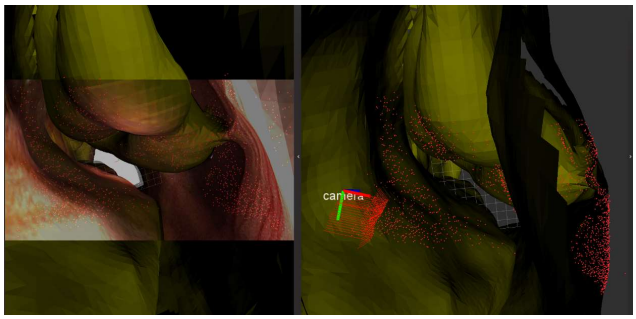
Sinus Registration and Navigation



- Sparse 3D structure can be observed from a sequence of endoscope images and then registered to CT data
- Use extended Kalman filtering to localize the endoscope in the sinus cavity and compare results to the telemetry of the robot

Sinus Registration and Navigation

- **Goal:** We can mount an endoscope to the Galen's tool holder and use our force sensor to cooperatively control its movements. However, unless we have an accurate gravity compensation method, this can often feel unintuitive. We may be able to use the data we are collecting from the endoscope to allow users the ability to directly interact with a camera feed in order to drive the endoscope properly through a phantom.
- **What Students Will Do:**
  - Calibrate the endoscope (intrinsic, pivot, hand-eye)
  - Adapt existing registration algorithm (using CT model of phantom) for video sequences to run online
  - Integrate to simple navigation system
  - Develop suite of simple functions (e.g., measurement,guidance)
  - Adapt existing phantom for testing registration
  - Test the control on an phantom and compare to manual
- **Deliverables:**
  - Calibration results
  - GUI Application
  - Results from phantom experiments
- **Size group:** 2 (online registration only) or 3 (with endoscope navigation)
- **Skills:**
  - C++
  - Computer vision
  - Design experience
- **Mentors:** Paul Wilkening, Dr. Russ Taylor, Yunus Sevimli, Simon Leonard
- **Note:** This could be the start of a good MS or PhD qualifying project

Slide 1

P6 I will talk to Simon, having his help would be very useful
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Slide 2

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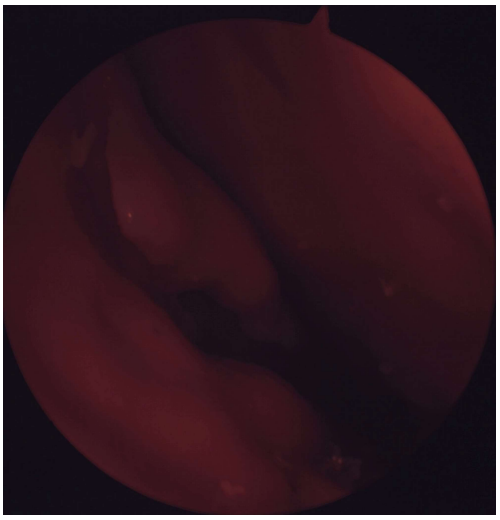
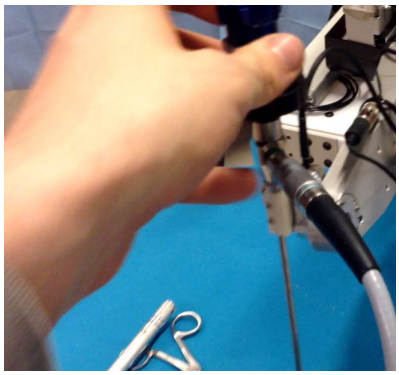
Sinus Registration and Navigation





Galen Kinematic Calibration

- **Goal:** We can make our understanding of the Galen kinematics more accurate by performing an AX = YB calibration using an optical tracker with a high accuracy. Tests have been performed in the past, but the code isn't integrated into the robot software and may be improved upon. The kinematics of the Galen will change with new parts, so this calibration must be done again (several times). An integration and optimization of this code could make the whole process much faster.
- **What Students Will Do:**
  - Integrate MATLAB scripts into robot architecture (C++)
  - Run tests of kinematic calibration and compare to original results
  - Perform additional calibrations once Galen hardware is changed
  - Improve upon existing code
- **Deliverables:**
  - Calibration results
  - New calibration functions in robot GUI
- **Size group:** 1
- **Skills:**
  - C++
  - MATLAB
  - General calibration methods
- **Mentors:** Paul Wilkening, Dr. Russ Taylor, Yunus Sevimli

Slide 3

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Slide 4

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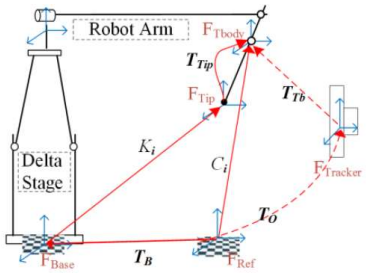
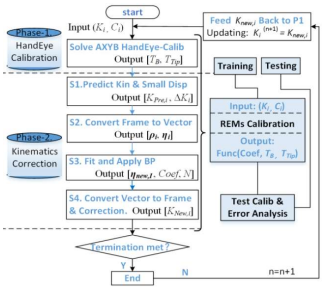
Galen Kinematic Calibration





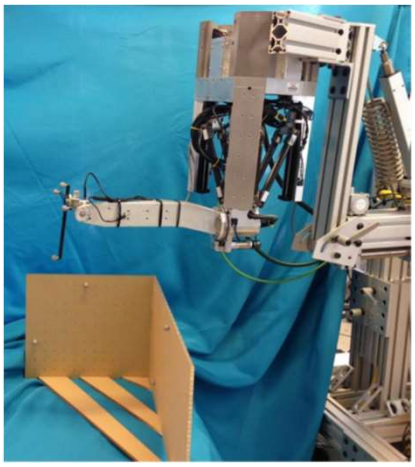


Photo Credit: Lihang Feng

Visual Feedback for Robotic Sinus Surgery

- The Galen system can currently guide the tool tip along a pre-determined path, which has applications in sinus surgery. In order to properly communicate the location of the tool tip relative to the desired path and registration errors within the path itself, however, we must augment the Galen system with more visual feedback. We propose to create a visual overlay on top of a endoscope feed for the user to see the current path location.
- **What Students Will Do:**
  - Set up a ROS node to pull information from the Galen and endoscope nodes
  - Perform a calibration of the endoscope and registration between Galen coordinates and endoscope coordinates
  - Experiment with different visualization styles and possibly interactions with the visualized path
  - Test the performance of navigating within a phantom with this overlay vs without it
- **Deliverables:**
  - ROS node
  - Registration
  - Path visualization
  - Study results
- **Size group:**
  - 2
- **Skills:**
  - ROS (optional), C++, Computer vision
- **Mentors:**
  Dr. Narges Ahmidi, Paul Wilkening

Slide 5

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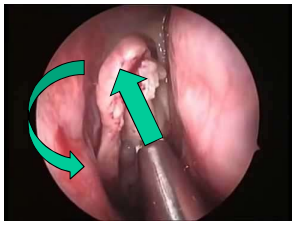
Paul, 1/4/2017

Visual Feedback for Robotic Sinus Surgery

given

- Endoscope is tracked: P^{W}_{cam}
- Tool is controlled by Galen robot: P^{G}_{tool}
- Optimal path is known: $P*^{CT}_{tool}$



(1) registration to find $P*^{W}_{tool}, P^{W}_{tool}$

(2) Define which visual directions will help user to go from P^{W}_{tool} to $P*^{W}_{tool}$

(3) Overlay that into the image (registration to image frame).