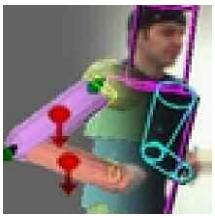
Chad Jenkins and an early robot: "Exceptional potential."

Robots for the real world



A rising scientific star and head of Brown's program in robotics translates human behavior into maps for increasingly complex, and helpful, robot behavior.

Chad Jenkins and his students talk to a robot. And the robot talks back. It responds to their words and their gestures. It follows them, turns with them, waits for them, and backs up in a natural way when they walk toward it. In collaboration with the research arm of manufacturer iRobot, and with support from the Office of Naval Research, Defense Advanced Research Projects Agency, and other funding agencies, Jenkins and his team are making it possible to interact with robots without the use of remote control devices. Instead, they use emerging sensor technology to create more natural, hands-free interactions.

This is just one of the exciting projects under way in the laboratory of a young faculty member who is a magnet and an inspiration for budding roboticists. Assistant Professor of Computer Science Odest Chadwicke Jenkins, who came to Brown in 2004, received national recognition for his work in robotics just four years after earning his Ph.D. at the University of Southern California. In 2007, he received the Presidential Early Career Award, the highest honor available to young scientists in the United States, recognizing "exceptional potential for leadership at the frontiers of knowledge." Jenkins has also won recognition from the Office of Naval Research and the Air Force Office of Scientific Research.

At Brown, Jenkins teaches graduate and undergraduate courses, including "Building Intelligent Robots." In the past year, the course focused on developing "brains" for robots and examined, among other things, the human-robot dynamic, which is the lodestar of Jenkins's own research. As leader of the University's robotics research program, Jenkins directs the RLAB: Robotics, Learning and Autonomy at Brown. There, he collaborates with and mentors graduate and undergraduate students in a fascinating array of research projects.

"My group works on robot learning and human-robot interaction," Jenkins says. "We need robots that can adapt over time, that can respond to human commands and interact with humans." This implies that robot behavior must be increasingly determined by user input, a problem a number of RLAB projects are addressing. Among them is a robot soccer experiment in which people use a Wiimote to participate in the game from the robot's perspective. "The player sees what the robot sees," says Jenkins, "and decides what it should do in a given situation. The person knows what he wants the robot to do, yet the robot's control policy – the entity that makes decisions for it – may not be capable of reflecting that. But when input from humans playing the game is gathered and used to refine the robot control policy, the player's will can shape what the robot does. The user can help the robot build on its primitive locomotion and manipulation skills to perform higher-level tasks."

Graduate student Daniel Grollman collaborated with Jenkins on the robot soccer project and was invited to present results at an international Human-Robot Interaction conference in Amsterdam last spring.

The mouse-driven robotic hand at right, which can grasp a variety of objects, was developed by graduate student Aggeliki Tsoli (above) and Chad Jenkins.

The goal of making robots more closely reflect the will and behavior of humans drives an RLAB project to refine movement in a NASA humanoid upper-body robot. Researchers use motion capture systems to record human movement in three dimensions, then translate that data into digital models that can be used to create a more effective control policy for the robot. The new policy has made it possible for the robot to replicate basic human motion and manipulate objects.

Jenkins is also producing interfaces that could work with a neural cursor control developed by Professor of Neuroscience John Donoghue. The multidisciplinary research team Donoghue leads has demonstrated that an implant in the primary motor cortex of a paralyzed human subject can convert thought into a control signal that, when decoded, will produce movement in a robotic hand or a jointed robotic arm. Jenkins is collaborating with graduate student Aggeliki Tsoli to make robotics perform in this situation with much more dexterity, not just grasping with power, for example, but grasping with precision and appropriate pressure for a given task, so people with paralysis can use the hand to cook and perform other household activities.

"Here again, we use motion capture to look at how all the joints in the human hand rotate and interact. Then we map those motions, compressing the data as fully as possible into a two-dimensional cursor control.

"I couldn't do this work without my student collaborators," adds Jenkins. "As a faculty member, I don't engage with projects as directly as I did when I was in graduate school. Instead, I'm more of a manager. I guide students to find interesting problems and determine how to approach them. I am leading the group, but the real work is done by students, undergraduate as well as graduate."

Students and alumni from the lab are already distinguishing themselves. Alumnus Mark Mosely is at iRobot working on PackBot systems such as those used by the military for bomb disposal. Graduate student Matt Roper has also worked on the PackBot to enable hands-free human-robot interaction. Alumnus Edwin Chang, who collaborated with Jenkins on a new methodology for facial expressions in animation, is at Pixar. Another graduate, Pawel Wrotek, who studied game technology with Jenkins and is pursuing a career at video game giant Electronic Arts, created physically simulated humanoid characters that move in a physically plausible manner in game environments. German Gonzalez, a master's student, has gone on to Ph.D. studies at the École Polytechnique Fédérale de Lausanne (EPFL).

Robotics is a global field, and many of the articles Brown students have co-authored with Jenkins have been published or presented abroad, as well as in U.S. journals and conferences. In July of 2007, Jenkins chaired an international Mobile Robot Workshop sponsored by the Association for Advancement of Artificial Intelligence (AAAI) in Vancouver, B.C. Jenkins is now a co-chair for both the AAAI Symposium Series and the AAAI Robotics Exhibition and Competitions, as well as a member of the steering committee for the IEEE Technical Committee on Robot Learning.

He has been building research relationships in Germany, where the field of robotics is particularly strong. He recently delivered talks on robot learning to research groups at the Technical University of

Chad Jenkins on widening the pipeline

"In May 2007, Brown joined the National Science Foundation's Advancing Robotics Technology for Societal Impact (ARTSI) Alliance, a group of research universities and historically black colleges collaborating to engage more African-American students in computer science and robotics. This is an exciting opportunity for Brown, which has a long history of fruitful relationships with historically black colleges and universities, to bring students from those institutions to the research-focused environment we foster in computer science on our campus. Given that less than five percent of computer scientists are African-American, and career opportunities in the field are burgeoning, this program has an important role to play. We need as many great minds in the field as possible."

Munich. Munich is home to DLR (the German Aerospace Center) and a major site for robotics hardware development. Some of Jenkins's students have traveled to the Technical University to work on research collaborations, and he hopes to make it possible for robotics students from Munich to visit Brown.

Jenkins sees Brown as a rich environment for research in his field. "Computer science is meant to be an interdisciplinary endeavor," he says. "The field of human-robot interaction has vital connections to psychology and brain science. I work on the algorithmic side of this problem, but it's no coincidence that my major research projects have brain science aspects. The strength of Brown's brain science program is a tremendous advantage."

He "really appreciates the great senior leadership" in computer science. Professor of Computer Science Michael Black, who works in neural interfaces, machine vision, and full-body tracking, "helped recruit me to Brown and has been an excellent advisor and mentor to me. I came here because I was looking for strength in research and strength in teaching. The balance is perfect. Interaction with students and the desire to inspire them keeps me fresh as a researcher.

"The department puts faculty in a great position. We can take chances, experiment, and make real progress in finding ways to help people function in the world."

Graduate student Daniel Grollman taught robot dogs to play soccer.