Projects and Work of a Carleton University PhD Student

ECOR 1055: Guest presentation

Symon Stowe B.Eng.

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November 9, 2020

About me

- Graduated from Biomedical and Electrical Engineering at Carleton University in April 2017
- Began Masters of Applied Science fall of 2017
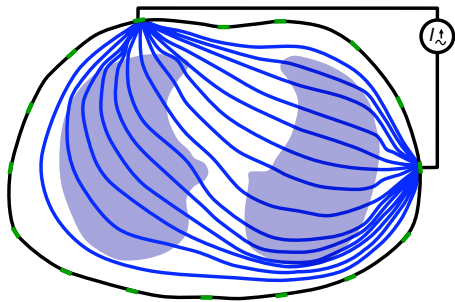- Fast-tracked into PhD program fall of 2018

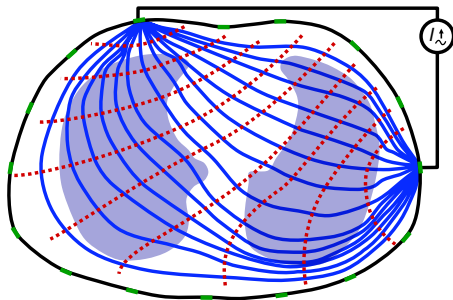# Undergrad Projects

Undergrad Projects
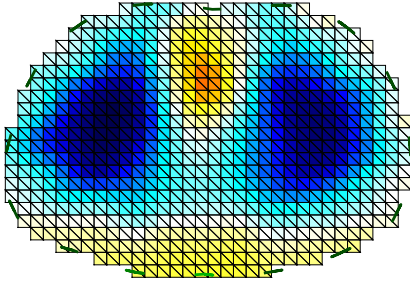
Electrical impedance tomography (EIT)

- current (blue) is injected between electrodes
- voltage is measured at the body surface
- voltages are reconstructed into images

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Uses of EIT

Why use EIT when image quality is not very good?

Great for sensitive patients
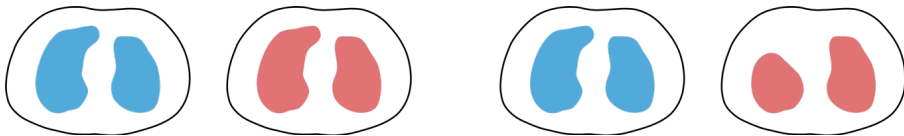
Current Projects

- Monitoring lung recruitment during Total Liquid Ventilation

- Monitoring lung volume during weighted restraint (2019)

- Adding internal electrodes to image the heart

Perfusion/Ventilation Monitoring

Why monitor lung perfusion?

Pulmonary embolisms (blood clots in the lungs) are notoriously challenging to diagnose and monitor

But they can be identified as regions where the blood flow in the lungs does not match the air flow

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Restraint

CBC News – Posted: Nov 25, 2013

Introduction

Positional asphyxiation is occasionally listed as the cause of death in restrained subjects

Major contributing factors are thought to be the posture of the subject and weight on the abdomen

Previous work has shown that prone posture and weight up to 102 kg have have not affected the health of subjects,

but

it is widely accepted that chest wall restriction has a significant impact on lung function...
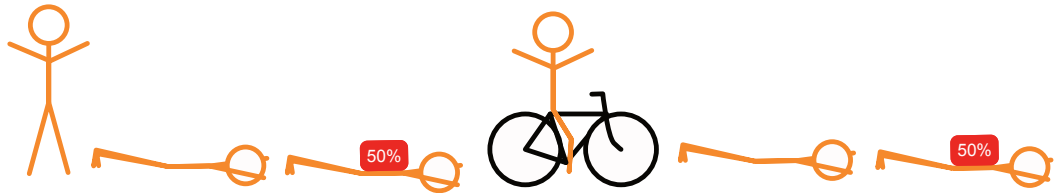
Objective

to develop a monitoring technique and protocol using EIT to determine:

- to what degree different restraint postures and weight applied to the thorax affect chest compression
- to what extent cardiovascular stress impacts lung function during periods of chest compression

