Group 21: Robotic Soft Tissue Assessment

Plan Presentation

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The Goal

The goal of this project to design and conduct a study that quantifiably assess robotically-assisted soft tissue manipulation.

The further aim of this project is to develop an algorithm to create otolaryngology-specific virtual fixtures to improve robotically-assisted surgical accuracy.
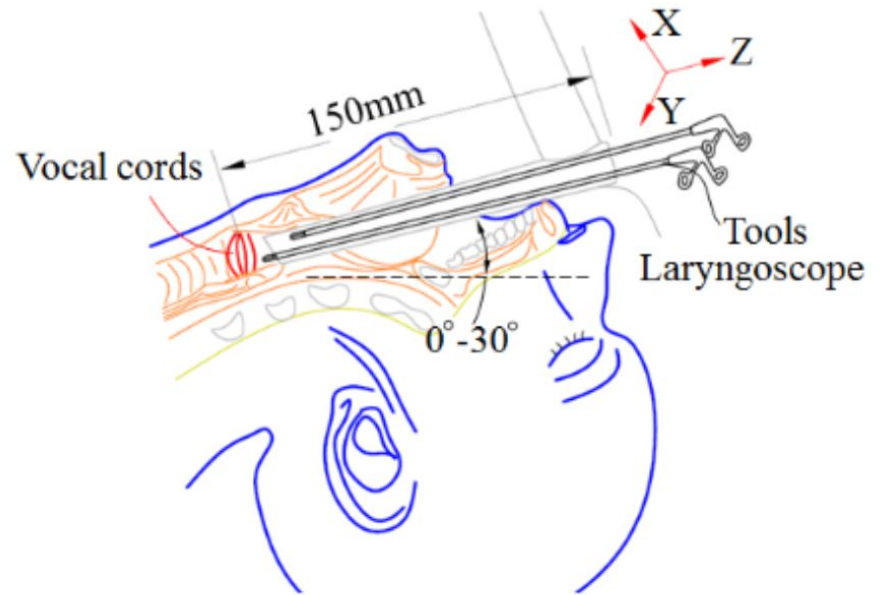
Figure 1: Microlaryngeal Phonosurgery

