

Holonomic Videobronchoscope

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Problem

- ⊗ Many non-expert practitioners are called upon to place a breathing tube into the airway (endo-tracheal intubation)
- ⊗ The skills needed to place an ETT require years of training with continued education and hours of continued practice annually {Hawkins,1995}, the later of which is not easily attained.
- ⊗ A study shows success rates of placing ETT is *decreasing*, especially in children, in the pre-hospital setting
 - ⊗ airway skills are not improving despite additional education and the initiation of extensive training programs. {Diggs,2014; Gausche, 2000}.

Project Overview

- ⊗ To build a self-driving, holonomic videobronchoscope that can place a breathing tube into a child, moving the tip of the bronchoscope automatically based on image recognition of airway anatomy that drives the bronchoscope into the airway. After the bronchoscope is in the airway, the breathing tube will advance ontop of the bronchoscope, intubating the patient. 2 innovative components:
 1. Mechanical Engineering: To build a holonomic tip for the vidoebronchoscope.
 2. Computer Program: To write a program where the computer recognizes airway anatomy and advances the bronchoscope to/ around structures, stopping after getting to the carina in the lungs.

Standard Breathing Tube Placement



Intubation



Current Technology

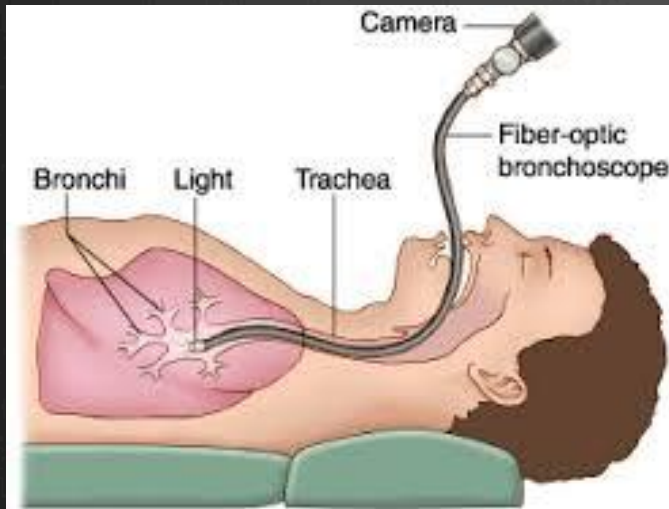


Camera on the end of a laryngoscope (left) or on a flexible bronchoscope (below)