A good model of restraint will allow studies to determine better safety limits and techniques.
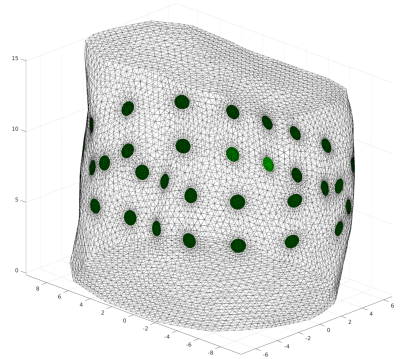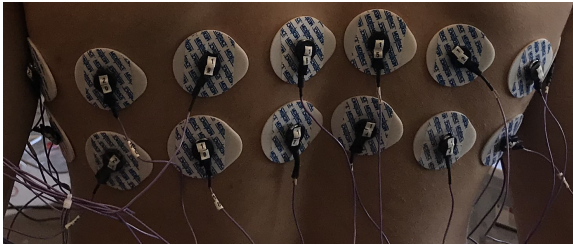
Protocol

Develop an experimental protocol and analysis method to:

- Evaluate the effect of posture, cardiovascular stress, and weight on subjects breathing
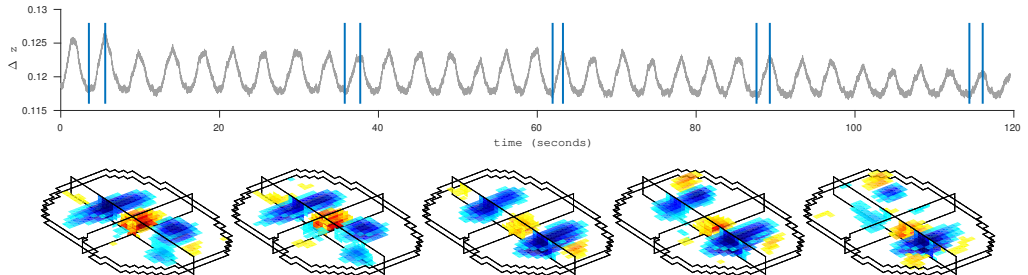- Enable EIT to be used as a monitoring tool

Subjects

3 healthy male subjects aged 20-30 years were selected and fitted with silver/silver chloride electrodes in two rows of 16.

The 3D forward model model was created through segmentation of a CT image
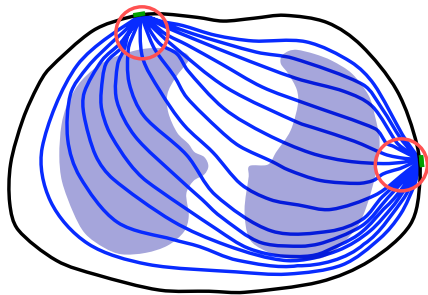
Initial Results

Before exercise there were drastic drops in tidal volume observed during periods of restraint.
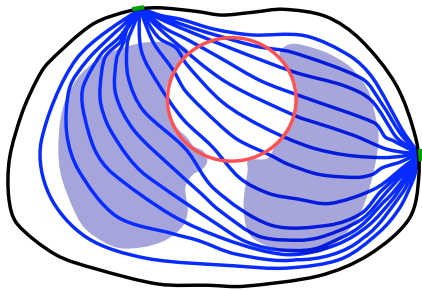
Current Projects

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Electrical impedance tomography (EIT)

- sensitivity to impedance change is not uniform
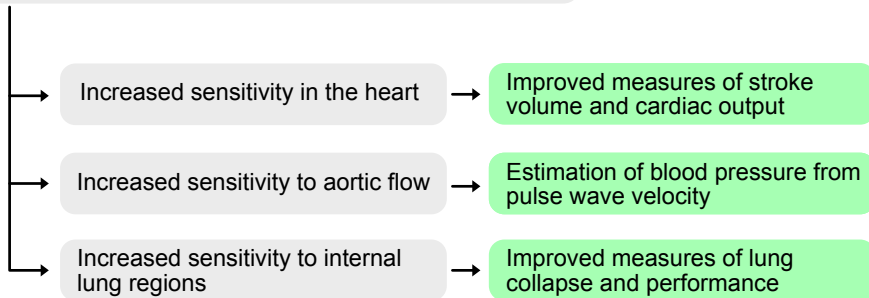- Regions of highest sensitivity are next to the electrodes

Electrical impedance tomography (EIT)

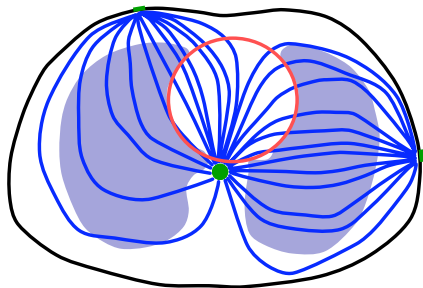- how can we obtain better images of activity in the heart?