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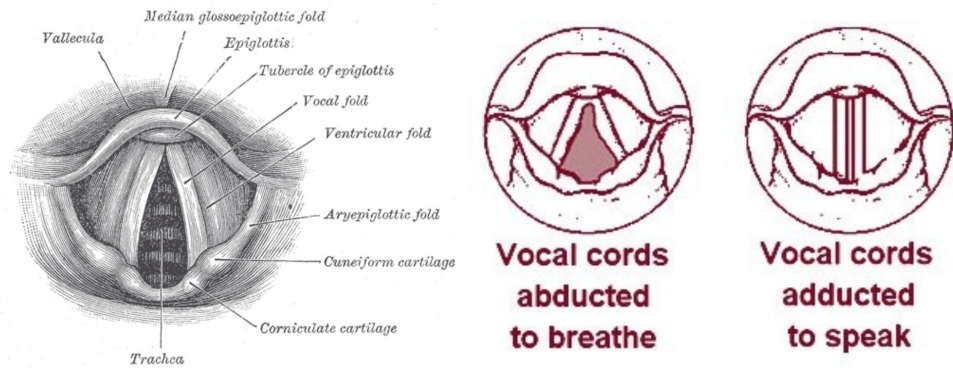
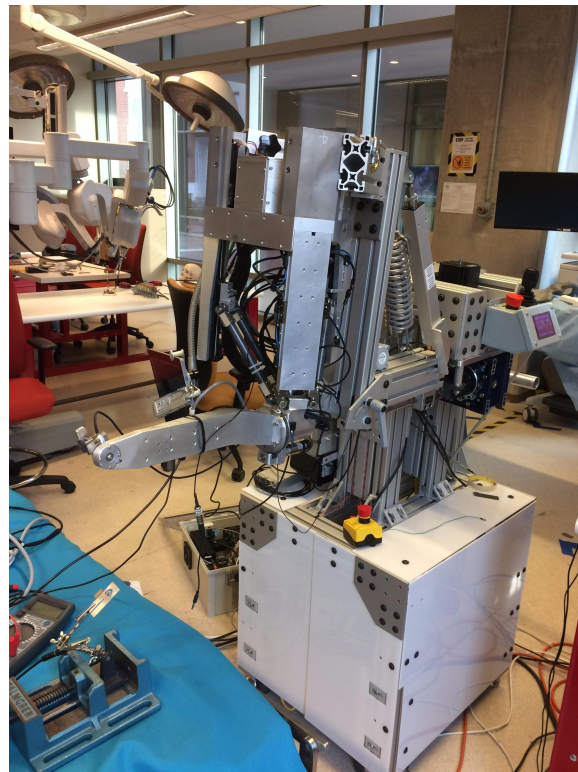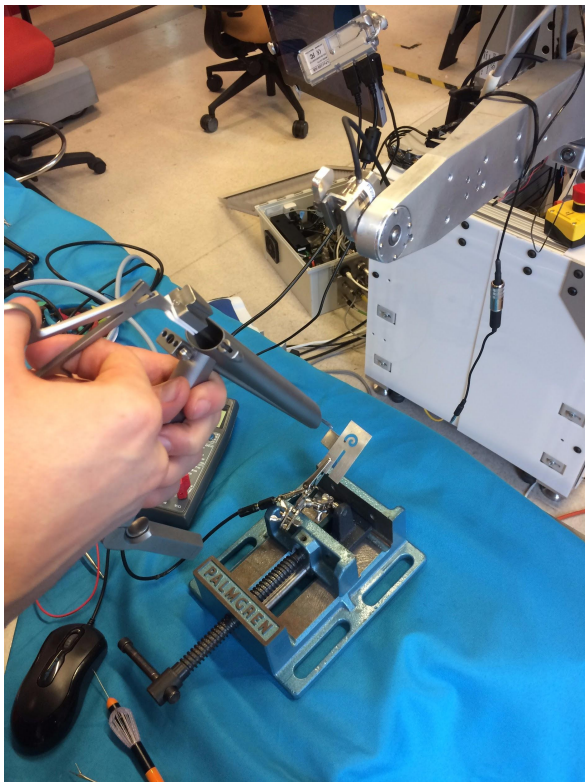# Building Vocal Cord Phantom

Figure 2: Anatomy of the glottis
(Image credit Gray's Anatomy of the Human Body, 20th Edition)

Figure 3: Vocal cord animation

Galen Robot in Mock OR

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Removal of Cyst

Figure 4: SerpENT surgical instrument.
(Image Credit: http://www.entriguesurgical.com/)

Figure 5: Vocal Cord Cyst

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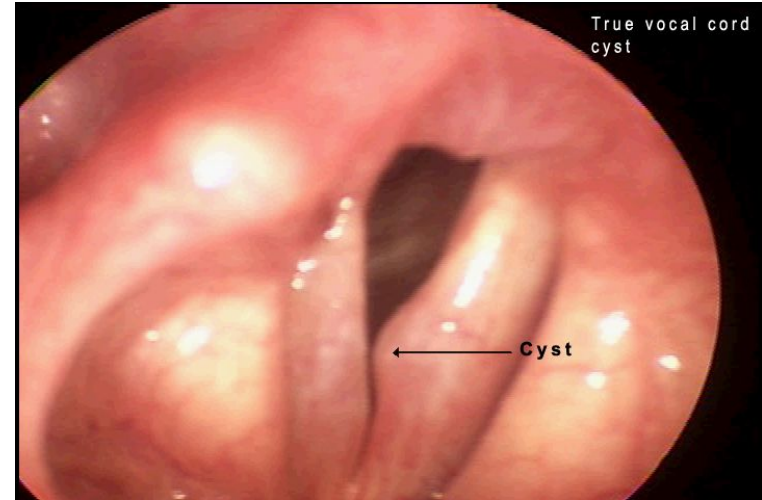
Assessment Software

