Clinical Motivation

• 1 in 5 people has a pituitary tumor
• Surgical goal: Tumor removal and decompression of surrounding structures
• Difficulty: Multiple tools through the nose
• Difficulty: Hand eye coordination
• Goal: Design a transnasal surgical robot

Design Objectives

- Provide interchangeable tool modules
- Design for sterile surgical field
- Deliver four tools simultaneously

System Architecture

- Surgeon Console
- Control Unit
- Actuation Unit
- Haptic Displays
- Endoscopic Video
- Image Guidance

Solution: Concentric Tube Robot

- Composed of nested, precurved, superelastic Nitinol tubes
- Actuated by translation and axial rotation at the tube bases

End Effectors

- Curette
- Gripper

Design for Sterility

- Tool modules are cleanable/reusable
- All power electronics are bagged
- Bag and sterility adapter plate are fused

Modeling Advancements

- Tubes twist one another
- Twisting may result in a buckling-like phenomenon
- Snapping is studied with respect to design parameters or actuation

Actuation Unit Design

- Tube collector collimates manipulators
- Brushless DC motors
- Gross translation provided separately
- Torque tubes enhance robot stability