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Design of a Combined Real-time Actuation, Imaging, and Local Heating System for Microrobot Tracking and Thermal Triggering

Portable gantry combining magnetics, ultrasound imaging, and local heating for low-cost microrobot control in therapy and surgery.

Researchers at Purdue have designed an integrated, low-cost, microrobot control and imaging system for patients undergoing treatment with magnetically controlled microrobots. Current systems for magnetic microrobot control require either large robotic arms, high current electrical coils and cooling systems, or extremely large permanent magnets. These systems can be prohibitively expensive, and are large and bulky, requiring a dedicated operating room for use. Ideally, a magnetic microrobot control system should be low-cost, easy to implement in hospital environments, and should be able to carry out many different end-use applications.

The researchers designed a portable, gantry-style, microrobot control system affixed to a metal frame large enough to accommodate humans and large animals. The control system can maneuver in the X and Y dimensions and has two arms that can move in the Z-dimension (towards vs away from the patient). Attached to one Z-axis control is a high-frequency ultrasound imaging system and a directed ultrasound probe for local heating. Attached to the other Z-axis control is a rotating permanent magnet with two degrees of freedom to control the movement of the microrobot.

Technology Validation:

The researchers plan to validate the design for the microrobot control system through several tests. First, the researchers will test the functionality of the ultrasound imaging system and heating probe in a biologically relevant fluid bath to calibrate the required heating settings. Next, they plan to optimize the ultrasound imaging system settings with a microrobot being actuated at different magnetic control frequencies. The functionality of the design will be verified initially by navigating the microrobot through a 5-10 mm diameter agarose tunnel immersed in biological fluid, with further tests

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Robotics & Automation/Automation & Control
Digital Health & Medtech/Implantable Medical Devices

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View online

including navigation through a anatomically-accurate phantom, and finally in an ex vivo pig model.

Advantages:

- Low cost

- Portable

- Versatile use-cases

Applications:

- Targeted drug delivery

- Directed sample collection

- Internal microrobot surgery

TRL: 2

Intellectual Property:

Provisional-Patent, 2023-09-27, United States

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