1. Measure Proper Cutting from Video Recording

    → draw an ideal trajectory and calculating deviation using MATLAB

2. Calculate Benign Tissue (White) to Cyst (Red) Ratio of Removed Region
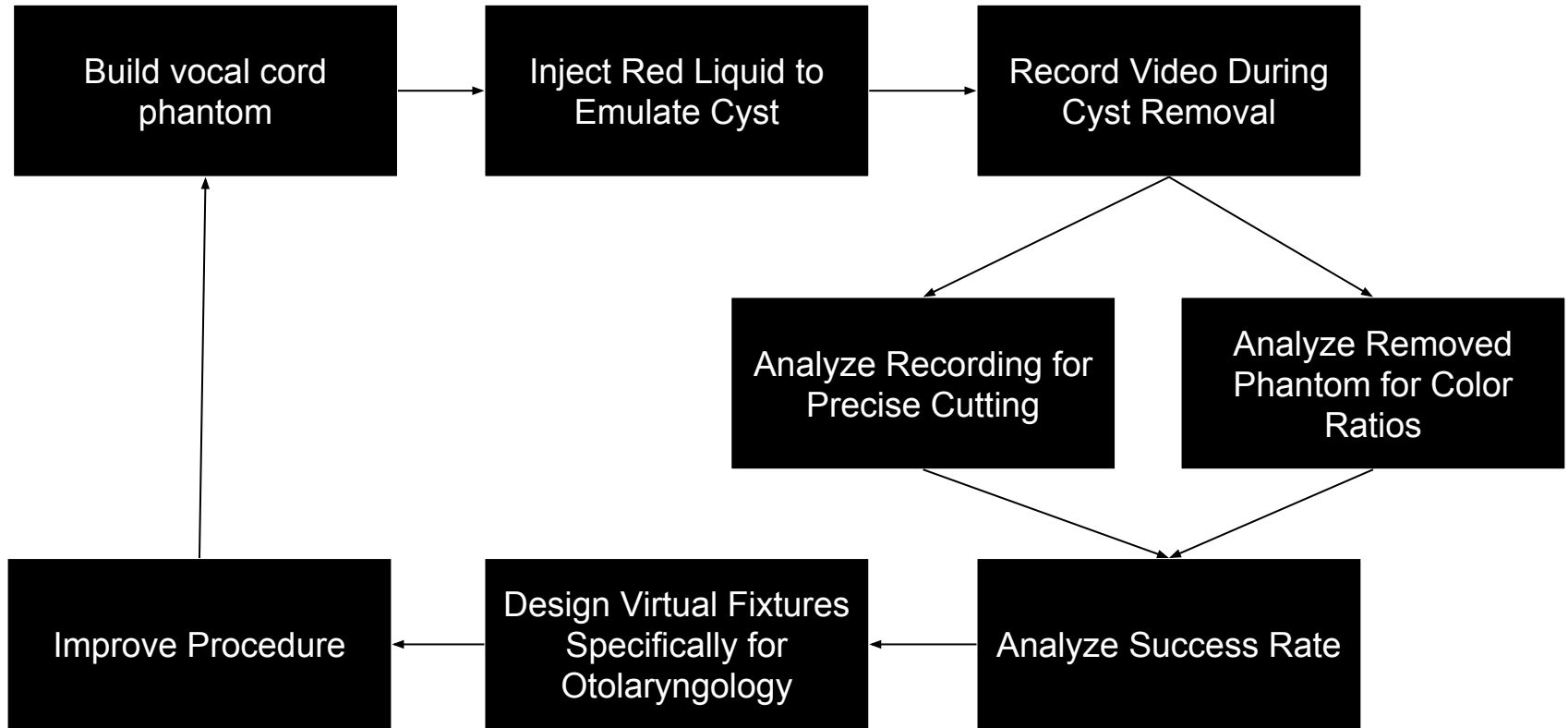
    → low WhiteArea/RedArea ratio in the removed piece

    → minimum RedArea value corresponding to the size of the cyst.

