Robotic, flexible needle for more effective cancer treatment

June 25 2019

Credit: Ivan Samkov from Pexels

Wood wasps use their stingers to drill into wood and lay their eggs inside trees. The resulting damage to wood that may end up as furniture and other structures in our homes might lead most of us to think of them as pests. Not so for the medical field, for which wood wasps are an inspiration. In their quest for safer surgical procedures, scientists have created probes that mimic the way this insect's stinger burrows into wood.

The EU-funded project EDEN2020 has used this inspiration to develop a robotically steered catheter that can deliver life-saving cancer drugs directly to a tumour in the brain. The project's patient-specific neurosurgical applications aim to meet the field's demand for better and minimally invasive treatment.

Called the programmable bevel-tip needle (PBN), the catheter is capable of following a tailored route through the brain that minimises tissue damage. Once it reaches the tumour, the PBN releases the chemotherapeutic drug to the tissue. This is all made possible through the project's five key technologies: preoperative magnetic resonance imaging (MRI) and diffusion MRI; ultrasounds performed during the procedure; a predictive engine based on sophisticated brain modelling; robotic-assisted needle steering; and a robotic platform for keyhole surgery.

The stinger-like needle and how it works

The PBN has four nested interlocking plastic segments that incorporate drug delivery channels. Each of the four channels also contains fibre-optic shape sensors. An ironless motor drives each segment, pushing a segment forward so that it slides over the others and causes the needle tip to curve. In this way, the needle is guided along a tailored path through the brain and can even reach deeply embedded tumours in impervious parts of the brain.

The PBN has four motors, each with their own drive. The drives' extremely low electromagnetic interference is critically important in such medical procedures. The system guides the PBN by analysing the MRI and ultrasound data, and then driving each of the four needle segments so that the needle can reach the tumour and deliver the drug. For treatment to be effective, this needs to be done with precision and at very high speeds. Path planning is performed by a high-performance motion controller with a multi-core processor and multiple features enabling ease of use. "[A] key factor in our choice of control solution for the project was the reduced development time," said Eloise Matheson, a Ph.D. candidate at project coordinator Imperial College London's Mechatronics in Medicine Laboratory, in a news item published on the "Med-Tech Innovation News' website.

EDEN2020 (Enhanced Delivery Ecosystem for Neurosurgery in 2020) has taken part in a number of events in order to present its technology to the public. These include a recent visit to Imperial College London by high school students from the Generating Genius Programme, and a pop-up science station set up by the EDEN2020 team at the Natural History Museum in London.

More information: EDEN2020 project website: www.eden2020.eu/

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