Dancing with robots

By Peter DeMarco
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The opening notes of "New York, New York" blare from the laptop computer of champion swing dancer Sommer Gentry as she offers her dainty hand to her partner, "Fred."

In perfect time, he twirls her wrist in a circle, then a semicircle, then back around the opposite way. He leads and she follows without a word being spoken, as all good dancers do, the two communicating entirely through the sense of touch.

Fred's footwork, of course, leaves much to be desired: He doesn't have any feet, legs, or a head, for that matter. The size of a desk lamp, Fred is merely a robotic arm programmed with a repertoire of simple dance moves. But, in Gentry's eyes, Fred's got something robots have sorely lacked up to now — a sense of rhythm.

"We know it works for a person to interact with another person this way. Why don't our robots think this way also?" asks Gentry, a 26-year-old doctoral student in MIT's Laboratory for Information and Decision Systems. Her idea that machines can be taught physical vocabularies that allow them to work hand in hand with humans is ground-breaking science, fellow researchers say.

Though the study of haptic robotics, which focuses on touch-based communication between humans and machines, is still in its infancy, Gentry's concept could have vast applications. In surgery, robots could

ROBOTS, Page C5

GLOBE STAFF PHOTO/JOHN TLUMACKI

Sommer Gentry hopes to develop a robot that can swing dance with her, responding to her touch the way a human partner does.

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Dancing with robots is high-tech research

▶ ROBOTS
Continued from Page C1

be programmed to react to a surgeon's moves: The surgeon cuts a section of skin, the robot lifts it, almost instinctively. Prosthetic, bionic legs could sense physical cues from upper-thigh movements and take steps without need of a command. On the battlefield, robotic equipment could help soldiers react faster to incoming fire when there's no time to exchange dialogue or push a button.

"Sommer's work is part of a general trend to make interaction with computers and machines a more gentle process," said Dr. Roderick Murray-Smith, a researcher at the Hamilton Institute in Ireland and a leading figure in haptic robotics. "In a few years, we might not view interacting with computers as a command-and-control scenario, but rather more like a waltz, where sometimes the computer leads the user and other times the user leads the computer, with smooth transfers of who is leading."

Dr. Allison Okamura, director of John Hopkins University's Haptic Exploration Laboratory, called Gentry's work "very original."

"The idea of dancing may seem kind of trivial. Why study that? But the fundamental laws of how humans and machines can interact through haptics are going to be essential for all these other types of tasks. I think dancing is just a great concept to study that type of system."

Gentry, a California native, was looking for a way to meld her love for the Lindy Hop with her scientific studies when she visited Murray-Smith's lab two summers ago. He suggested she program one of the commercially-produced PHANToM robotic arms in his lab on how to dance.

Writing code to order a robot to perform a task, in this case a dance, was nothing new. The challenge was finding a way to teach the robot to dance in unison with a person, imbuing the machine with both the lifelike pull and push of a partner's hand and the spontaneity of a real swinger.

Gentry knew how automatic dancing can be. She and her husband, Dr. Dorry Segev, who met six years ago while dancing at the Cambridge VFW hall, have twice placed fifth in the American Lindy Hop championships, and they won the UK championship in 2002. In some competitions, known as "Jedi" dances, experienced partners are so in synch they dance while blindfolded.

Studying hours of videotapes of dance meets, she discovered that even first-time partners fared well, so long as each was accustomed to a basic set of dance moves and the physical hand cues that signaled the start of a half-spin, a Charleston, or a Susy Q.

Not only did partners recognize such touch signals, "they were able to turn around before it was physiologically possible for them to get the signal from the hand to turn around," Gentry said.

Gentry said she realized that this concept of "pre-programmed control" was rooted in the dancers unspoken physical vocabulary, and could be transferred to a robot, provided it was programmed with the same vocabulary of moves. Six months later, Fred — as in Fred Astaire — was strutting his stuff.

Gentry's work garnered her the Best Student Paper Award last fall at the 2003 IEEE International Conference on Systems, Man and Cybernetics, a gathering of hundreds of robot scientists from around the world. At last year's Eurohaptics conference in Dublin, her dancing robot was

Some machines already feel real

Lending a human touch to robots isn't just a futuristic idea that will someday help in operating rooms and space exploration. Such "haptic" technology, though still in its infancy, is already being used in video games, sports cars and airplanes.

