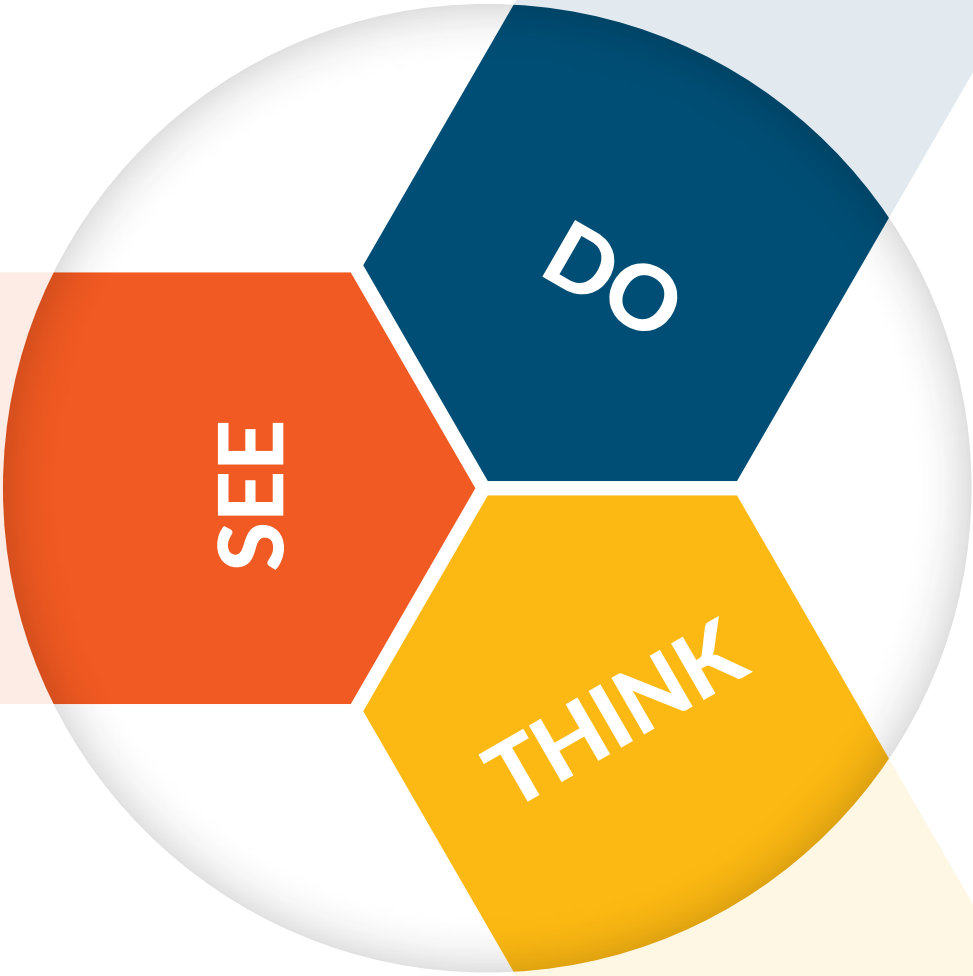
UC San Diego

CONTEXTUAL ROBOTICS INSTITUTE



A partnership between the UC San Diego Jacobs School of Engineering
and the UC San Diego Division of Social Sciences

THE FUTURE. IN CONTEXT.

We are launching the Contextual Robotics Institute to integrate researchers from across UC San Diego who work in disciplines and technologies that need to converge in order to develop autonomous robotics systems that are helpful to humans. These "contextual robotics systems" will perceive, coordinate and act based on a real-time understanding of different types of context around them.

Real-time robotics systems have the potential to transform elder care and assisted living, disaster response, medicine, transportation, environmental sensing, education and a range of other consumer-oriented applications.

This work will require research and education collaborations between engineers, computer scientists and cognitive and other social scientists. Together, we will establish the San Diego region as a hub for the design, development and production of useful robotics that act based on a real-time understanding of the world.

