MRI scanner steers magnetic particle in live animal's blood

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Microscopic medical devices could one day be steered through a patient's bloodstream using magnetic resonance imaging (MRI) machines, Canadian research suggests. In the study, researchers were able to move small magnetic beads through the arteries of live pigs using the magnetic coils inside an MRI device.

Being able to move tiny working medical devices through the body this way could let doctors reach areas beyond the scope of keyhole surgery or other existing techniques, explains Sylvain Martel, of École Polytechnique Montréal, who is developing the approach.

Martel has previously worked on microscopic walking robots (see Lord of the dance) but had a brainwave three years ago. "I was thinking how magnetic fields can be used to propel magnetic objects," he told **New Scientist**, "and I realised hospitals already have devices that can provide them."

MRI scanners use two sets of magnets to peer inside the body. A large superconducting magnet creates a very strong field and three weaker coils interact with it to build up a 3D scan. Martel suspected that the three scanning coils could be used to exert a force in any direction on a magnetic object inside the scanner.

Trajectory planning

With colleagues, Martel then created software that uses the three coils to steer magnetic objects around. The scanner provides the user with an image showing the object and any surrounding material, allowing the controller to mark the trajectory for it to follow on a computer screen.

The software then uses the scanner's three coils to apply magnetic gradients to move the object along the chosen path. It checks on the object's progress 24 times every second and continuously alters the strength of each coil to keep it on course. "It's like a pilot programming a flight plan into an autopilot," Martel explains.

Experiments involving carotid arteries in the necks of live pigs suggest that the technique works. It was possible to steer a 1.5-millimetre-diameter magnetic bead back and forth through the artery, using the technique (after blood flow was temporarily halted). The beads could be moved at up to 10 centimetres per second, with an accuracy under 1 millimetre.

A video produced by the researchers shows the progress of a bead moving along the artery (0.5MB, wmv format), Another clip shows the trajectory marked on top of an MRI scan (6.1MB).

With the flow

Moving larger objects would be problematic, Martel admits, since the magnetic "vessel" would distort the image produced by the scanner. But the researchers are mainly interested in piloting smaller objects that can travel through very small blood vessels. "Smaller particles would move with the blood flow more," Martel explains. "We would just steer the path they take."

The team is working closely with cancer specialists to devise new ways to target treatment to tumours. "They are particularly interested in making it easier to reach into the brain," says Martel.

One possibility is to use a millimetre-scale device like that used in the pig experiment to find the best route to a tumour, before steering in particles that deliver drugs or heat its interior to kill it.

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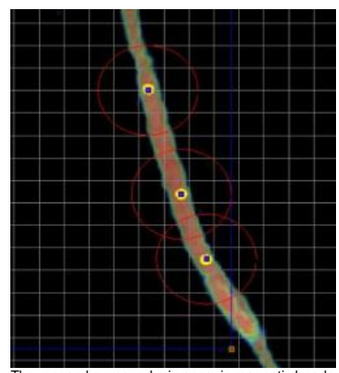

The researcher moved microscopic magnetic beads through the arteries of live pigs (Image: Applied Physics Letters)

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