# Autonomous Placement of Ultrasound Probe for Spinal Surgeries

Student: Josh Shubert
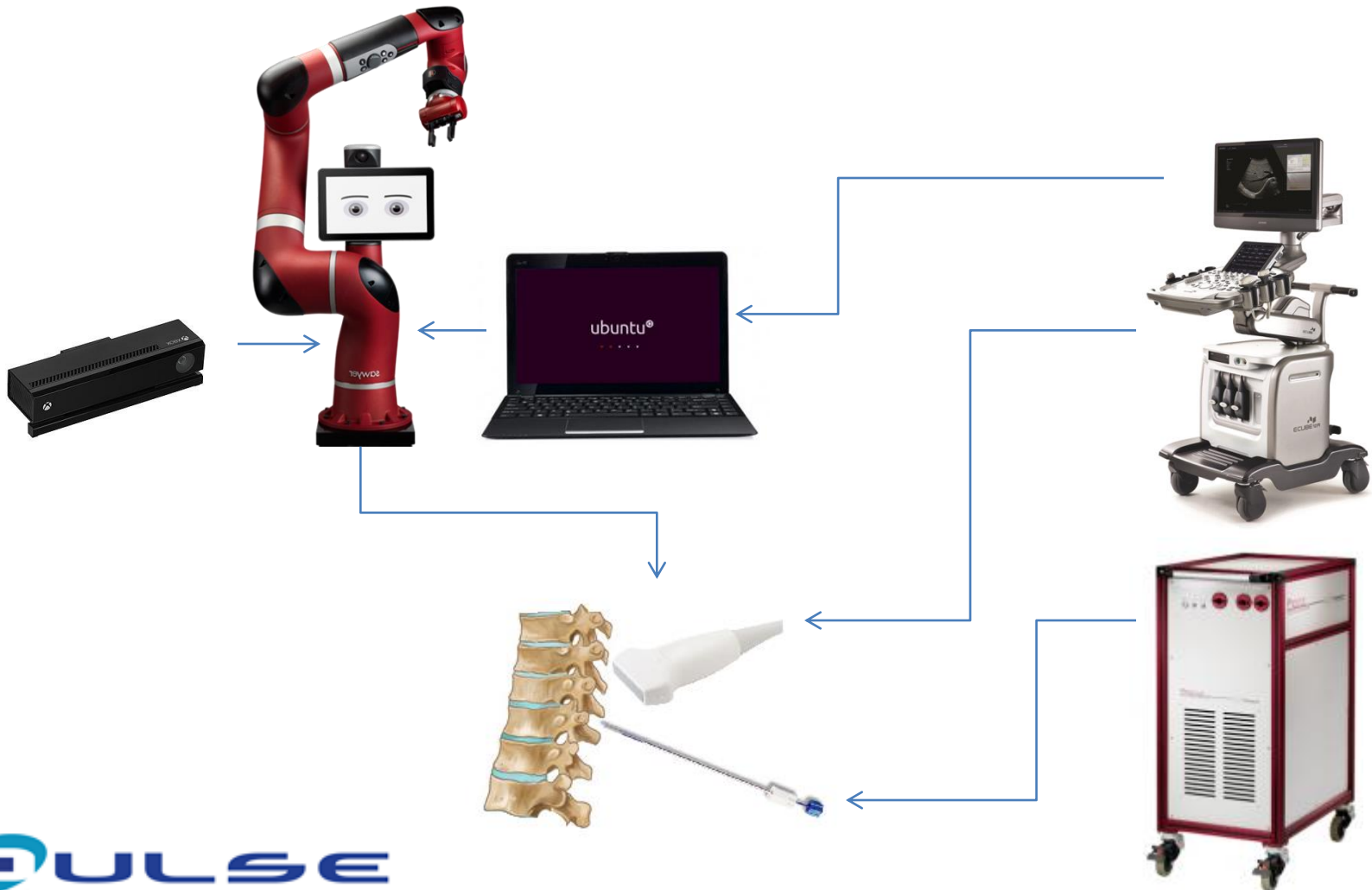
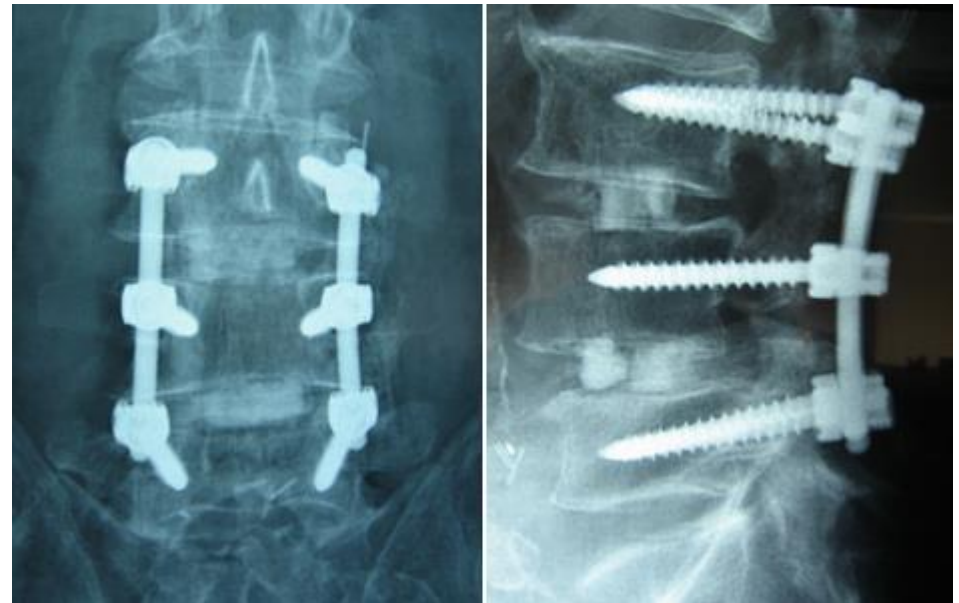Mentor: Dr. Muyinatu Bell

