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ROBOTICS AT OUR FINGERTIPS

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On the cover: Associate Professor Veronica Santos' lab improves the functionality of artificial hands.

Cover Photo: Joanne Leung

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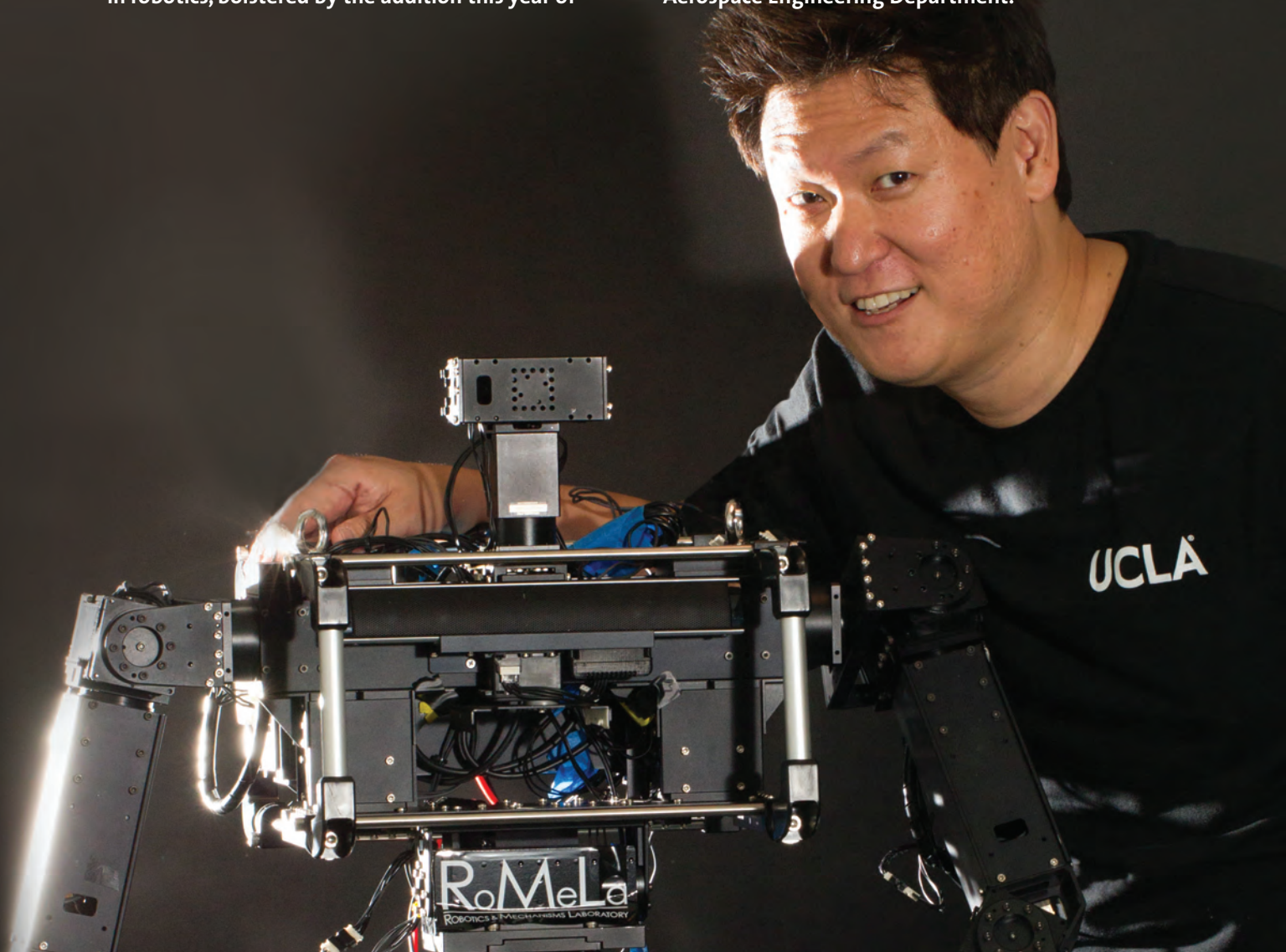
ROBOTICS AT UCLA

BY MATTHEW CHIN

Humanoids that can respond to natural or man-made disasters. Artificial hands with supreme articulation and sensitivity. Surgical robots that can help doctors save lives from thousands of miles away. These technologies are being developed today at UCLA Engineering.

