enter robots, which have made their way into operating rooms to alleviate some of those drawbacks. Among the most popular is the da Vinci surgical system, introduced in 1999 by Intuitive Surgical of Sunnyvale, Calif. Unlike a traditional surgeon, a doctor using the robot does not handle most of the surgical instruments directly. Instead, after making the small incisions, the surgeon inserts instruments attached to three or four robotic arms, one of which holds a stereoscopic camera.

The surgeon then sits at a control console near the operating table, looks through a viewfinder to examine 3-D images from inside the patient, and uses joystick-like controls located beneath the screen to manipulate the surgical tools. The da Vinci, with more than 2400 systems installed at nearly 2000 hospitals worldwide, is now



THE HAMLYN CENTRE/IMPERIAL COLLEGE LONDON

IEEE Fellow Guang-Zhong Yang [center] with colleagues from the Hamlyn Centre for Robotic Surgery, at Imperial College London.

used in about 80 percent of prostatectomies in the United States.

But such surgical robots also have their problems, not the least of which is their expense. At more than US $1 million, a da Vinci system is a steep investment for a hospital. Plus, the robot's size and weight—about 180 centimeters tall and more than 900 kilograms—can be an issue. And if a complication arises and the operation must be converted to an open surgery, it's difficult to move the robot out of the way quickly so the surgeon can step in.

IEEE Fellow Guang-Zhong Yang and other engineers are hard at work developing a new generation of robots that can give surgeons a wider variety of options.

"My vision is that future surgical robots shouldn't be large and expensive machines that are accessible only to the privileged few," Yang says. "Robots should be a lot smaller, more affordable, and integrated more seamlessly with normal surgical work flow."

Yang and his colleagues, with a bit of reptilian inspiration, have built such a robot.

SURGICAL SNAKE

Many surgeries, including those performed on the heart, throat, and stomach, involve getting to tissue deep within the body. That can be a challenge for a minimally invasive approach because the instruments are long and rigid. But Yang and his team—which includes computer scientists, physicists, and surgeons—developed a snakelike robot that can help surgeons do the job.

The i-Snake (which stands for imaging-sensing-navigated, kinematically enhanced) robot has fully articulated joints, allowing the tool to move around obstacles just as a snake can. The joints are powered by micromotors, and the tip is fitted with multiple sensing and imaging mechanisms.

The i-Snake's flexibility yields perhaps its biggest benefit: Surgeons can guide the tool into regions of the body that are hard to get at, with minimal cutting. "If you can navigate between natural anatomical planes, you don't have to cut through muscles or cause inadvertent damage to structures such as the nerves—which makes recovery much better," Yang says.

The robot requires just one incision, as opposed to the several used in today's laparoscopies for inserting an endoscope and surgical tools. Using a joystick, the surgeon can digitally control the robot's shape and movement inside the body.

"The i-Snake is not meant to compete with or replace the da Vinci robot, per se," Yang says. "It is based on a different principle. We wanted to develop something that is more hands-on, as a smart instrument, rather than large machinery—similar to how computers are now (such as mobile devices) compared to what they were like more than 20 years ago."

The i-Snake is about 12.5 millimeters in diameter and can have a variable length, typically about 40 centimeters long. It can be held by the surgeon or have its end docked on to a robotic arm fixed to the operating table. The robot has a hollow center through which surgeons insert different surgical tools.

"The i-Snake can increase surgeons' perception and the consistency of their motor manipulation skills, ultimately improving the outcome of the surgical procedure," Yang says.

Last year, a paper on the i-Snake won the Best Medical Robotics Paper Award at the IEEE International Conference on Robotics and Automation.

So far, the team has tested the i-Snake on animal subjects. Yang says he hopes to see the device in hospitals within five years. "I think we are close to that," he says, adding that the robot could be used to perform gastrointestinal, gynecological, and cardiothoracic surgeries.

CHEAPER OPTIONS

The key to making surgical robots less expensive lies in their size, according to Yang. "When I design a robot," he says, "my thinking is that if you cannot carry it in a case, then don't bother making it. You want it to be compact and small."

Another way to keep the price down is to make robots geared to specific tasks. "You don't want to try to make a robot that can do everything," Yang says.

Yang envisions that surgeons will one day have a fleet of small robots at their disposal, each to help with different tasks. "In the future," he says, "you may have four or five robots in the operating room. One may be for dissecting delicate tissue, another for precision-controlled tissue ablation, and yet another for microscopic anastomosis.

"Robots are ultimately just very smart instruments. They can be used to enhance a surgeon's vision, dexterity, or precision—all with less pain and trauma for the patient." ■

What It Takes to Be a Bioengineer

Here are the skills you need in this life sciences field

BY ANIA MONACO

BIOMEDICAL engineering is expected to be the fastest-growing job market in the United States during the next seven years, according to the U.S. Bureau of Labor Statistics (BLS). Between 2010 and 2020, the number of biomedical engineers is projected to rise by about 62 percent.

The popularity of biomedical engineering—an area of life sciences that combines engineering techniques with biology to develop medical devices—can be seen around the world. Australia, for example, has become home to a thriving biomedical industry, with companies such as Cochlear (developer of the cochlear implant), Resmed (which makes devices to treat sleep apnea), and Ventracor (developer of artificial hearts), all in Sydney. In England, several state-of-the-art research facilities have started up, including institutes of biomedical engineering at both Imperial College London and the University of Oxford.

Despite the projections, biomedical engineering—often called bioengineering—is a very competitive field. "The total field of biomedical engineering is small, representing 2 to 3 percent of the total engineering job market, and a large percentage growth does not necessarily translate to large numbers of new job opportunities," says Life Fellow Kenneth Foster, a professor of bioengineering at the University of Pennsylvania School of Engineering and Applied Science, in Philadelphia.

In fact, with a little under 16 000 biomedical engineering jobs in the United States in 2010, that 62 percent growth equates to just about 10 000 jobs being added through 2020, as projected by the BLS. So what can an engineer do to stand out and snag a bioengineering or other life sciences job?

To help answer that question, *The Institute* spoke with Foster and IEEE Member David Barry, who is working in another life sciences area—biology research. Foster, a member of the IEEE-USA Medical Technology Policy Committee, researches biomedical applications of nonionizing radiation from audio through microwave frequency ranges and health and safety aspects of electromagnetic fields as they interact with the body.

Barry is a postdoctoral fellow at the Cancer Research UK London Research Institute, where his work focuses on developing image analysis algorithms to automatically quantify cellular and subcellular processes. He is based at the Cell Motility Lab, where researchers are trying to understand the molecular basis for cell migration.