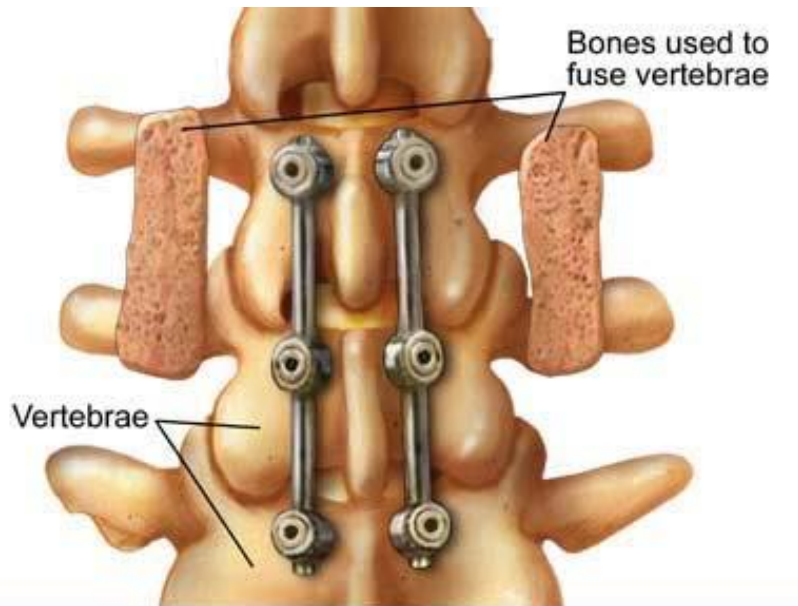# Project Goals

- Autonomously place an ultrasound probe onto a patient's spine via robot

- Ideally use this probe placement to inter-operatively track needle using photoacoustic imaging (and adjust probe placement using this feedback)

