Medical Xpress

CWRU team building an MRI-guided robotic heart catheter

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In a matter of years, a doctor may see real-time images of a patient's beating heart and steer a robotic catheter through its chambers using the push and pull of magnetic fields while the patient lies inside a magnetic resonance imager.

Researchers at Case Western Reserve University have received a $1.3 million grant from the National Institutes of Health to perfect such technology over the next four years.

The project aims to improve treatment of arterial fibrillation—an irregular beat that occurs when electrical conductivity in the heart short-circuits and can lead to a stroke or heart disease.

To treat the problem, doctors slip a catheter through a vein in the thigh up into the heart, where an electrode tip is used to burn, or ablate, the tissues involved in the short-circuiting. When successful, this allows the heart's electrical currents to travel smoothly, resulting in normal beating and blood flow.

But doctors sometimes have trouble maintaining contact with the target tissue. A beating heart moves the target, and flowing blood creates turbulence similar to airplanes through wind currents. The two-dimensional view produced through fluoroscopy imaging is often grainy or blurry. The result is surgeons sometimes burn more tissue than necessary, or not enough to eliminate the problem.

"With our technologies, we believe physicians will be able to accurately navigate and target tissues; they will see exactly where they are inside the heart in real time and see the tissues they are ablating in real time," said M. Cenk Cavusoglu, professor of electrical engineering and computer science and principal investigator on the project.

Doctors will still hand-feed the catheter from thigh to heart. But once there, the robotics will take over, Cavusoglu said.

To make a catheter robotic, the researchers have wrapped the inch behind the tip in tiny copper coils. By passing an electrical current through them, the coils create a magnetic field.

When this magnetic field is paired with the magnetic field created inside the MRI to produce images, the catheter has the ability to move. In order to control the movement, Cavusoglu's lab is now developing software to use the fields like a pair of deftly controlled bar magnets.

A doctor using a joystick or touch screen will guide the catheter inside the patient. In the heart, to turn the catheter to the left or right, a current will be applied to coils in either direction.

The magnetic fields can produce the same effect as aiming two like poles of magnets at each other: they repel. Or aiming two unlike poles at each other: they attract. But, because the MRI field is much stronger, it's the catheter that moves. And, because the fields encircle the catheter, it can move up and down, not just side to side.

Nicole Seiberlich, an assistant professor of biomedical engineering, has already developed the technology to see images inside the body 10 times faster than what's commercially available, without sacrificing the clarity for which MRI's are renown.

She and colleagues will continue to increase the speed, enabling a doctor to clearly see the landscape inside the heart in three dimensions in real time.

Mark Griswold, professor of radiology at Case Western Reserve School of Medicine, had begun investigating the idea of a robotic catheter inside an MRI several years ago, but his lab dropped the effort when the device could not be properly controlled.

Jeff Duerk, dean of the Case School of Engineering and a professor of biomedical engineering who specializes in imaging, introduced Cavusoglu to Griswold, Seiberlich and others in their labs. When the others learned Cavusoglu had control algorithms and was looking for a place to use them, they restarted the effort.

To maintain a steady aim and contact with target tissues inside the beating heart, Cavusoglu's lab has already developed algorithms that automatically compensate for the contracting and expanding muscles and the pulsing blood.

"His algorithms come from the automated-car-driving world—they are predictive modeling—and our work comes from clinical medicine," Griswold said. "But because we got to know each other, we could see how we can work together."

In addition to the researchers named above, Jeff Ustin, MD, an assistant professor of medicine at Case Western Reserve School of Medicine and researcher and surgeon at the Cleveland Clinic, is assisting with the project.

Provided by Case Western Reserve University

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