EARLY EXPOSURE

Is biomedical engineering the right career for you? "It's a great choice for a particular kind of student," Foster says. "Biomedical engineering students at Penn tend to be more research-oriented, compared with other engineering majors." It's important to get the right educational foundation, he says.

"Students should go to a stellar university with an engineering and medical school and get involved early in research," Foster says. "And if you intend to work in industry you should pick up traditional engineering skills such as signal and image processing and software design so you can compete for entry-level design jobs."

But a biomedical engineering degree is not always necessary, he points out: "Majoring in electrical engineering does not foreclose job opportunities in biomedical engineering. Many medical imaging companies hire EEs for image- and signal-processing projects, and most medical device companies hire EEs and mechanical engineers for instrumentation design."

Neither Barry nor Foster were bioengineering majors. "When I got started, there were few biomedical engineering programs," Foster explains. And Barry says, "My first exposure to anything life sciences–related was a biomedical engineering class I took in the final year of my electronic engineering bachelor's degree program at University College Dublin in 2004. I came up against a pretty steep learning curve when I started my Ph.D. program in 2005 in biotechnology."

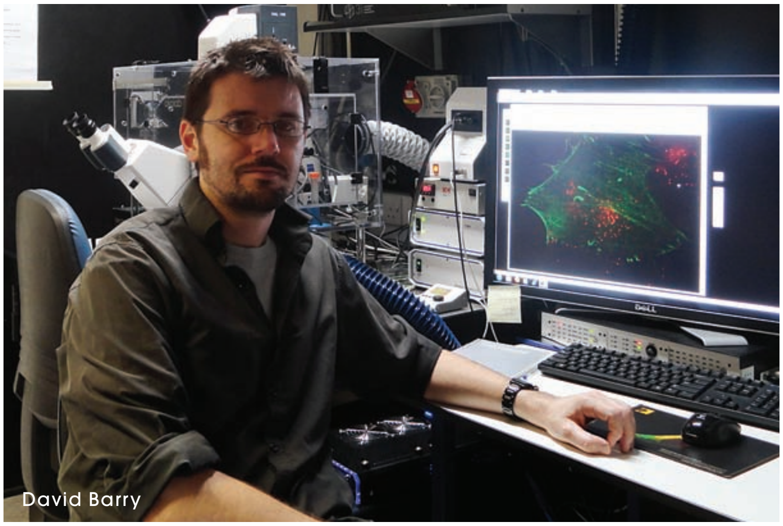
His Ph.D. research involved the development of image analysis methods to quantify the form and structure of filamentous microbes, organisms used to produce a variety of substances in the biotech industry. That experience led Cancer Research UK to hire him in 2010.

Foster earned a Ph.D. in physics in 1971 from Indiana University, in


Kenneth Foster

Bloomington. He next joined the U.S. Navy, where he studied the biological effects of radio-frequency radiation. "There was controversy at the time about the safety of emissions from military radar sets," he says. The work was so interesting that he decided not only to stay in the field but also to teach bioengineering at Penn. "One of the best-known experts in the field at the time was Herman Schwan at Penn in the newly formed department of bioengineering," Foster says. "I went there in 1977 and stayed."

Foster decided to teach, but career paths in the field can be diverse, he says. Each year, about half the students at his university graduating with a bioengineering degree go on to medical or graduate school, eventually becoming doctors or biomedical researchers. The other half join medical device companies, become consultants, or do a dual-degree program with management to land leadership jobs in the field.


David Barry

THE RIGHT SKILLS

The right education is not all an aspiring bioengineer needs. Soft skills are particularly important in the life sciences, because cooperation is so critical, according to Barry. "It's a bit of a cliché, but you have to be comfortable working as part of a team," he says. "Biology is a highly collaborative field. You tend to see a lot more authors listed on a paper about biological research than you would on a typical IEEE technical paper."

And when you're part of a diverse team, communicating well is essential. "The term 'good communication skills' gets abused quite a bit," he says. "It's almost a standard filler on most curricula vitae. But engineers and biologists do speak

TOP: UNIVERSITY OF PENNSYLVANIA; BOTTOM: DAVID BARRY different languages. Biologists don't speak math. Engineers have to communicate complex concepts succinctly if they're going to get their colleagues on board with what they're trying to do."

COMPETITION

Looking past the job forecasts and statistics, what does the actual job situation look like for those in the field?

"Research jobs are very competitive and will probably become more so in the future," Foster says. And as with so many areas, Barry adds that the struggling economy is a challenge. "Job prospects for anyone in research are not great right now, due to the economic climate," he says. "Funding everywhere is tight."

But both Foster and Barry see a reason for optimism.

"Generally speaking, there is a demand for engineers in biological research," Barry says. And the competitive nature of the field can translate to a growth in innovation, and with it, an increase in opportunity.

"The biomedical device industry consists of thousands of companies, most of them small, with specialized products competing for niche markets, and many start-up companies trying to get innovative new products onto the market," Foster says. "That translates to a large but scattered job market for engineers of all kinds, with plenty of opportunity for entrepreneurship."

Another reason for hope is the constantly shifting nature of the life sciences. "Our fundamental understanding of biology is changing, seemingly on a daily basis," Barry says. "It's comparable to what happened in the world of physics at the beginning of the last century, and it's very exciting to be involved in such a rapidly evolving field."

For Foster, the excitement of a job in biomedical engineering stems from the variety of areas involved. "It is a very interdisciplinary field that cuts across medicine, health, biology, and traditional engineering fields," he says. "I find the whole area tremendously exciting and intellectually rewarding, even after all these years." ■

BUSINESS

IEEE Expands Open-Access Offerings

Two publishing models are to launch in 2013

BY KATHY PRETZ

IEEE IS NOW offering two new fully open-access publication models: topical journals and a megajournal.

Open access is the movement in scholarly publishing to make content available via the Internet at no charge to readers. Publications recoup their costs by charging processing fees to authors who want to gain as wide a readership as possible by offering their articles for free. IEEE's traditional journals instead charge subscription fees to members, libraries, and other organizations, and magazines and most journals are still available to subscribers only.

The Web-only journals are expected to have a faster peer-review process and publishing cycle than other IEEE publications.

The two new publishing models join the IEEE's hybrid open-access model, introduced last year. That allows traditional IEEE journals to publish author-paid open-access articles along with subscription-based content in the same issue. Open-access articles are free to anyone once they're published in the IEEE Xplore digital library.

"With the addition of these new publishing models, IEEE now offers authors several open-access publishing choices for meeting their wishes and/or sponsor requirements," says David Hodges, vice president of IEEE Publication Services and Products.

