MrBot is the First Fully MRI Compatible Robot

MRI Prostate Robot was Developed in the URobotics Lab at Johns Hopkins University

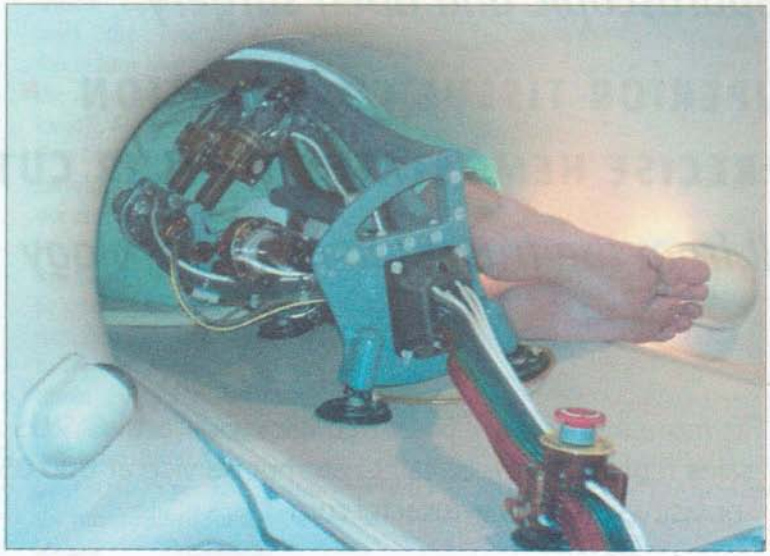
BALTIMORE – The robot, MrBot, is designed for fully-automated image-guided transperineal interventions of the prostate.

The first fully MRI compatible robot was recently developed in the URobotics lab at Johns Hopkins (http://urology.jhu.edu/urobotics). It mounts alongside the patient on the MRI table and precisely manipulates a needle. High-field MRI scanners give high contrast images of the gland, and in conjunction with spectroscopy (MRSI) are one of the most promising methods for imaging prostate cancer. Precise manipulation of instruments within the scanner under image feedback allows for performing precisely localized interventions such as tumor-centered biopsies and effective therapies.

Challenging engineering task

The design and construction of MRI compatible robots is a very challenging engineering task because most of the components commonly used in robotics may not be used in close proximity of the imager. Upgrading a standard instrument for MRI compatibility requires its construction of non-magnetic (and preferably dielectric) materials such as plastics. The problem becomes more intricate for robot actuation, where the ubiquitous electromagnetic motors are incompatible by principle. Unfortunately, a motor to concurrently satisfy the MRI, precision, and safety requirements of the medical interventions was not available, so a new motor was developed for the application.

MrBot uses pneumatic actuation and fiber optic sensing and is entirely made of plastics, ceramics, rubbers, and glasses. This electricity-free robot is virtually translucent in the MRI. Its control cabinet remains outside the MRI room and is connected with a bundle of hoses. The work is the result of a four-years long project sponsored by the NIH-NCI.



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The MrBot robot in a T3 MRI scanner

MrBot applies to MRI guided needle procedures such as biopsies, thermal therapies, delivery of genes and other agents, or seed brachytherapy. Images of the patient are acquired and the plan of the intervention is made by the physician, from the control room. The robot then automatically executes the task under image supervision and monitoring. In-vitro tests have been successfully completed showing sub-millimeter accuracy if image-guided targeting. A set of animal trials and cadaver experiments are presently underway sponsored by the Prostate Cancer Foundation. These show very promising results, and will generate the preliminary data required for clinical trials. Surgical robotics has already shown its potential through the introduction of the daVinci™ robot for remote laparoscopy. The true potential of robotics in medicine, however, has not yet been reached.

Most likely the next leap will come with the integration of additional information. Augmenting imaging to the surgical view by fusing and overlapping multiple image sets will give robotic surgeons capabilities unattainable with the naked eye. Unlike humans, the robots and imagers are digital devices and may more naturally communicate to execute physician's tasks.

It is now feasible and foreseeable in the short term for tumor-centered biopsies, real-time pathology, and focalized therapy to be delivered to the prostate in a single image-guided intervention.

New technologies will help urologists perform more effectively and in a less disruptive manner. ■

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