Join us as we invent the future of robotics for the public good.

Albert P. Pisano, Dean
Jacobs School of Engineering

Carol Padden, Dean
Division of Social Sciences

INTEGRATING DISCIPLINES FOR CONTEXTUAL ROBOTICS

Context — physical, emotional or sociological — enables situational awareness and is essential to achieving true autonomy in robotics systems. Contextual Robotics is envisioned as a future where robotics systems understand context and apply known capabilities, derive new capabilities from context and even change the context in a controllable manner by applying new capabilities. Below are some of the research areas we are advancing and integrating to develop robotics systems that see, think and do in real time, in the real world, often in close proximity to humans.

SENSING + PERCEPTION

- Deep learning and statistical analysis of images and video for object detection, scene understanding and context sensing
- Computational models for recognizing actions and inferring intent and relationships
- Processing of inputs from real-life applications
- Sensing, control and optimization algorithms

COGNITION + COORDINATION

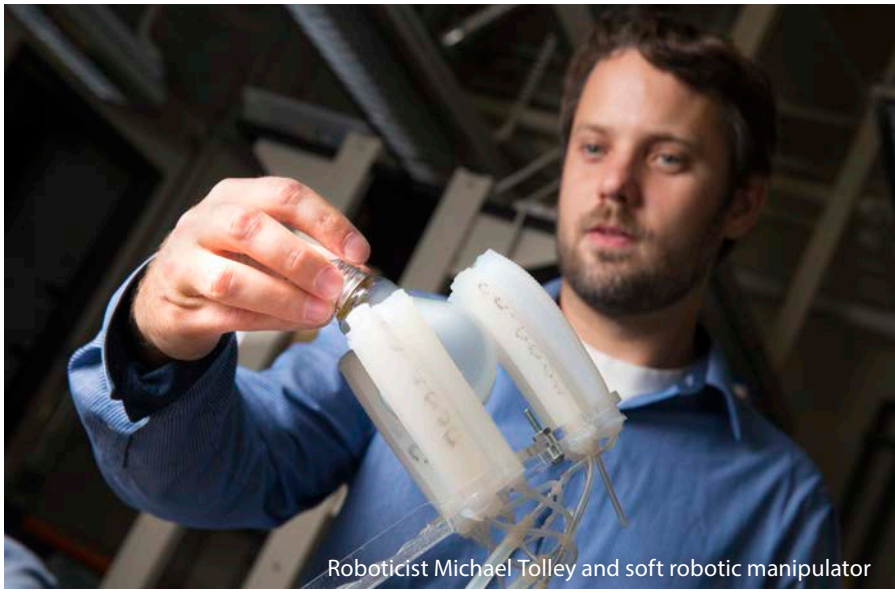
- Distributed decision making and evolution of group behavior despite uncertainty and limited communication
- Embodied Artificial Intelligence
- Synthetic brain architectures
- Methods of coupling high-performance computing and the Internet of Things with local planning and decision making
- Conveying ethical and moral imperatives to robot behavior

MOBILITY + MANIPULATION

- Biologically inspired actuators (limbs) and new materials
- Robust feedback control mechanisms for distributed, noisy, unknown environments
- Models using context to direct safe and appropriate action
- Coordinated fault-tolerant motion of multiple actuators or vehicles despite limited communications and time delays
- Nano- and micro-robotics

Human-friendly Robots

Future generations of fast, agile robots will work safely alongside humans in unprecedented ways. UC San Diego engineers are developing robots with both soft and rigid materials, which is one of the keys to achieving this goal. Mechanical engineering professor Michael Tolley and colleagues at Harvard recently designed, programmed and manufactured the first robot with a 3D-printed body that transitions from a rigid core to a soft exterior. They presented their results in *Science*. The project is part of Tolley's effort to expand the field of biologically inspired robotics. They will be a subset of future contextual robots outfitted with advanced communication and sensing capabilities that recognize context, empowering them to move and interact with the environment safely and effectively.