IEEE will continue to publish magazines and some journals available to subscribers only.

TESTING THE WATERS

The three open-access models being implemented result from policies issued by the IEEE Board of Directors in the past few years to encourage organizational units to experiment with new ways of distributing their information. The initial policy supporting the exploration of new publishing models

ISTOCKPHOTO

was approved in November 2007. In August 2010 a set of guidelines was approved for units wishing to develop the new models.

Each model must be self-sustaining and recoup the publication's operating costs. Those costs include paying for content management, article submission and review systems, editorial and typesetting services, and marketing and other investments.

OPTIONS

Authors of articles in nearly all IEEE's transactions and journals now have the option of making their articles available for free under the hybrid open-access publishing model. To do so, each author must pay a processing fee per article, which has been discounted for 2013 from US $3000 to $1750. About 1400 articles were offered this year at no charge to the reader.

Content must, of course, fall within the scope of the publication and undergo the same comprehensive peer-review process as other articles. All content—free or not—will be published in the print edition.

The new topical electronic journals will only publish open-access articles, which must focus on either an overarching theme or a narrow topic within a specific engineering discipline. The processing fee starts at $1350 per article. Three such journals were introduced this year.

The monthly *IEEE Journal of the Electron Devices Society* publishes papers on topics such as the theory, modeling, design, performance, and reliability of electronic and ion integrated circuit devices and interconnects. Tutorials and review papers are included.

The semiannual *IEEE Transactions on Emerging Topics in Computing,* sponsored by the IEEE Computer Society, publishes papers on evolving aspects of computer science and computing technology applications not being covered in the society's other transactions.

And a quarterly from the IEEE Engineering in Medicine and Biology Society, the *IEEE Journal of Translational Engineering in Health and Medicine*, aims to bridge the engineering and clinical worlds. The journal provides a platform for state-of-the-art biomedical engineering technology. Topics include health care delivery systems and global initiatives and advanced technical applications for solving clinical problems.

Then there is the IEEE megajournal. Set to launch in the second quarter of 2013, the online-only journal is expected to touch on all IEEE fields of interest while providing practical articles on technology applications, manufacturing techniques, experimental methods, and interdisciplinary topics.

To shorten the publication cycle, articles will be reviewed only for technical accuracy, although the megajournal plans to ask its reviewers to rate articles for reader interest as well. Authors pay a processing fee of $1750 per article; articles are expected to average nine pages. For now, an author will be asked to sign a copyright transfer form for an open-access article. IEEE is reviewing options for new legal instruments for authors, however, including a license that would define usage rights for open-access articles. When the appropriate documents are ready, IEEE systems now used to manage copyright transfer will be modified for open access. ■

FOR MORE INFORMATION about IEEE open-access strategies, visit http://www.ieee.org/open-access.

QUESTION OF THE MONTH

Will Robots Replace Surgeons?

More robots are popping up in operating rooms around the world. The da Vinci Surgical System robot is now used in four out of five prostatectomies in the United States, and more than 1800 of the machines are installed at some 1400 hospitals worldwide. In August, the U.S. Food and Drug Administration cleared a robot-assisted system for minimally invasive treatment of coronary artery disease. Although today's robots are still controlled by surgeons, some researchers say that may not be the case in the future. Bioengineers at Duke University, in Durham, N.C., have demonstrated that an autonomous robot can perform simple surgery, such as taking a sample of a cyst, on its own. Since then, other researchers have wondered whether fully autonomous robots could perform more complicated tasks.

Do you think robots will one day replace surgeons for certain procedures? Would you trust a robot over a surgeon?

Respond to this question by commenting online at http://theinstitute.ieee.org/opinions/question. A selection of responses will appear in the March issue of The Institute *and may be edited for space. Suggestions for questions can be sent to institute@ieee.org.*

RESPONSES TO SEPTEMBER'S QUESTION

Do Layoffs Target Older Workers?

Hewlett-Packard recently announced it will eliminate 27 000 jobs, which the company's chief executive, Meg Whitman, claims is "absolutely critical for the long-term health of the company." This year, Yahoo laid off 2000 employees, and BlackBerry maker Research in Motion announced it will make "significant spending reductions and head-count reductions."

A recent opinion piece on CNN.com by Norman Matloff, a professor of computer science at the University of California, Davis, said engineers older than 35 will have a hard time finding new jobs. He noted that a lot of HP's current job listings include the terms "intern," "recent graduate," or "postdoc."

Are companies using layoffs to get rid of older engineers? Do you think older engineers now have a harder time finding jobs than recent graduates do?

The following responses were selected from comments that appear at http://theinstitute.ieee.org/opinions/question/do-layoffs-target-older-workers. Unsigned responses are from readers wishing to remain anonymous.

YOU BET!

This is a no-brainer. I was a victim of age discrimination and have been working as a contractor for the last 15 years because of it. Not only are salaries higher for older technical workers, but also the older your workforce, the more benefits cost. What management loses sight of is that with age comes experience. That experience is being lost to early retirement.

LOWER PRODUCTIVITY

With HP in layoff mode for some time, its layoffs will naturally include mainly older, higher-paid engineers. Management will be happy temporarily as it pays newly hired and less experienced engineers a lower salary. The average age of the workforce is reduced, and it's all perfectly legal.

But in a year or two, these same managers will wonder why the productivity of their engineering workforce is less than they desire.

WASTED EFFORT

I have a master's degree in electrical engineering and graduated summa cum laude from my undergraduate institution. But at 58, I'm changing oil and tires at an auto shop for one-fifth of what I used to make. I've got a job, but it feels like such a waste.

FORCED OUT

Age-based discrimination doesn't just happen in the United States. My former employer, a large Canadian consulting firm, deliberately downsized senior employees to lower its costs and allow younger employees to move up the corporate ladder. The firm became so junior-friendly and elder-hostile after the layoffs that many senior employees just quit in disgust.

TOUGH ALL AROUND

I'm a recent graduate, and in this economy it's not easy for younger people to find jobs. Cisco recently laid off some 2000, and among them were a lot of young people as well as experienced employees.

The biggest problem I've seen in the corporate world is the separation between older managers and younger engineers. Many people still live by stereotypes. It would benefit both camps if there were more sharing of ideas between the two, without prejudice. Lack of open communication often stands in the way of a successful corporate culture.

EXPERIENCE IS VALUED

It depends on the industry and company values. In petrochemicals, my experience has been that mature power system and control system electrical engineers are highly valued as intellectual capital. It took decades for these engineers to accumulate their skills. As long as individual performance standards are met or exceeded, layoffs are no threat.