In video games, steering wheels that allow players to feel the "bump, bump, bump" of driving off-road are transmitting what is called vibration feedback — the "poor man's haptic feedback," said Dr. Allison Okamura of the Haptic Exploration Laboratory at John Hopkins University.

In some high-end cars with manual transmissions, stick shifts have been imbued with sensors that mock the sensation of gears shifting, said Eric Feron, professor of aeronautics and astronautics at MIT. Some airplanes likewise have yolks that allow pilots to feel a "virtual" resistance on the rudder so they don't pull back too hard.

"As the field matures in the next 10 years," Okamura said, "you'll see a lot more."

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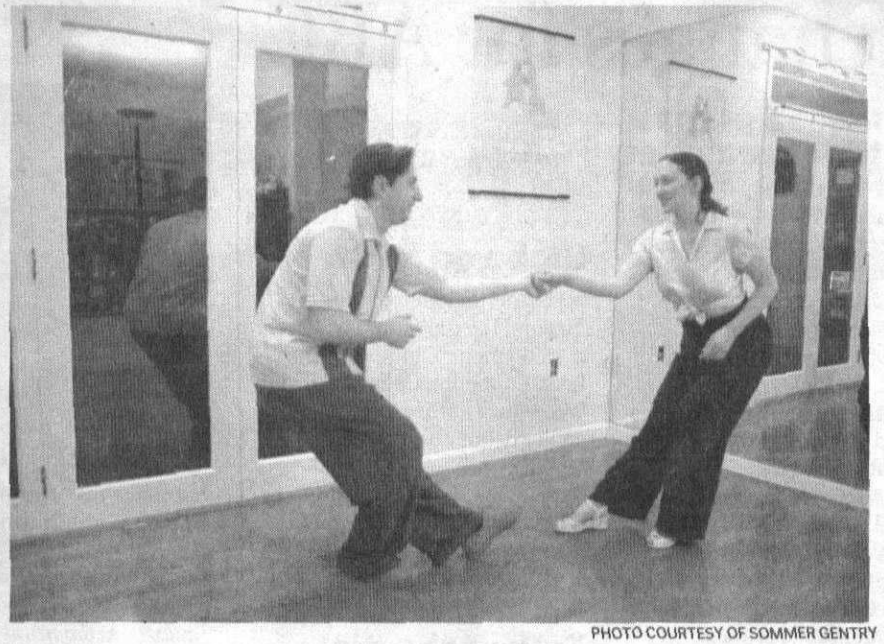

PHOTO COURTESY OF SOMMER GENTRY

MIT doctoral student Sommer Gentry applied some of what she learned while dancing with her husband, Dr. Dorry Segev, to her research on touch-based communication between humans and robots.

a big hit with those brave enough to give him a whirl.

"It's kind of like playing a video game. 'Oh, did I get the move right?'" Gentry said, explaining that Fred chooses his moves at random. "It even made a few people nervous. 'Oh, you're going to be able to tell from your data that I have no rhythm.'"

Admittedly, some MIT faculty members haven't warmed to her work, Gentry said, seeing no real scientific benefit in swing dancing. A description of Gentry's robot on the swing dancing website, Yehoodi.com, prompted one message-board user to joke, "Of course an MIT student would try and remove all human contact from any activity."

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Gentry is unfazed by such negativity, explaining that her work could pay off for both dancers and scientists. By digitizing the physics of the fox trot, she said, people can better understand how we dance with one another.

"It's difficult to teach people what dancing is supposed to feel like," she said. "If you were dancing with a robot, you could have him force you to feel the appropriate level of interaction with the different parts of the move."

Her thesis on robot dancing nearly finished, she has been working with Okumura's laboratory on applying her work to surgery, where remote-controlled (or teleoperated) robots are already being used.

"If you were working with a person — your surgical assistant across the table — he knows what you want lifted before you lift it," Gentry said. "[What] if I sit down with my robot and say, 'OK, these are the things I might be doing. I might be lifting. I might be cutting. I might be pulling. What are ways you can help with each of those?'"

Though she isn't looking to put any surgeons — or dance instructors — out of work, she dreams of taking her robotic partner to new levels, eventually programming him to sense emotional highs and lows in songs, to react to her mistakes, or to follow her lead.

And, who knows? One day, if robots ever learn to walk, Fred might just step on her toes.