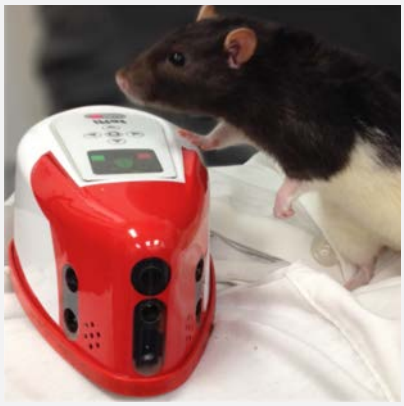
Roboticist Michael Tolley and soft robotic manipulator

Environmental Sensing Swarms

Picture hundreds of sensor balloons communicating via inexpensive cellphone technology that can be released into a developing hurricane; self-distribute; and track the storm over several days while sending data back to forecasting centers. The balloons steer by using buoyancy control, leveraging winds' strong stratification. Storm monitoring with this method can radically improve the accuracy of track and intensity forecasts, providing more time to move people out of harm's way. Mechanical engineering professor Thomas Bewley and his team are working to solve this difficult controls problem, improving our understanding of complex environmental flows in real time. This is just one example of the world-class controls expertise at UC San Diego that is being advanced and applied to improve tomorrow's robotics systems.

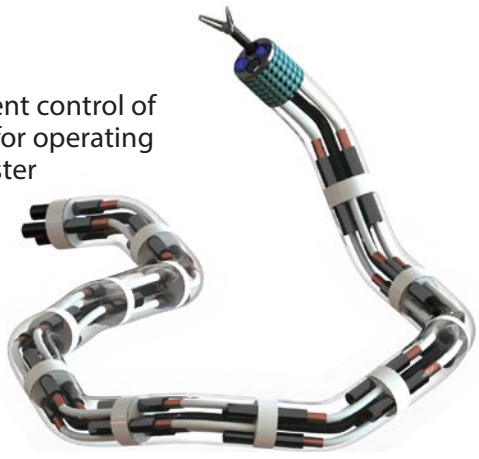
Animal Model for Contextual Robotics

iRat is a robotic rodent. Cognitive scientists and engineers are using iRat in social neuroscience research that could lead to robots that are better equipped to interact with humans. The researchers, led by cognitive science professor Andrea Chiba, bioengineering professor Todd Coleman, and Janet Wiles from the University of Queensland, are studying how their robotic rodent interacts with and triggers responses from rats equipped with heart rate, brain function and breathing monitors. These kinds of projects are part of broader efforts at UC San Diego to develop context-sensing capabilities that will be critical for contextual robotics systems that detect, and then act, based on human needs, intentions and emotions.



Flexible and Surgical Robotics

Electrical engineering professor Michael Yip is a pioneer in the design and intelligent control of flexible, snake robots and surgical robotic systems. His robot systems are suitable for operating in unstructured and unpredictable environments such as the human body or disaster scenarios. In addition, Yip develops sensors and actuators for biomedical systems, systems for augmented reality in surgical training and image-guided surgery. In this capacity, he adds to UC San Diego's strength in visual computing, a research community which will play key roles in advancing the sensing and perception capabilities of contextual robotics systems. Yip joins a dynamic group of researchers in the San Diego region who work at the intersection of clinical medicine, robotics, medical devices, biotechnology, electrical engineering and wireless communications.



Snake-like robot for navigating within the human body for minimally invasive surgery.

ROBOTICS HUB

"We aim to grow San Diego into a world-class robotics hub. In addition to our research efforts, we are developing cross-disciplinary education programs, focusing on industry partnerships and strengthening our entrepreneurship programs. These efforts will converge in common lab spaces where we will inspire and prepare tomorrow's robotics workforce."

Albert P. Pisano
Dean, UC San Diego Jacobs School of Engineering

Deborah Forster (right) a cognitive scientist from the Qualcomm Institute with robotics students

Learn more about advanced robotics systems at UC San Diego
ContextualRobotics.ucsd.edu

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