POOR RETURN

This sad erosion of the engineering profession is driven by companies wanting cheap labor. No wonder there's a lack of so-called qualified engineers in the United States. Why spend money and time in engineering school knowing you'll be told that knowledge and experience are worthless after 15 to 20 years? That's a poor return on investment. If this country really needs more engineers,

JAVIER LARREA/GETTY IMAGES

then companies should pay them what they're worth and keep seasoned experts around to train the next generation. There will be no app for that for some time.

Ingee

VALID REASONS

Yes, older engineers are being targeted for purely financial motives. But high compensation combined with low or average contribution to the primary corporate mission are valid reasons for a layoff. Top contributors are usually retained. This is a rational and reasonable business practice. Employees should know what is most important to their employer to ensure that they make meaningful contributions to the company's success. A little self-promotion doesn't hurt, either.

John M.

DAY LABOR

Most corporate decisions are based on money, and older engineers like me make more money than recent grads—at least twice as much and often more. I worked for a consulting company that applied the term "casual employee" as an alternative to layoffs. A casual employee has no benefits and gets paid only for hours billed to a client.

Twelve of us who are over 60 were recently reclassified as "casual" and told we could work on a project only if there were no full-time employees who could do the work. It was like being laid off in place, and the company didn't have to pay unemployment compensation to the state.

I had two job offers in two months based on experience, not age or salary, and now I have a new job even better than the one I left. Not all of my former colleagues have been as lucky.

Mike Rowley

CORRECTION

An item in the Calendar [September] should have stated that Nick Holonyak Jr. received the 2003 IEEE Medal of Honor, not the 2002 medal.

PRESIDENT'S COLUMN

Sustainability

SEARCH FOR THE meaning of "sustainability" and you'll soon be led to this: "Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

It comes from "Our Common Future," the 1987 report of the World Commission on Environment and Development, a U.N. exploration of conflicts between development and preservation of the environment.

Growth is also essential, and thus the three goals of social progress (or development), environmental protection, and economic growth, pursued together, have become known as the pillars of sustainability.

They are important everywhere, in rich countries and poor. If the use of natural resources in developed countries already threatens our environment, how can advances in quality of life and prosperity be extended to all without making the environmental damage far worse?

Sustainability must be approached by both the public and private sectors. Governments can contribute through laws, regulations, planning, and infrastructure development. These actions primarily serve to accelerate progress in the private sector, where opportunities for improving sustainability are great. Businesses are large consumers of energy and natural resources. Their operations often affect our environment, sometimes dramatically, while at the same time there are many business opportunities in sustainable development.

Within the business community, interest seems to be growing. Customers, employees, and stockholders are pushing for more attention to sustainability, and the pillars are sometimes recast as "people, planet, and profit," or the "triple bottom line" of social responsibility.

INDUSTRY INVOLVEMENT

The U.N. Global Compact, which describes itself as "the world's largest corporate sustainability organization," has 7000 business signatories from 135 countries. The World Business Council for Sustainable Development, an organization of CEOs of large corporations, has 200 members committed to "business solutions for a sustainable world." In June, I was among 2500 participants in the U.N. Corporate Sustainability Forum, a prelude to the Rio+20 Conference on Sustainable Development, where more than 200 new commitments to sustainable solutions were announced. Regarding Rio+20, CNN reported: "Businesses played a much bigger role at this summit than they did 20 years ago, with many observers saying they have actually taken the lead by providing real examples of sustainable development."

The position of chief sustainability officer (CSO) has been added to many executive rosters, including those of large corporations, such as 3M, DuPont, Ford, Procter & Gamble, Siemens, and Toyota. Scott Wicker, an electrical engineer and the first CSO of the delivery service company UPS, argues that corporate sustainability strategies require the expertise, mentality, and instincts of engineers. He says these strategies should be approached like an engineering project, with a particular emphasis on data-driven design. One of Wicker's first contributions was to develop computer algorithms to dynamically plan delivery routes, saving substantial time and fuel.

ENGINEER INVOLVEMENT

Most engineers will steer a conversation about sustainability toward energy. It's a big target. By one estimate, 87 percent of the world's primary energy consumption is derived from fossil fuels, principally oil, coal, and natural gas.

And within the energy sector, engineers will focus first on opportunities to improve the efficiency with which energy is converted (such as electricity generation), transported, and used. According to the U.S. National Academy of Engineering, accelerating the deployment of established energy-efficiency technologies could more than offset the growth of energy demand in the United States, a conclusion that probably applies to other developed countries as well. Further, the payback time for investments in efficiency can be relatively short, leading to substantial long-term savings.

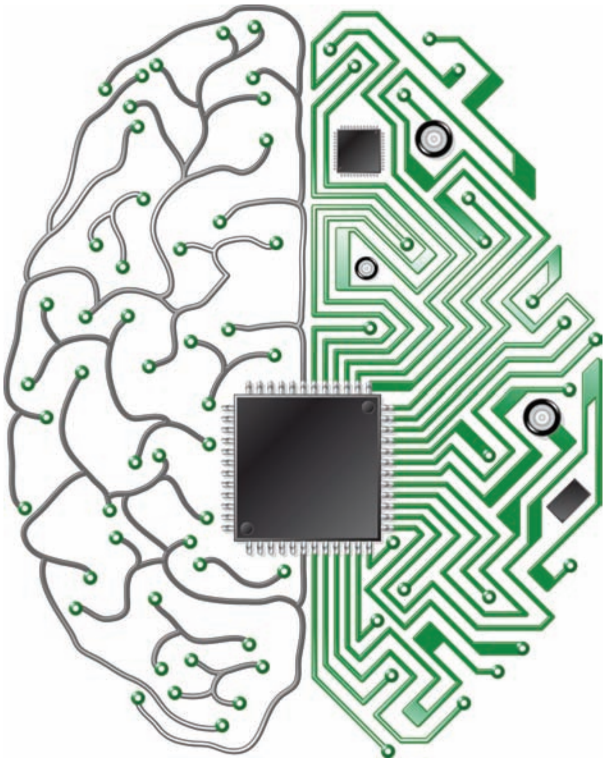
Second, engineers will focus on changing the mix of energy sources, recognizing that the optimum may differ widely by country or region. Greater use of natural gas, wind, and solar technologies to generate electricity has reduced U.S. carbon emissions to a 20-year low. Denmark has set a path toward a 35 percent renewable component in its energy supply by 2020 and 100 percent by 2050.

It will also be engineers who answer many of the key questions about energy technology. Is a breakthrough in mass energy storage essential for renewable energy to supply a large fraction of our energy needs? Can carbon-capture and -storage technology be made to work, at scale and with a cost low enough so that coal can remain an important energy source? If the component of fossil fuels in the energy supply is to diminish, is nuclear generation the only way to meet base-load electricity demand?

