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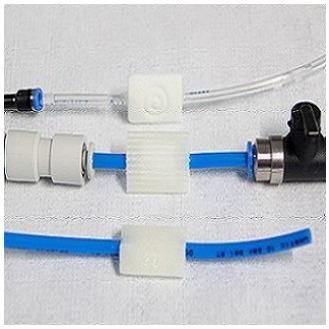
Flexible Robotic Worm Optimises Surgery



Surgeons may one day be able to remove tumours from within the inner ear in a less invasive fashion — ie, without removing the entire mastoid bone. All they will need to do is cut a tunnel of 5 mm in diameter through the bone using a miniature robot named NiLiBoRo. The robotic "worm" can adjust its path while drilling through bone to steer around sensitive tissue such as blood vessels and nerves. Researchers will be displaying the new technology at the Compamed exhibition from 16-19 November in Düsseldorf, Germany.

NiLiBoRo — a German acronym which stands for “Non-linear Drilling Robot — is being developed by researchers in the Mannheim Project Group for Automation in Medicine and Biotechnology, part of the Fraunhofer Institute for Production Technology and Automation IPA, in cooperation with the Technical University of Darmstadt, the University of Aachen, and the Düsseldorf University Clinic.

Drilling machines capable of boring a tunnel through bone already exist, but they can do so only in a straight line. If the tunnel were to run in a straight line, it would at times come troublingly close to hitting nerves. To avoid injuring nerve tissue, the tunnel would have to be no more than 1 to 2 mm in diameter. However, it is impossible to perform surgery through such a small opening. NiLiBoRo on the other hand is capable of steering around sensitive areas. This makes it possible to achieve a tunnel diameter of 5 mm, which is wide enough to perform the operation.

The robotic worm consists of a "head" and a "tail" section that are linked with one another by means of a flexible bellows mechanism, says project group scientist Lennart Karstensen. The design is reminiscent of an articulated public transit bus in which the front and rear sections are coupled by means of a hose-like centre section that looks like an accordion.

As it travels through the bone, the robot is connected to the “outside world” — in other words the control units and pumps in the operation room — by means of 8 to 12 hydraulic lines. It is these lines that allow the robot to crawl forward in the right direction. This is done by first pumping hydraulic fluid into three bladders found in the rear section of the robot. The bladders fill in the empty space between the worm and the bone and thereby fix the rear section of the robot in place. The hydraulic fluid then travels into the bellows. This causes the “accordion” to expand, which pushes the head forward.

The path NiLiBoRo takes as it drills its way forward is monitored by an electromagnetic tracking system (EMT), which works by sporadically capturing images of the robot using computer tomography in order to track its position.

The research team has already constructed an initial prototype of NiLiBoRo, which is currently five times larger than the planned final version. Right now it is composed of only the forward section together with the heart of the machine, the bellows. The team plans to continue optimising and expanding the prototype piece by piece. They hope to have the miniature robot ready for testing by physicians in two years.

Source and image credit: Fraunhofer-Gesellschaft

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