Force-Controlled Robot for Elasticity Imaging

- Maintain consistent contact with patients during shear wave elasticity imaging to detect differences in tissue mechanical properties

What Students Will Do:
Use integrated force sensor to write force control laws that maintain probe contact

Deliverables:
- Prototype system with Sawyer robot
- Demonstration with ultrasound phantom
- Compare new method to existing standards

Bell MAL et al. IEEE Transactions on Biomedical Engineering, 2016

Force-Controlled Robot for Elasticity Imaging

- **Size group:** 2-3
- **Skills:**
  - ultrasound imaging knowledge
  - experience with robotics
- **Faculty Mentor:** Muyinatu Bell (mbell36@jhu.edu)

5 N Compression
3 cm push focus
F/# =1

Bell MAL et al. IEEE Transactions on Biomedical Engineering, 2016
da Vinci-Compatible Shear Wave Imaging

- Bring benefits of shear wave elasticity imaging to minimally invasive surgeries
- **What Students Will Do:**
  - make existing da Vinci drop in probes compatible with shear wave imaging
- **Deliverables:**
  - Build connector for custom research scanner
  - Interface drop in probe with shear wave imaging script
  - Demonstrate working prototype
- **Size group:** 2
- **Skills:** circuit analysis and design, ultrasound imaging knowledge
- **Mentors:** Muyinatu Bell (mbell36@jhu.edu)

Photoacoustic-Guided Spinal Fusion Surgery

- Determine the feasibility of using photoacoustic imaging to guide spinal fusion surgeries
- **What Students Will Do:** perform photoacoustic imaging experiments with sine specimens
- **Deliverables (choose 3):**
  - Distinguish cortical from cancellous bone
  - Visualize pedicle boundaries
  - Visualize nerves
  - Determine optimal entry point
  - Evaluate imaging resolution
  - Define energy requirements
- **Size group:** 2
- **Skills:** experience with ultrasound imaging, experience with lasers and laser safety, hands-on experimental skills
- **Faculty Mentor:** Muyinatu Bell (mbell36@jhu.edu)
Light Delivery Systems for PA-Guided Surgery

Develop a specialized light delivery system for photoacoustic-guided surgery

What students will do:

- Choose a compatible surgical tool
- Answer design questions:
  - How many fibers? (Zemax Simulations)
  - How far apart? (Monte Carlo Simulations)
- Build working prototype and demonstrate surgical photoacoustic task with the da Vinci

Deliverables:

- Design custom light delivery system
- Build phantom for chosen clinical application
- Demonstrate working prototype with integrated photoacoustic system and da Vinci surgical system
- Perform task with and without photoacoustic guidance

Size group: 2-3

Skills: programming for simulation software (Monte Carlo, Zemax), Solid modeling (SolidWorks, Creo), hands-on experimental skills, experience with lasers and ultrasound desired but not required

Faculty Mentor:
Muyinatu Bell
(mbell36@jhu.edu)

Eddins and Bell, JBO, 2017