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...
Dancing with robots is high-tech research
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 yolkels 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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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...
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.

"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."

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 Oku-mura'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.