I'm optimistic. Engineers created the technologies that dramatically advanced quality of life in developed countries. And though our community sometimes failed to adequately consider the environmental consequences of those technologies, ours is also the profession that can mitigate those consequences while extending the benefits of technology to the rest of the world.

Gordon W. Day
IEEE President and CEO

IEEE



PRODUCTS AND SERVICES

Delving Deeper Into Life Sciences

Several resources monitor developments in the field

BY **KATHY PRETZ**

THE PAST TWO YEARS have been a productive time for those working on the IEEE Life Sciences Initiative, which debuted in February 2011. Here's what has been accomplished so far.

WEB PORTAL

The first place to go to learn about IEEE's life sciences activities is its portal (http://lifesciences.ieee.org), launched in June 2011. It contains standards, educational materials, research papers, and information about conferences. More than 150 papers excerpted from IEEE publications have been posted on a variety of topics, including artificial skin sensors, developments in the brain-machine interface, and wearable medical devices.

NEWSLETTER

Launched in April, the *IEEE Life Sciences Newsletter* is e-mailed to subscribers each month. Subscription information and articles from past issues are available at http://lifesciences.ieee.org/publications/newsletter. The electronic publication offers news, analysis, and feature articles written by IEEE members on innovations and emerging trends. Recent articles covered neural stimulations that help patients with spinal cord injuries walk again, microfluidics for cancer cell detection, and an overview of apps for the medical field.

ANNUAL CONFERENCE

Identifying key issues facing the field and figuring out how to solve them are two other initiative goals. To that end, the Grand Challenges Conference was held on 4 and 5 October in Washington, D.C., during which leaders in the field discussed the convergence of engineering, life sciences, and health care.

Invited presenters at the conference, which is to become an annual event, included representatives from academia, government, and industry. Among them were IEEE Fellows Rashid Bashir and Guang-Zhong Yang, whose work is featured in "The Marriage of Engineering and Biology," on pp. 5–6 in this issue and "The Next Generation," on pp. 6–7. More general conferences touching on the life sciences are listed on p. 13.

PUBLICATION

A new, open-access electronic journal is in the works as a channel for publishing original contributions by authors who may not be allied with a biology laboratory, according to Bichlien Hoang, senior program director for the life sciences initiative.

A proposal to produce the monthly eJournal *IEEE Emerging Topics in Life Sciences* is expected to be submitted to the Periodicals Committee in 2013. Because the open-access journal is to be supported by processing fees charged to authors, readers will have free access to the articles after they're published in the IEEE Xplore digital library. In turn, the review process for articles will be faster, Hoang says. The journal, she adds, will publish manuscripts about mathematical and statistical modeling and analysis methods that can be applied to biological problems at the molecular, cellular, and organ levels. ■

FOR MORE INFORMATION on the IEEE Life Sciences Initiative, contact Bichlien Hoang, senior program director, at b.hoang@ieee.org.

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IEEE MEDIA
PUBLISHER JAMES A. VICK
BUSINESS DEVELOPMENT MANAGER SUSAN SCHNEIDERMAN
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CONFERENCES: JANUARY–JULY 2013

Several upcoming IEEE conferences cover topics relating to life sciences

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IEEE International Conference on Micro Electro Mechanical Systems

TOKYO; 20–24 JANUARY

TOPICS: Biosensors and systems; medical microsystems; energy harvesting; microactuators; mechanical sensors and systems; fabrication; packaging technologies; and microdevices for biomedical engineering, data storage, wireless communications, power supply, and analysis systems.

SPONSOR: IEEE Robotics and Automation Society
VISIT: http://www.mems2013.org

IEEE Topical Conference on Biomedical Wireless Technologies, Networks, and Sensing Systems

AUSTIN, TEXAS; 20–23 JANUARY

TOPICS: Wireless technologies and biosensors for medical applications, microwave systems for imaging and diagnostics, microwave interaction with biological tissues, energy scavenging, and biosensor e-textiles.
SPONSORS: IEEE Engineering in Medicine and Biology and IEEE Microwave Theory and Techniques societies
VISIT: http://www.radiowirelessweek.org/biowireless

IASTED International Conference on Bioengineering

INNSBRUCK, AUSTRIA; 13–15 FEBRUARY

TOPICS: Electronic medical devices, biosensors, noninvasive measurement tools, optical and ultrasound imaging, medical data storage and compression, rehabilitation technology, surgery simulation programs, tissue engineering, and labs-on-chips.
SPONSORS: The International Association of Science and Technology for Development (IASTED) and the IEEE Engineering in Medicine and Biology Society
VISIT: http://www.iasted.org/conferences/cfp-791.html

IEEE Biosignals and Biorobotics Conference

RIO DE JANEIRO; 18–20 FEBRUARY

TOPICS: Bioelectric signal processing, mobility devices, wearable robots, prosthetic limbs, rehabilitation robots, human-machine interfaces, and issues of sustainability related to health care devices.
SPONSOR: IEEE Engineering in Medicine and Biology Society
VISIT: http://www.brc2013.org

International Symposium on Biomedical Imaging

SAN FRANCISCO; 7–11 APRIL

TOPICS: Image formation and reconstruction; computational and statistical image processing and analysis and dynamic imaging; visualization; image quality assessment; and physical, biological, and statistical modeling.
SPONSORS: IEEE Engineering in Medicine and Biology and IEEE Signal Processing societies
VISIT: http://www.biomedicalimaging.org/2013

IEEE Engineering in Medicine and Biology Society Annual International Conference

OSAKA; 3–7 JULY

TOPICS: Biomedical signal and image processing, bioinstrumentation, wearable sensors, bioinformatics, cardiovascular and respiratory systems engineering, rehabilitation technology, molecular and cellular biomechanics, therapeutic and diagnostic systems, health care information systems, and biomedical engineering education.
SPONSOR: IEEE Engineering in Medicine and Biology Society
VISIT: http://embc2013.embs.org

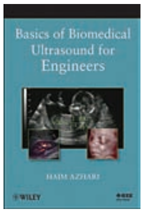
BOOKS OF INTEREST

BY **ANIA MONACO**

Here's a sample of e-books published by Wiley-IEEE Press on the subject of bioengineering.

Basics of Biomedical Ultrasound for Engineers

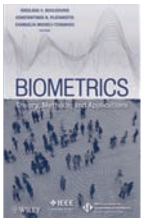
BY HAIM AZHARI (MARCH 2010)



Geared toward those taking engineering courses in biomedical ultrasound and to researchers in the field, this textbook begins with basic definitions of ultrasound, then delves into ultrasound in fluids and solids. Included are definitions of waves and discussions of focusing devices, transducers, and acoustic fields.