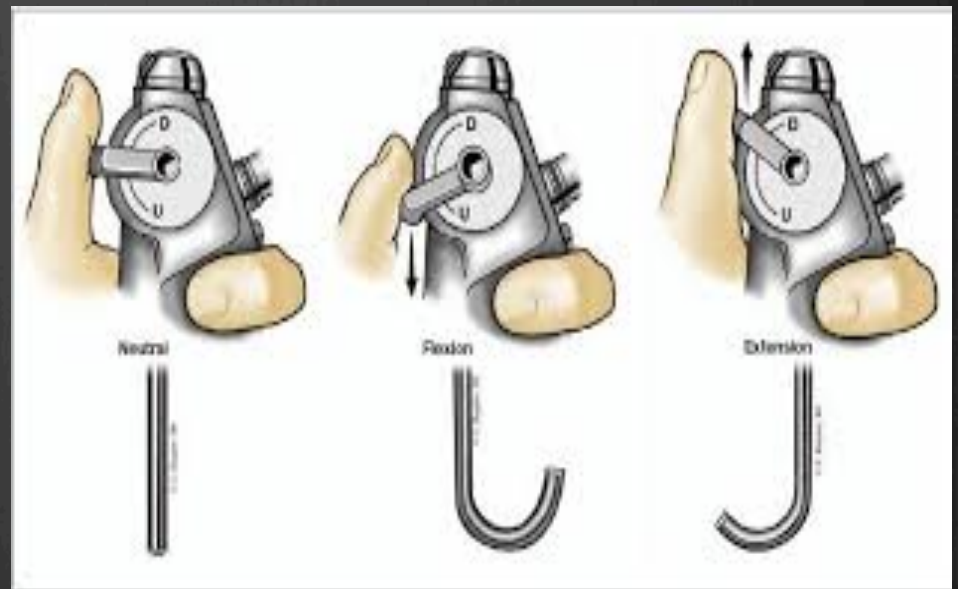
GOLD STANDARD



Current Flexible Bronchoscope

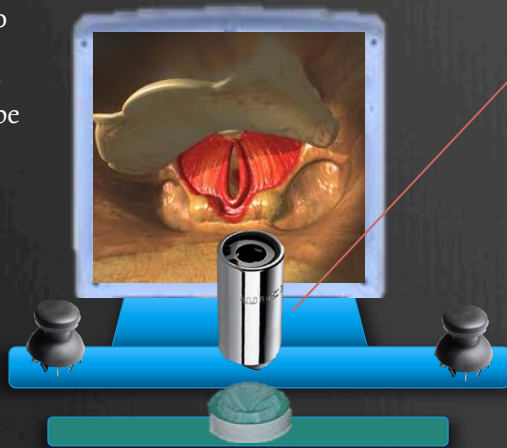


The flexible bronchoscope only flexes up and down (no side to side movement)

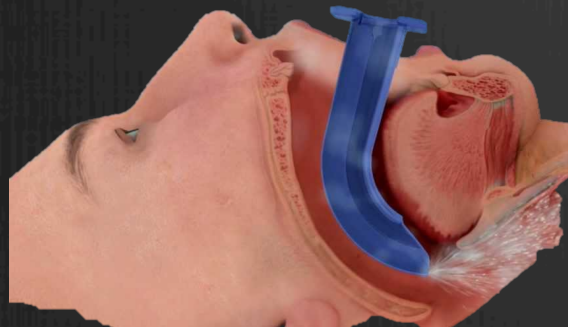


Holonomic Videobronchoscope

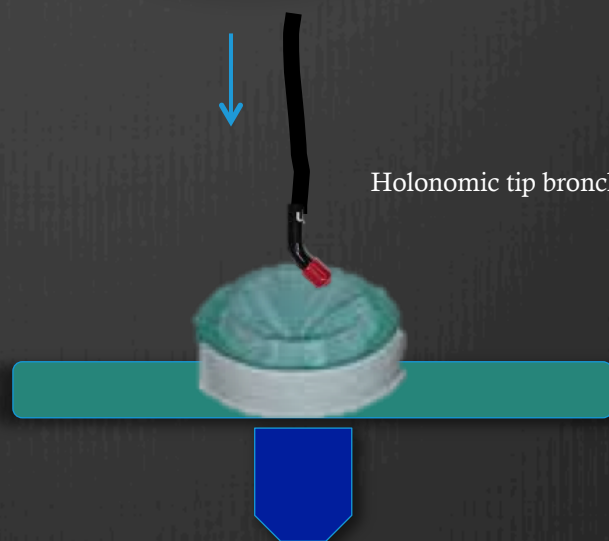
Computer to recognize image/drive bronchoscope



Motor



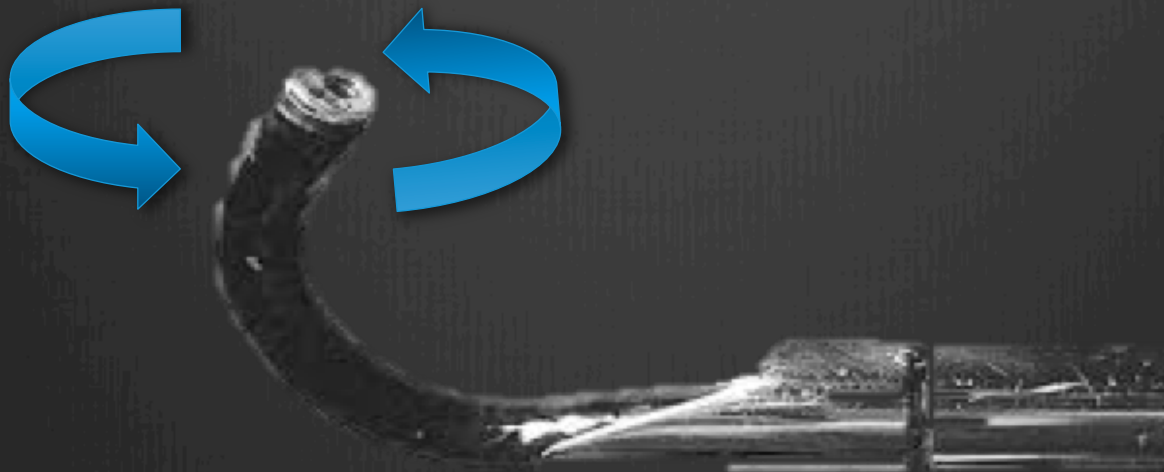
Holonomic tip bronchoscope



Disposable Component

Holonomic Videobronchoscope

- ⦿ Mechanical Engineering
 - ⦿ Develop a Holonomic Tip
 - ⦿ Tip of the Videobronchoscope moves in every direction