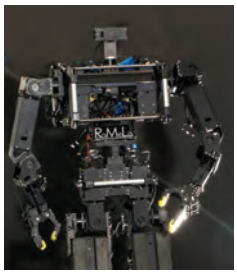
UCLA Engineering has a comprehensive program in robotics, bolstered by the addition this year of three new faculty members – Dennis Hong, Jacob Rosen, and Veronica Santos – who are profiled on the following pages.

"We already have a number of people in the school and at UCLA who work in areas that are related to the interdisciplinary field of robotics," said Professor T.C. Tsao, chair of the Mechanical and Aerospace Engineering Department.



This includes Tsao and others working in dynamic systems and controls, as well as researchers in microelectromechanical systems, manufacturing and design, computer vision and artificial intelligence. For example, computer science professors Stefano Soatto and Demetri Terzopoulos each have done groundbreaking work in computer vision – how computers "see" the world around them – and professors Judea Pearl and Richard Korf are longtime innovators in artificial intelligence. In addition, UCLA Engineering faculty across several disciplines frequently collaborate with researchers at the UCLA David Geffen School of Medicine.

"Now we have great faculty who are at the center of the robotics program," said Tsao. "They build robots!"



"Robots are needed for what are known as the 'three Ds' – dull, dirty, and dangerous. These are jobs that are unsuitable for humans. At RoMeLa, we are building robots to get into the dangerous places and do the dirty work."

– Dennis Hong, *Professor of Mechanical and Aerospace Engineering*

At 7 years old, **Dennis Hong** was blown away by watching "Star Wars." What stood out for him were the droids. After watching the movie, he told his parents he wanted to build robots. Today he leads the Robotics and Mechanisms Laboratory (RoMeLa), which designs and develops humanoid bipedal robots, as well as novel locomotion strategies. He and his students are four-time winners of the RoboCup.

Next year his lab will take THOR-OP, a full-size humanoid robot, into the finals of DARPA's Robotics Challenge, which seeks to find the best robots for disaster response scenarios. Among the tasks THOR-OP needs to complete: get into a car, drive it, and get out; open doors; and climb ladders.

romela.org

◀ *Dennis Hong with THOR-OP —short for Tactical Hazardous Operations Robot, Open Platform —which is a bipedal electro-mechanical humanoid.*

▶ *DARWIN-OP, an open platform miniature humanoid robot.*

Photos: Joanne Leung

A schematic of Raven IV, a surgical robotics platform.

"We're trying to push technology beyond the teleoperation mode into automation of surgical procedures, allowing surgeons to focus on making critical decisions."

– Jacob Rosen, Professor of Mechanical and Aerospace Engineering

Jacob Rosen is focused on surgical robotics systems and rehabilitation robotic systems. He is best known for developing Raven, an award-winning open platform robotic system for minimally invasive surgery. The newest version, Raven IV, includes four operating arms and two stereo cameras that can substitute for two surgeons. His current research is focused on testing the feasibility of performing telesurgery aboard the International Space Station, with the operator stationed on Earth.

Rosen also is studying and developing an exoskeleton system with applications in stroke rehabilitation, brain plasticity and human machine interfaces. The current mode of study is based on mirror-image symmetric motion, in which a patient uses his or her fully functional arm to control the disabled arm through a therapeutic virtual reality environment.

Rosen is a member of UCLA's Center for Advanced Surgical and Interventional Technology.

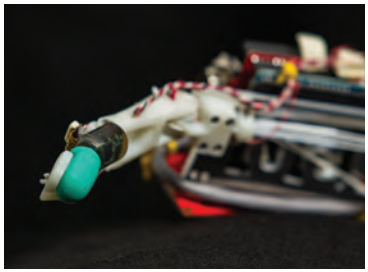
bionics.seas.ucla.edu

◀ *An upper-limb exoskeleton prototype to study joint movement in human arms.*

▶ *Rosen with a Raven IV model.*

Images Courtesy Jacob Rosen

The overarching theme of Veronica Santos' research is to get humans and robots to work together.