Biometrics: Theory, Methods, and Applications

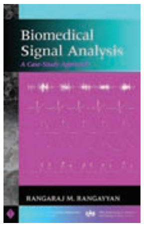
EDITED BY NIKOLAOS V. BOULGOURIS, KONSTANTINOS N. PLATANIOTIS, AND EVANGELIA MICHELI-TZANAKOU (NOVEMBER 2009)



Describes theories, methods, and applications of biometric systems. Topics include multilinear discriminant analysis for biometric signal recognition, biometric identity authentication techniques based on neural networks, multimodal biometrics, and the design of classifiers for biometric fusion.

Biomedical Signal Analysis: A Case-Study Approach

BY RANGARAJ M. RANGAYYAN (DECEMBER 2001)

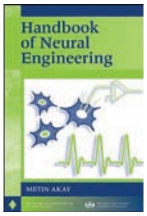


This guide to biomedical signal analysis focuses on diagnostic challenges that medical professionals face. Each chapter begins with a description of a different biomedical signal problem followed by real-life case studies. Signal processing, modeling, and analysis techniques are presented.

The following titles, in the IEEE eBook Classics Collection, are available for free to IEEE members.

Handbook of Neural Engineering

BY METIN AKAY (JANUARY 2007)



Provides a theoretical foundation in computational neural science and engineering and includes applications in wearable and implantable neural sensors and probes. Includes peer-reviewed papers on the brain-computer interface, nanoneural engineering, neural prostheses, imaging the brain, and neural signal processing. Other topics include how to measure functional, physiological, and metabolic activities in the brain and changes in neural networks after a stroke or spinal cord injury; and improvements in therapeutic applications using neural prostheses.

Genomics and Proteomics Engineering in Medicine and Biology

BY METIN AKAY (JANUARY 2007)

Topics include qualitative knowledge models, how to interpret microarray data, gene regulation bioinformatics, methods for analyzing microarrays, cancer behavior and radiation therapy, and error-control codes and the genome.

Electromyography: Physiology, Engineering, and Non-Invasive Applications

BY ROBERTO MERLETTI AND PHILIP A. PARKER (JULY 2004)

An overview of electromyography (EMG) by pioneers in the field, the book is aimed at physiologists, medical professionals, and biomedical engineering students. It discusses the broad applications of EMG data in such areas as neurology, ergonomics, exercise physiology, rehabilitation, movement analysis, biofeedback, and myoelectric control of prostheses.

STANDARDS

IEEE Adds to Its Life Sciences Standards

BY **ANIA MONACO**

THE IEEE STANDARDS Association (IEEE-SA) has been developing new life sciences standards to add to its IEEE 11073 series. This family of standards is designed to help health care product developers build instruments and systems for disease management, physical fitness, and independent living. Two new standards and a revised one have been added, with several more on the way. They are sponsored by the IEEE Engineering in Medicine and Biology Society.

IEEE 11073-00103

RELEASED AUGUST 2012

The "Guide for Health Informatics — Personal Health Device Communication—Overview" profiles communications among personal telehealth instruments monitoring a patient's health. The profiles define data representation, data exchange, and communications between telehealth instruments and such tools as cellphones, personal computers, and TV set-top boxes.

IEEE 11073-10103

RELEASED AUGUST 2012

The "Standard for Health Informatics—Point-of-Care Medical Device Communication—Nomenclature—Implantable Device, Cardiac" defines terms for implantable pacemakers, defibrillators, cardiac monitors, and tools for cardiac-resynchronization therapy.

IEEE 11073-10417

RELEASED JANUARY 2012

This revision to the "Standard for Health Informatics—Personal Health Device Communication—Part 10417: Device Specialization—Glucose Meter" supports plug-and-play interoperability between personal glucose meters and compute engines.

The following projects are under development. If approved by the IEEE-SA Standards Board, they will also be added to the IEEE 11073 family.

IEEE P11073-10419

The "Draft Standard for Health Informatics—Personal Health Device Communication—Device Specialization—Insulin Pump" specifies the possibilities of information exchange between interoperable insulin pumps.

IEEE P11073-10441

This revision to the "Draft Standard for Health Informatics—Personal Health Device Communication—Part 10441: Device Specialization—Cardiovascular Fitness and Activity Monitor" supports interoperable communications among devices that measure a person's activity and the body's physiological responses to it.

IEEE P11073-10404

This revision to the "Draft Standard for Health Informatics—Personal Health Device Communication—Device Specialization—Pulse Oximeter" defines the communications between pulse-oximeter devices and compute engines. Pulse oximeters monitor the saturation of a patient's hemoglobin.

IEEE P11073-10413

The "Draft Standard for Health Informatics—Personal Health Device Communication—Device Specialization—Respiration Rate Monitor" defines plug-and-play communications between compute engines and devices that monitor respiration rate.

FOR MORE INFORMATION on these and other standards from the Personal Health Device Working Group, visit https://standards.ieee.org/develop/wg/PHD.html.

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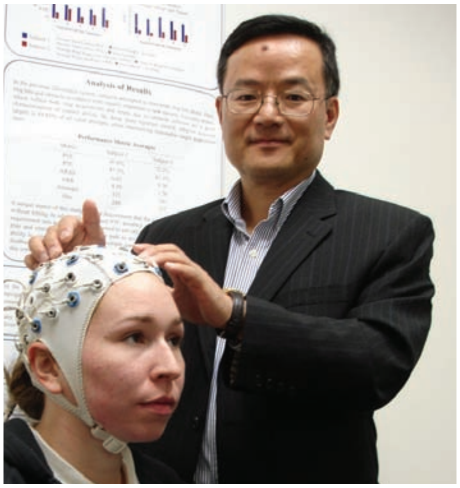
PROFILE

Bin He: New Partnerships

Bringing together engineers and life scientists

BY SUSAN KARLIN



IEEE Fellow Bin He conducts brain wave experiments in his lab at the University of Minnesota, in Minneapolis

ALEX DOUD

YOU MIGHT THINK scientific professionals all speak a similar language. Not so when it comes to engineers and life scientists. But as the two fields have moved closer together in recent years—in such areas as medical imaging, prosthetics, brain wave transmission, and robotics—IEEE realized it needed a more organized interface between the two.

IEEE Fellow Bin He, cochair of the IEEE Life Sciences New Initiative and chair of the IEEE Life Sciences Grand Challenges team, which held its first conference in October in Washington, D.C., is a key leader in fashioning that interface.