Internal electrodes
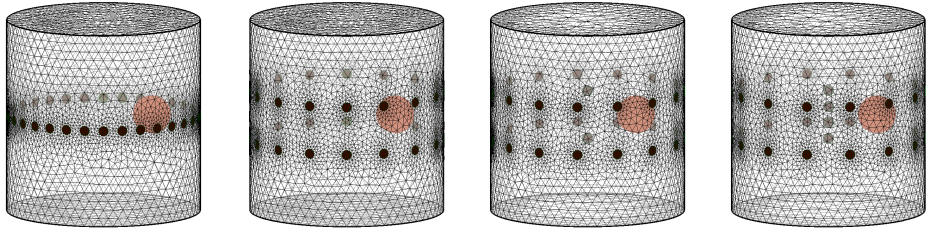
Higher sensitivity in internal regions

Increased sensitivity in the heart → Improved measures of stroke volume and cardiac output

Increased sensitivity to aortic flow → Estimation of blood pressure from pulse wave velocity

Increased sensitivity to internal lung regions → Improved measures of lung collapse and performance

Engineering challenges

Before we can approach the clinical problem...

- How many internal electrodes should be used?
- What injection current should be used?
- What injection pattern should be used?
- How can we apply reconstruction algorithms to improve reconstructions?
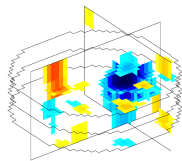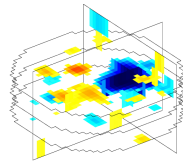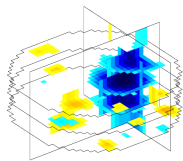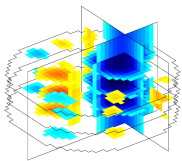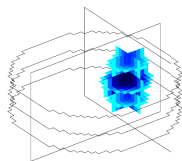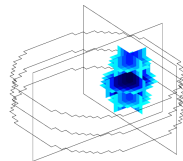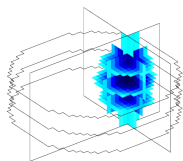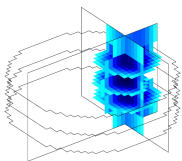- What external electrode configuration should be used?

Little is known about the applications of internal electrodes in EIT

Target object

A conductive object was placed half way between the centre and edge of the tank.
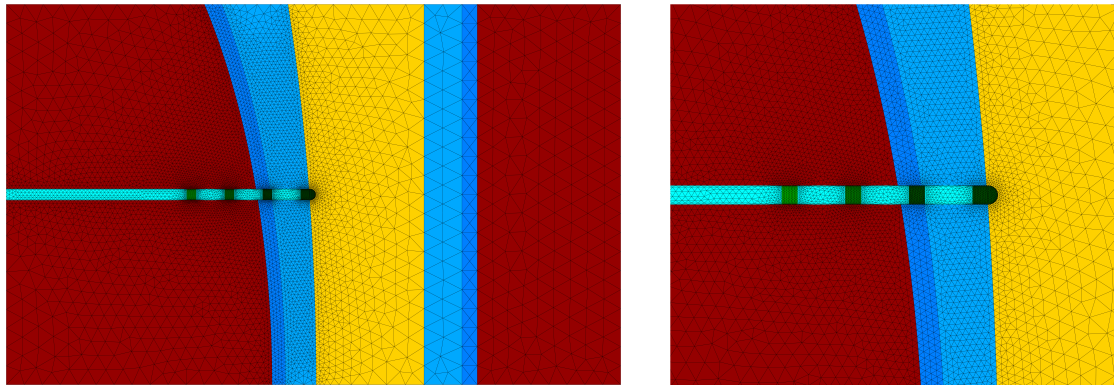
Image reconstructions

configs: 2D   3D   2 internal   4 internal

Additional applications of internal electrodes

A probe with electrodes entering different tissue types.

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