Health & Medicine

Eye, Robot

Winter 2007-08

Sometimes it's not what doctors know, but how deftly they can handle surgical tools that determines the limits of medicine.

If surgeons' hands were perfectly still, for instance, they could inject clot-busting drugs into the eyeball's tiniest veins, which can clog as we age, obscuring our vision. And if their tools could twist into an S-shape, they might navigate more nimbly the confined regions of the throat, where the removal of a tumor can easily damage vocal chords.

To help doctors perform these kinds of delicate operations safely, Nabil Simaan, a 35-year-old Columbia assistant professor of mechanical engineering, has developed small, snakelike robots to handle surgical tools in tight quarters. "They're made for spaces where doctors have trouble moving their hands and where lots of tiny anatomical parts can easily get damaged, such as inside the eye, ear, and throat," says Simaan.

The robots are at least two years away from testing on animals or cadavers, but they're so promising that Simaan and Columbia University recently launched a start-up company, Auris Technologies, to raise funds to perfect the technology and eventually bring it to market. The Massachusetts-based biotech investment firm Medical Capital Advisors has joined the venture, one of about 10 start-ups launched last year by Columbia's technology transfer office, Science and Technology Ventures.

The robots' arms are made of nickel titanium, a flexible alloy, and they're tiny - ranging in width from one half a millimeter to four millimeters, depending on the surgical application. They can be equipped with lasers, tiny needles, grippers for tying sutures, sensors for determining how much resistance tissues exert, lights, and cameras. Doctors can control the arms using a joystick while viewing a three-dimensional image of the operating site on a computer workstation.

"Today, even high-tech laser surgeries are performed with handheld tools that are inflexible," says Simaan, who directs the Advanced Robotics & Mechanism Applications Research Laboratory at Columbia's engineering school. "That makes it difficult for doctors to work in certain areas of the body. Doctors are also constrained by the innate tremors in their hands, and they typically can do the most high-precision tasks with only one of their hands. With our robots, doctors will be able to perform high-precision manipulations ambidextrously, using more than one tool at a time."

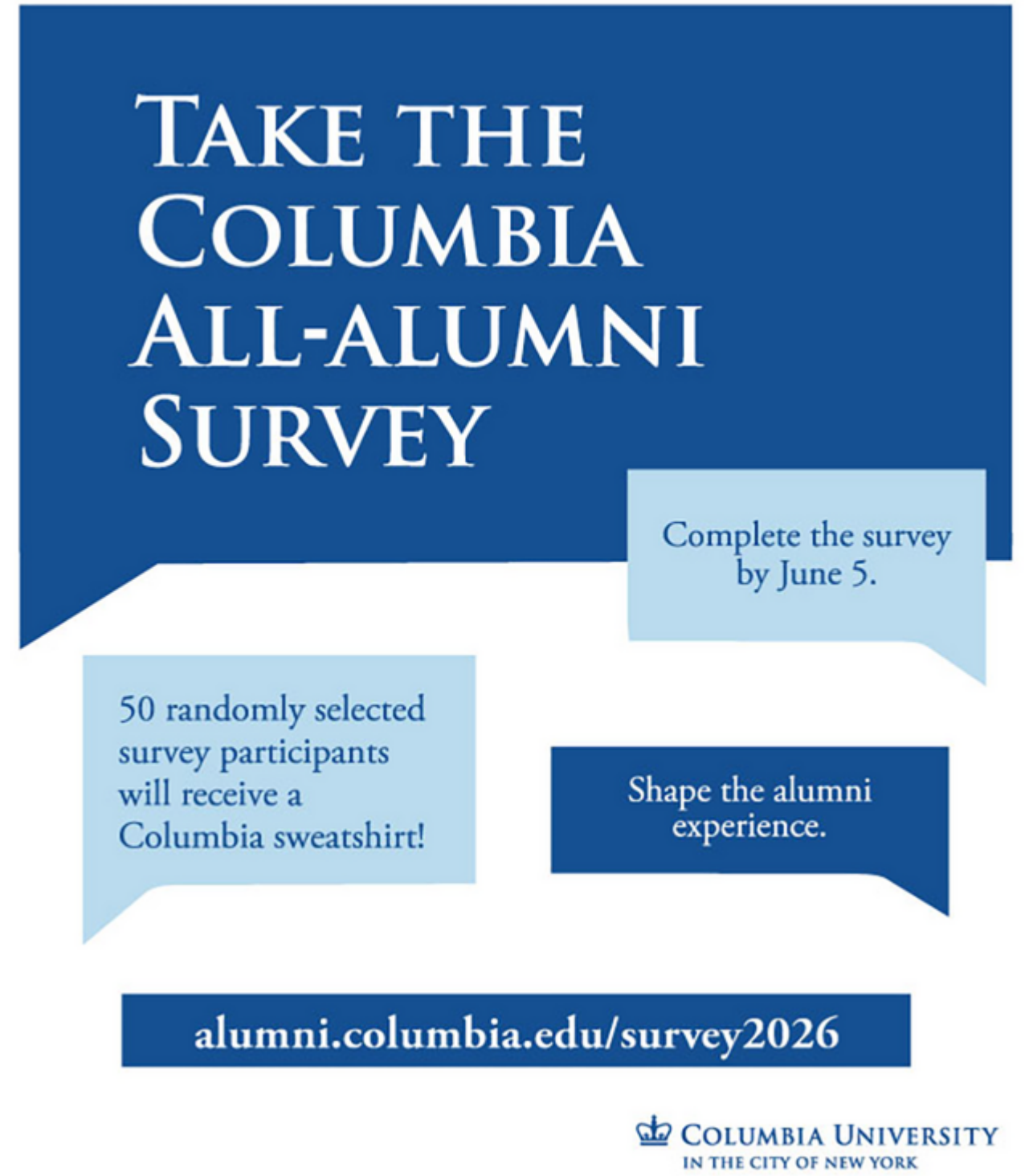
The robots' arms are incredibly nimble because a computer fine-tunes their positioning 1000 times per second. "Our goal is to achieve precision to the nearest five microns, or about 20 times more stable than a surgeon's hand," says Howard Fine, a Columbia ophthalmologist and assistant professor who's helping Simaan design a robot for eye surgery. "Doctors could then inject drugs into smaller veins than ever before. That would have implications for vascular microsurgery throughout the body, not just in the eye."

Simaan is also developing robots that could guide cochlear implants into the ear and help doctors remove tumors near the vocal chords. The robot for throat surgery, which is pictured at left, is being built with computer science professor Russell H. Taylor at John Hopkins University, where Simaan began designing his robot as a postdoctoral researcher in 2002. Simaan is also working with Columbia professor Dennis Fowler, a pioneer of minimally invasive surgery, on a robot for abdominal procedures.

"The robot's small size and dexterity will allow us to enter the body through a single incision in a natural orifice, whereas minimally invasive surgeries today require at least three access ports," says Fowler, who's vice president and medical director for perioperative services at Columbia University Medical Center. He made national headlines last year by removing a woman's gallbladder through her vagina.

"We could use the technology to remove an appendix, a kidney, or a gallbladder," Fowler says. "And it will mean less pain, less trauma to the body, and easier recovery."

Guide to school abbreviations



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