CRUCIAL INTERSECTION

Last year, IEEE formed the Life Sciences New Initiative to become a major player at the intersection of life sciences and engineering. Since becoming cochair in early 2011, He has helped establish five teams to further that initiative. One group developed a life sciences Web portal and provides some of its content; a second ensures the quality of that content; a third creates programs to attract life science professionals to join IEEE; a fourth promotes IEEE publications and conferences, bringing life sciences news to the larger scientific community; and the fifth identifies and tries to solve the major problems—or "grand challenges"—facing the field.

One of He's main efforts was to organize the Grand Challenges Conference, which focused on eliminating obstacles impeding the cohesion of engineering and the life sciences and determining how collaboration between the two fields can affect the scientific community, government, business, and society. The conference attracted entrepreneurs and representatives from political, professional, and academic institutions for a two-day brainstorming session.

Next month, He is to become editor in chief of *IEEE Transactions on Biomedical Engineering*, which plans to publish a special issue highlighting the ideas that emerged from the conference.

"The most difficult task is getting engineers and people in the life sciences to better communicate," He says. "Another is learning how engineers, specifically IEEE members, can play a major role in innovating and revolutionizing medical devices and procedures and health care. And a third is figuring out ways to join forces and craft partnerships."

He has been in the midst of that culture clash since his days as a biomedical engineering researcher in the late 1980s and early '90s at the Harvard-MIT Division of Health Sciences and Technology, which attracted a mix of engineers and doctors. He is now a distinguished professor of biomedical engineering at the University of Minnesota, in Minneapolis, and director of its Institute for Engineering in Medicine, which cosponsored the Grand Challenges Conference.

He, who was president of the IEEE Engineering in Medicine and Biology Society from 2009 to 2010, was admitted this year to the International Academy of Medical and Biological Engineering, an elite worldwide organization of 100 scientific professionals.

"Every one of my grant proposals for my research has a life scientist or physician as a coinvestigator," He notes. "We have to work together as a team."

INSPIRED BY THE BRAIN

He's passion dates back to his teenage years. Growing up in a small town near Shanghai, he decided on a career involving life sciences and engineering after reading a magazine article in high school about research measuring the brain's biomagnetic field. "I wanted to understand my own brain better," he says.

He earned a bachelor's degree in electrical engineering from Zhejiang University in China in 1982. He went on to earn a master's in electrical engineering in 1985 and a Ph.D. in bioelectrical engineering in 1988 from the Tokyo Institute of Technology. He followed that with a postdoctoral fellowship and took a research scientist position at the Harvard-MIT Division of Health Sciences and Technology, where he remained until 1994.

During the next decade, he rose to become a professor of bioengineering and electrical engineering at the University of Illinois, in Chicago, before taking a position as a professor of biomedical engineering at the University of Minnesota in 2004.

The UM programs he directs include the Biomedical Functional Imaging and Neuroengineering Laboratory and the Center for Neuroengineering. Most of his research focuses on neuroengineering and imaging. His labs developed dynamic 3-D medical imaging techniques to ascertain brain and cardiac health and to detect cancer. The techniques enable neurosurgeons to see what's happening in the brain in real time and how it affects the rest of the body.

Another research effort applies engineering methods to read signals from the brain, and modulate it using electrical or magnetic stimulation. Applications of such research include mitigating the effects of Alzheimer's disease, Parkinson's disease, epilepsy, and depression.

One school of thought suggests that symptoms of those disorders can be caused by neural misfiring, which could be alleviated by electrical modulation. That involves implanting devices in the brain or employing wearable devices that counteract impulses of major nerve clusters. The battery-driven implants send electrical signals along neural pathways that override or nullify the impulses causing the damaging symptoms, such as tremors, depression, or lost memory.

He has also worked on brain-computer interfaces that translate thoughts into commands. "Last year, my lab was the first to control the flight of a virtual helicopter in 3-D space using electroencephalography and novel signal processing," he says. "When I first heard of the possibility of moving a cursor by thought, I didn't believe it could be done. But I spent the next 10 years trying to do it. This year, we succeeded in using an EEG to control a real [propeller-driven] flying robot—for the first time in the world, to our knowledge."

In that experiment, volunteers each wore a cap containing multiple electrode sensors that picked up the slight electric currents produced by brain waves. Different thoughts changed the wave patterns. As the subjects imagined steering the flying robot, the sensors would pick up the waves and wirelessly transmit them to a laptop that amplified the waves and ran them through signal processing algorithms to extract control signals. Those signals were then wirelessly transmitted to the drone to control its flight in real time.

"Key to our success was the integration of engineering innovation and neuroscience research," He says. "It reflects the essence of the IEEE Life Sciences New Initiative." ■

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PART-TIME PASSIONS

Joshua Wilson
Metal Mania

PASSION
Drumming

OCCUPATION
Graduate research assistant

HOMETOWN
Dayton, Ohio

WHO KNEW PLAYING trombone in a middle school band could lead years later to a stint as a heavy-metal drummer? That's what happened to IEEE Graduate Student Member Joshua Wilson.

By day, Wilson is an electrical engineering graduate research assistant at the Air Force Institute of Technology at Wright-Patterson Air Force Base, in Ohio. By night, he channels his inner rock god as the drummer of a still unnamed metal band that rehearses weekly, preparing for gigs in the Dayton area.

"This is definitely my creative outlet," Wilson says. "I listen to a ton of music—not only metal but also classical, pop, rock, and experimental. I think about what made the musicians write those notes and then play along for the challenge.

"Engineering requires me to remain objective, so I can't express a lot of emotion in my work. Music is where I express my feelings and let my energy out."

Wilson picked up the trombone at age 11, only to put it down the next year. Instead, in his middle school he played percussion for the concert band and drums for the jazz band. And he found his true calling in high school: Inspired by Metallica and Pantera, he formed his first heavy metal band. Its one gig was at his class graduation party.

In his junior year at Wright State University, in Dayton, he played part-time in a hard-rock group, Eyeshot, which recorded a professionally produced album that debuted as online MP3s.

For a few years, thin apartment walls made practicing the drums impractical. Then last year he moved into a house, which facilitated rehearsing and recording on his laptop recording studio. His current band—made up of two guitarists (one an EE grad student, the other a high school buddy), a bassist (another EE grad student), and Wilson—rehearses about 4 hours per week. They play cover tunes and original material influenced by such metal bands as Between the Buried and Me, Dream Theater, Gojira, Iced Earth, Lamb of God, Machine Head, and Mudvayne.