The plan

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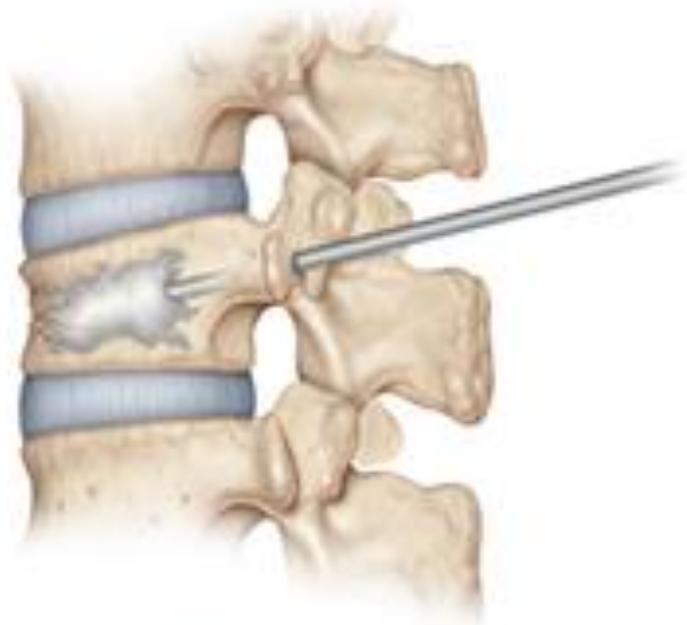SYSTEMS ENGINEERING LAB
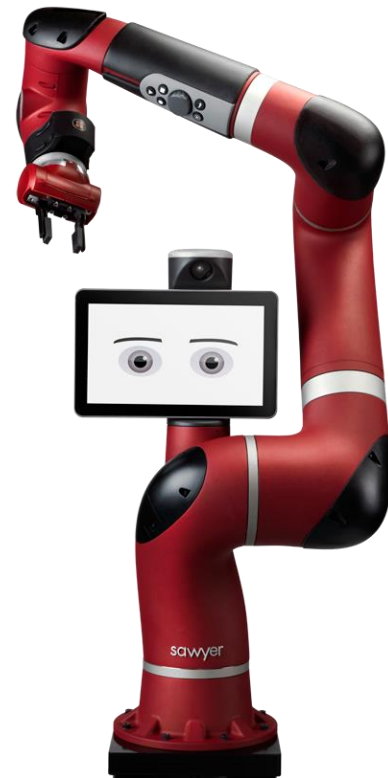
Background – Spinal Fusion

Background - Vertebroplasty

Fracture

Cement Injection

Background - Kyphoplasty

Balloon inserted into fractured vertebra

Balloon inflated inside damaged vertebra

Special material injected into fractured vertebra

Special material hardens, stabilizing vertebra

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Dependencies

Maximum
- Intentionally damaged spine in gelatin (Need)

Expected
- A Spine (Need)
- Powerful Laser Source
- Hollow-bore Needle
- Optical Fiber

Minimum
- Ultrasound Scanner + (Calibrated!) Probe
- Sawyer Robot
- Kinect v2

Deliverables

Maximum

- Robot Control Software with:
  - Needle Segmentation
  - Visual Servoing to track needle
  - Visual display of PA image coregistered to Ultrasound in GUI
- Demonstration on Spine Phantom

Expected

- If it is possible to do PA imaging , Images of the needle tip inside the vertebrae (perhaps registered to Ultrasound)
- Results of applying previously developed needle segmentation algorithm to detect needle in PA image
- If not possible, report of what I attempted (laser energies and wavelengths)

Minimum

- Robot Control Software with:
  - Human Shape segmentation
  - Inverse Kinematics for Probe Placement
  - Force Feedback
  - A nice GUI
- Demonstrations of probe placement and segmentation algorithm

Timeline

Minimum	Expected	Maximum
• 2/19 – Set up all hardware • 3/13 – Develop segmentation algorithm • 4/2 – Develop Inverse Kinematics algorithm • 4/9 – Add force control and package all elements into a robot software package with a nice GUI	• 3/1 – Obtain Spine • 3/13 – Determine feasibility of imaging a damaged vertebrae with PA imaging • (If its at all viable) 4/9 – Compile a set of PA images of the vertebrae • 4/16 – Apply segmentation algorithm to locate and track needle.	• 4/23 – Create Spine-in-Gelatin phantom • 4/30 – Add needle segmentation and coregistered US + PA image to robot software package • 5/14 – Demonstrate visual servoing of the ultrasound probe to track needle placement in the spine

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