A fingertip-sized multimodal tactile sensor used to study haptics.

"Our Biomechatronics Lab is dedicated to improving quality of life by enhancing the functionality of artificial hands and their control in human-machine systems."

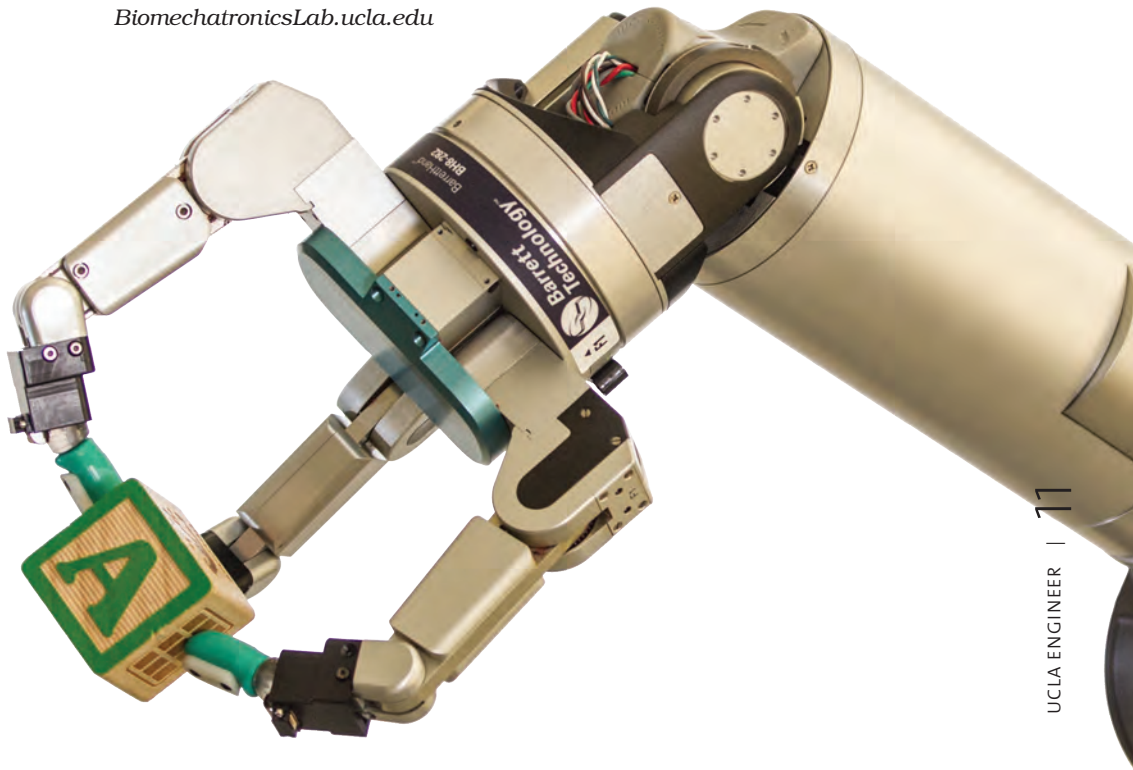
– Veronica Santos, Associate Professor of Mechanical and Aerospace Engineering

Veronica Santos hurt her elbow during basketball practice in high school. That injury, which slightly limits her elbow's mobility today, was the inspiration for her scholarly path into robotics, where she aims to improve the quality of life of people with significant physical limitations.

The overarching theme of her research is getting humans and robots to work together – specifically, developing technologies for artificial hands that incorporate rich sensory feedback with intuitive control and functional movement.

One current project is the development of a robot hand testbed for human-inspired grasp, manipulation and exploration of objects. Another project is designing and testing deformable, polymeric tactile sensor skins for artificial hands. ■

BiomechatronicsLab.ucla.edu



◀ *Santos with a robotic arm using specially designed fingertip sensors.*

▶ *Santos is developing robotic fingertip sensors to detect temperature and texture, among other qualities.*

Photos: Joanne Leung