"One of my bandmates wants to put gigs on hold until we find a vocalist," Wilson says. "I'm motivated to play regardless of whether we have a singer.

"We also need a name, but one of the guitarists is really indecisive."

As for the band's image, its members don't have stereotypically long, head-banging manes of hair. "We don't look very scary at all," Wilson says. "Our hair is short. But I think the music will make up for that." *—Susan Karlin*

Anne Meixner
Divine Alpine

PASSION
Downhill skiing

OCCUPATION
Electrical and computer engineer

HOMETOWN
Portland, Ore.

THE PHOTO ALBUMS of IEEE Member Anne Meixner's parents contain pictures of Meixner and her three siblings as kids, successively wearing each other's ski outfits and skis as they were handed down every year.

"We grew up skiing as a family," says Meixner, who tests semiconductors for Intel Corp., in Hillsboro, Ore. "Every year, my parents would take us on a family ski vacation at Gore Mountain, in North Creek, N.Y. It had a learn-to-ski week, so we'd have 5 days of 90-minute lessons. Every season we spent about 10 days skiing."

Meixner continued skiing throughout her doctoral studies in electrical and computer engineering at Carnegie Mellon University, in Pittsburgh. When she moved to Oregon in 1994 to join Intel, she hoped to improve her skiing technique and learned she could get free advanced skiing lessons if she became a ski instructor.

She's now teaching in her 17th season at Mount Hood Meadows Ski Resort in the Mount Hood National Forest, about 80 kilometers east of Portland. As a member of the Professional Ski Instructors of America, she has earned a Certification II in Alpine (downhill) skiing, with additional training in teaching children and seniors. She spends about 30 days teaching and skiing during the season, which runs November through April, and she attends instructor development clinics at Timberline, on Mount Hood.

"I'm inside all day at work, so I love being outdoors when I get the chance," Meixner says. "You drive into the mountains, and you're in another world. It's a great stress reliever.

"In electronics, you don't always see the end result. However, with teaching you get to watch your students master skills and overcome their fears."

Meixner believes her teaching has made her a better engineer. "It helps me work on my communication skills," she says. "At Intel, becoming a senior engineer means not only having the ability to solve technical problems but also to communicate effectively. Teaching helps me work on both those areas. I'm using the same analytical skills I use at work but to solve a different problem: what the student wants to achieve and how to achieve it." *—S.K.*

TOP: THANG TRAN; BOTTOM: ANNE MEIXNER

IN MEMORIAM

Leonard R. Kahn

AM STEREO PIONEER
Member Grade: **LIFE FELLOW**
Age: **86**; *Died:* **3 JUNE**

Leonard R. Kahn was founder and president of Kahn Communications, in Carle Place, N.Y. The company developed compatible AM digital (CAM-D), a hybrid digital format for AM broadcasting.

Before starting his company, Kahn was a radio engineer for several years at RCA Laboratories, in Princeton, N.J. There, he developed AM radio broadcast technology for high-frequency, shortwave, and single-sideband transmission.

He developed his own radio system, called the Kahn-Hazeltine digital stereo system, in 1958.

He was a member of the IEEE Aerospace and Electronic Systems, Broadcast, Communications, Engineering in Medicine and Biology, Information Theory, and Vehicular Technology societies.

Kahn earned a bachelor's degree in electrical engineering from Polytechnic Institute of Brooklyn (now part of New York University), in New York City.

Robert S. Ledley

RADIOLOGY PIONEER
Member Grade: **LIFE SENIOR MEMBER**
Age: **86**; *Died:* **13 JULY**

Robert S. Ledley, a dentist turned biomedical researcher, invented the first computerized tomography (CT) scanner capable of producing cross-sectional images of any part of the body.

In 1956, Ledley became an assistant professor of electrical engineering at George Washington University's School of Engineering, in Washington, D.C. Four years later, he founded the National Biomedical Research Foundation (NBRF), a nonprofit organization, also in Washington, D.C., dedicated to promoting the use of computers among biomedical scientists.

Ledley joined Georgetown University, in Washington, D.C., in 1970 as a professor of radiology, physiology, and biophysics and soon established the NBRF headquarters on the university's campus. Three years later, he led the team of NBRF researchers that developed the computerized full-body scanner.

Ledley was a member of the IEEE Computer, Engineering in Medicine and Biology, Information Theory, and Nuclear and Plasma Sciences societies.

He received a doctor of dental surgery degree in 1948 from New York University, in New York City. He went on to earn a master's degree in theoretical physics in 1949 from Columbia University.

Marzuki bin Khalid

REGION 10 VICE CHAIR FOR TECHNICAL ACTIVITIES
Member Grade: **SENIOR MEMBER**
Age: **53**; *Died:* **13 AUGUST**

Marzuki bin Khalid was an IEEE volunteer for 25 years, serving most recently as Region 10 vice chair for Technical Activities.

Previously, Khalid was the region's conference coordinator from 2008 to 2010 and secretary from 2006 to 2008.

Khalid was deputy vice chancellor at the University of Technology, Malaysia (UTM), Kuala Lumpur, where he oversaw engineering R&D. He was also a professor in the school's electrical engineering department, as well as director of its Center for Artificial Intelligence and Robotics.

Recently he was given the honorific title of Dato' by the governor of his home state of Malaka for contributions to UTM and to Malaysia. Khalid was a member of the IEEE Control Systems; IEEE Industrial Electronics; and IEEE Systems, Man, and Cybernetics societies.

He received a bachelor's degree in electrical and power engineering in 1980 from UTM and also earned a bachelor's degree in electrical engineering in 1983 from the University of Southampton, in England. In 1986, he received a master's degree in control systems engineering from the Cranfield Institute of Technology, in England, and he earned a Ph.D. in neurocontrol in 1994 from the University of Tokushima, in Japan.

ROBERT S. LEDLEY: THESCIENTIST.COM; MARZUKI BIN KHALID: UNIVERSITY OF TECHNOLOGY OF MALAYSIA

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Nominations Needed

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IEEE Edison Medal
For a career of meritorious achievement in electrical science, electrical engineering, or the electrical arts.
SPONSOR: Samsung Electronics Co., Ltd.

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For outstanding accomplishments in the application of technology in the fields of interest of IEEE that improve the environment and/or public safety.
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IEEE Founders Medal
For outstanding contributions in the leadership, planning, and administration of affairs of great value to the electrical and electronics engineering profession.
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For exceptional contributions to information sciences, systems, and technology.
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IEEE Medal for Innovations in Healthcare Technology
For outstanding contributions and/or innovations in engineering within the fields of medicine, biology, and healthcare technology.
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For outstanding achievements in signal processing.
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