Image-Guided Medical Robotics

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Outline

• What is image-guided robotic surgery?
• Where does it fit in OR of the future?
• Image-guided robotics
• MRI-compatible robotics
• Rehabilitation robotics
• Conclusions

What is image guidance?

• Very broad term
  – Might say any procedure using medical images is image guided including ultrasound for joint injections, etc.
• The use of medical images to guide an intervention
  – Mostly the domain of interventional radiologists
  + (or interventional cardiologists)
• Use of imaging in procedures/surgery continues to grow
• Image guidance: commonly used for surgical procedures such as pedicle screw placement or central line insertion
• Image-guided robotic surgery
  – Use of robotic technology coupled with medical image to guide a procedure
Digital Operating Room

- Robot is one part of the digital infrastructure
- Robot couples “information to action” (R. Taylor, JHU)
- Surgical cockpit is the control center

RAVEN teleoperation with Surgical Cockpit
https://www.youtube.com/watch?v=WnJ2V988UUM

DaVinci Robot and Beyond

**KEY POINTS**
- New platforms – current patents impending expiry with expiry of Medtronic and Yebi
- Advances – haptics, patient interface, image guidance, flexible robotics with webconnectivity
- Great anticipation of advances to improve patient care
Image-guided Facet and Nerve Blocks

Robotically assisted nerve and facet blocks: a cadaveric study.
Cleary K, Stoianovic D, Patriciu A, Mazilu D, Lindisch D, Watson V.

Mazor Robotics

The Current Role of Robotic Technology in Spine Surgery
Srikanth Divi, Sean Pollstar, Edwin Ramos, and Michael J. Lee
Oper Tech Orthop 27:275-282C2017 Elsevier Inc

Figure 2 Use of robotic guidance during percutaneous pedicle screw placement.

Which Spine Robot Will Dominate?
Surgical robotics systems took center stage at the North American Spine Society meeting last week. Here’s analysts’ take on the offerings from Zimmer Biomet, Mazor Robotics, and Globus Medical.
https://www.mddionline.com/which-spine-robot-will-dominate
Brainlab: Image-Guided Spine Surgery

- Portable, light-weight design (approx. 11kg)
- Mounted directly to the O.R. table rail
- Fully integrated computer unit with no footprint
- Port for different application-specific modules


Globus Medical

"ExcelsiusGPS is the only robotic system that combines surgical navigation and robotic guidance for spinal surgery, which offers significant advantages to spine surgeons."


Mako® Robotic-Arm Assisted Technology

This is Mako, a robotic arm assisted technology that helps surgeons provide patients with a personalized surgical experience. A 3D model of your hip or knee will be used to prepare and assist your surgeon in performing your joint replacement surgery.
**MRI Compatible Robotics**

- Access is difficult in closed-bore MRI
- Robot can provide a steady guide for instrumentation
- Can enable in-bore interventions
- Can enable real-time image during interventions

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**Body Mounted Robot for Shoulder Arthrography**

NJH award R01EB020003
Built by: Nirav Patel, Iulian Iordichita, JHU

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**Table Mounted Robot for Long Bone Biopsy Under MRI**

Dan Stoianovici, Changhan Jun, Sungwhan Lim, Doru Petrisor
Johns Hopkins Urobotics Laboratories

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Research Challenges

- Access to body
- Imaging
- Instruments
- Human-machine interface
- Prototype systems (added by me)

Summary and Conclusions

- Will there be a surgical robot in your future?
  - The robots are here to stay
  - Activity in the field continues to increase
- Scientists need to work with clinicians to develop these system to improve the precision and lessen the invasive of these procedures
- AAPM is a good venue for these discussions