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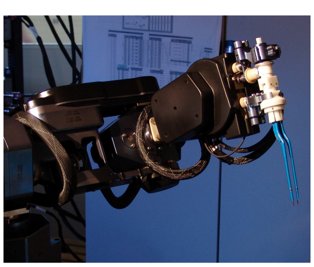
Methuen Company's Motors Power MRI Surgery Robot

By Neil Savage

Combine the folks who brought you the giant robot arm on the space shuttle with a company that makes miniature ceramic motors and what do you get? A brain surgery robot that works inside an MRI machine, of course.

Researchers at the University of Calgary in Alberta, with help from MacDonald, Dettwiler, and Associates (MDA), makers of the Canada arm that helps the space shuttle pluck satellites from orbit, have developed something called the neuroArm, an experimental robotic arm complete with scalpels for performing brain surgery. And Johnson Medtech, a Methuen, MA, subsidiary of Hong Kong's Johnson Electric, is supplying the tiny ceramic motors that give the arm mobility, the company announced Wednesday.

What's cool about the neuroArm is that a brain surgeon can stick it inside a magnetic resonance imaging (MRI) scanner and use its remote manipulators to operate while getting a real, live MRI picture of what's going on. That gives surgeons better information about where to cut and where not to, and how to change their procedure as they go. The robot is also accurate to less than half the width of a human hair, more than 20 times the dexterity of a human hand, says the team who designed it. That means instead of operating on the brain as a whole organ, they can start to think about their surgeries nearer to the cellular level.



There aren't many instruments that can be used in conjunction with an MRI, all because of that pesky M. Standard metal objects get pulled away by the strong magnets that produce the image, and anything that produces a magnetic field itself distorts the picture. So most of the robot is made of titanium or a plastic composite. That's where Johnson Medtech comes in.

The company makes a piezo-ceramic motor that is unaffected by the magnets. "It's basically a piece of ceramic crystal," says Alan Feinstein, president of Nanomotion—one of the companies that makes up Johnson Medtech, an umbrella organization encompassing bits of several Johnson Electric subsidiaries. "The actual motor element is about the size of a stick of Trident chewing gum."

This particular crystal is piezoelectric, meaning that when you apply an electrical field to it, it changes its shape. In the neuroArm, the piezo-ceramic motor is hit with 270 volts, and its bends and distorts, wriggling back and forth like an eel at a rate of about 40,000 oscillations per second. As it vibrates, it presses a tiny fingertip of ceramic against a ceramic ring, spinning it like you might spin a bicycle wheel with one finger. Six motors around a 150-millimeter-diameter ring provide plenty of torque for moving the robot arm around. Other parts have smaller set-ups; just one motor and a 40-millimeter ring move the robot's "wrist."

So *(a)*, the fact that the motor is all ceramic means it's immune to the MRI's magnetic field. And *(b)*, because the design uses a high voltage and low current (about 100 milliamps) to drive the motor, the current doesn't produce enough of a magnetic field to distort the MRI's image. Feinstein said the MDA builders tried out a couple different motor concepts. "Ultimately, our motor was the only motor that claimed to be non-magnetic and was non-magnetic."

Feinstein says that the neuroArm's creator, Calgary professor of neurosurgery Garnette Sutherland, is doing early trials with the device, using mannequins and cadavers to show that it's safe and reliable. He expects there'll be about 100 test robots built over the next four years while the thing works its way though the U.S. Food and Drug Administration's and Health Canada's approval processes, with clinical trials going on in various hospitals.

He also expects that the developers of the robot will want to make a smaller version of the current prototype, and then might look at tools for other types of surgery that could be done using MRI. For instance, an MRI image could provide a very clear picture of where a prostate tumor ends and something you really don't want to cut out begins. And for tools that use lasers or ultrasound to burn away tumors, the MRI could provide not only a 3D image but a heat profile, giving doctors finer control of exactly what they're zapping.

The three-way collaboration began almost by accident, the way Feinstein describes it. He'd been to MDA about five years ago to talk about whether Johnson Electric's motors might be useful in the space-based systems that MDA builds. They might be used to focus or aim a laser beam on some space-based spectroscopy instrument, for instance. Later, when Calgary teamed up with MD Robotics, the MDA's robot-building branch, the MDA engineers knew where to go for motors.

Feinstein says Johnson Electric created Johnson Medtech last December to bring together experts from its different subsidiaries to see which of the company's existing technologies could be applied to the medical field. Johnson Medtech is based in Methuen with Parlex, which makes printed circuits for, among other things, medical equipment. Nanomotion, of Ronkonkoma, NY, is the U.S. headquarters of an Israeli company, and brings the expertise in piezoceramics. Saia-Burgess Controls, a Swiss company, builds control systems for automation.