Figure 6: Galen microlaryngeal phonosurgery cadaver setup.

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Overall Technical Approach

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List of Deliverables

Minimum

I. Study design for surgery, data collection and analysis

II. CAD design of a phantom to conduct surgical experiments on

III. Collected data and results of surgical experiments on 3D printed phantom conducted by experts & med students with and without robotic assistance

IV. Computer vision based analysis algorithm using Matlab/Python to quantify success of vocal cyst removal surgery

Expected

I. Study design for conducting surgery on an non-living animal vocal cord

II. Collected data and results of surgical experiments on animal vocal cord conducted by experts & med students with and without robotic assistance

III. Improved computer vision based analysis algorithm to quantify success of vocal cyst removal surgery

Maximum

I. 3D virtual fixture algorithm developed for the robot using C++

II. Study design for conducting robotically-assisted surgery with virtual fixtures

III. Collected data and results of robotically-assisted surgical experiments with virtual fixtures on the phantom conducted by experts

IV. Comparison of quantified success results of non-assisted, robotically-assisted with no virtual fixtures, and robotically-assisted with virtual fixtures surgeries on the phantom

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Key Dates & Assigned Responsibilities

	Feb W4	Mar W1	Mar W2	Mar W3	Mar W4	Mar W5	Apr W1	Apr W2	Apr W3	Apr W4	May W1	May W2
Minimum												
Plan Presentation	■											
Design phantom experiment procedure	■	■										
Design phantom CAD		■	■									
Manufacture phantoms				■								
Conduct surgery with experts					■							
Conduct surgery with med students					■							
Develop quantitative analysis algorithm					■	■						
Analyze experiment results						■						
Expected												
Project Checkpoint Presentation							■					
Design animal experiment procedure							■					
Conduct surgery with experts								■				
Improve quantative analysis algorithm								■				
Analyze experiment results									■			
Maximum												
Design VF experiment procedure										■		
Develop VF algorithm										■		
Conduct surgery with experts											■	
Compare results with past experiments											■	
Prepare Poster												■
Project Final Presentation												■

List of Dependencies & Plan for Resolving

Dependency	Resolution
Computer Vision library decision and tutorial	Meet with Paul Wilkening
3D CAD software decision and tutorial	Meet with Yunuscan Sevimli
Mock OR access	Access granted
3D printer access for phantom manufacturing	Access granted
Get experts to conduct experiment Mar W4	Confirmation received
Get experts to conduct experiment Apr W2	Meet with Yunuscan Sevimli
Get experts to conduct experiment May W1	Meet with Yunuscan Sevimli
Get med students to conduct experiment Mar W4	Confirmation received
Get permission to experiment with animals	Meet with Yunuscan Sevimli
ROS background for virtual fixture algorithm	Meet with Paul Wilkening

Last Minute Update: Still need to submit IRB forms, and decide on the budget for building the phantom. Scheduled meeting with Dr. Akst and Dr. Razavi.

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References

Jensen JB, Rasmussen N. Phonosurgery of vocal fold polyps, cysts and nodules is beneficial. *Dan Med J*. 2013 Feb. 60(2):A4577. [Medline] .

Stanković P, Vasić M, Djukić V, Janosević Lj, Vukasinović M. Vocal fold masses removal--the sub epithelial micro flap technique. Acta Chir Iugosl. 2008;55(4):43-7.

Schweinfurth, J., MD. (2016, March 21). Vocal Fold Cysts Treatment & Management (A. D. Meyers MD, Ed.). Retrieved February 21, 2017, from http://emedicine.medscape.com/article/866019-treatment#d13

D. Aarno, S. Ekvall, and D. Kragic. Adaptive virtual fixtures for machine-assisted teleoperation tasks. In Proc. *IEEE Intl. Conf. on Robotics and Automation*, pages 1151-1156, 2005.