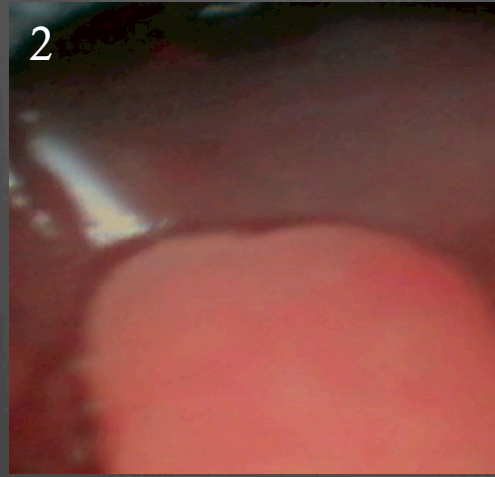


Multi-Flex Videobronchoscope

- ⊗ Computer Programming
 - ⊗ Structure from motion
 - ⊗ Using fiberoptic imaging from patients all ages, we will “teach” the computer to advance/move around/to airway structures to perform endotracheal intubation.
 - ⊗ Visual surveying, matching, and movement



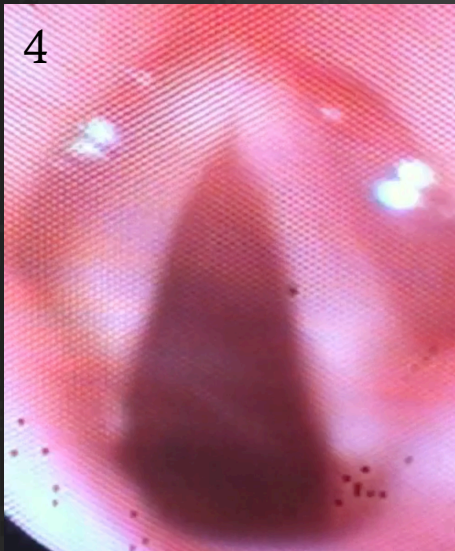
Advance midline



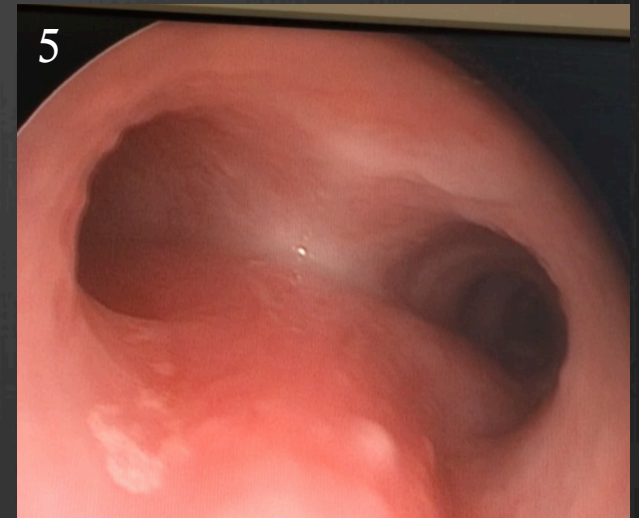
Anterior flex over uvula



Advance under Epiglottis



Advance between VC



Stop 2 cm above carina

Deliverables

- ⊗ Mechanical Engineer
 - ⊗ Draft of holonomic tip design
 - ⊗ Prototype of holonomic videobronchoscope
- ⊗ Image recognition and movement computer program
 - ⊗ To write program where the computer recognizes the anatomic image and navigates to/around specific airway structures to complete intubation

Group Size

- ⊗ 2 – 3 students for Mechanical and Computer components

- ⊗ Mentors:

- ⊗ Nicholas Dalesio, MD ndalesio@jhmi.edu

- ⊗ Russ Taylor, PhD rht@jhu.edu

- ⊗ Iulian Iordichita, PhD iordachita@jhu.edu

References

- ⊗ Gausche, M. Effect of out-of-hospital pediatric endotracheal intubation on survival and neurological outcome: a controlled clinical trial. 2000. JAMA. PMID: 10683058