STA Engineering Challenge 2015
PACE Intubation
Android Wear Application

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Introduction

- Interest in Analyzing Body Motion
- Inertial Monitoring Devices are available and relatively inexpensive
- Push for context aware medical equipment

Apple Watch  
LG G Watch  
 Fitbit Flex  
 MYO Armband
Myo Armband
Introduction

- Thousands of physicians will soon be wearing smart watches featuring Inertial Monitoring Units (IMUs).
- Millions of data points generated during procedures which can be captured for analysis.
Challenge

Use a wearable device to assess difficulty of a laryngoscopy
Our Approach

Hardware used

- Google Nexus 7 Tablet (2013 version), ASUS
- Moto 360 Android Wear Smartwatch, Motorola Mobility (9-axis sensor)
Our Approach

Mobile Device

• Built on top of open source software – SensorDashboard
  (https://github.com/pocmo/SensorDashboard)
• Android Studio, Google, Stable version 1
• Android 5 Lollipop
• Java programming language
Data capture

1. Android smartwatch have multiple sensors which are useful for our purposes (Gyroscope and Rotation vector sensors)

2. Each sensor has limitations, but with sensor fusion you can address some of these limitations such as drift and need for calibration.
Implementation

- Two applications
  - Android wear device
  - Android phone or tablet.
Implementation

Android wear device

Android phone / tablet
Initialize App

Press the Start wearable App on Phone
Initialize App

Press the Start wearable App on Phone
Watch Interface

Wear App is started and remains in Notification Stack
Watch Interface

Wear App is started and remains in Notification Stack

Swipe up when you’re ready
Watch Interface

Screen timeout time is increased

Flip the switch then

initiate laryngoscopy
Data transmission via Bluetooth
Data transmission via Bluetooth
Results

Easy: 16
Hard: 150
Threshold

From multiple intubation attempts on easy and difficult to intubate mannequins, a threshold score was determined using a modified supervised machine learning technique (we manually adjusted our threshold based on observations).
Data Sampling

From empirical data we gathered from a set of intubations, we realized that hand movements in any type of intubation occurs with a frequency component less than 10 Hz.

In other words, we only see (at most) 10 movements in a second when an intubation is in progress.

According to Nyquist-Shannon Sampling Theorem, we set our devices data gathering rate at 20 Hz.
Data Analysis

- Our hypothesis is that a difficult intubation has more periodic changes compared to an easy intubation.
- These periodic changes are best captured with the Gyroscope and Rotation vector sensors.
- By looking at the frequency component of the signals from Gyroscope and Rotation vector sensors, and constructing a score based on those components.
- If the score is above a certain threshold, we call the intubation difficult, otherwise, we call it easy.
Fourier transform decomposes a function of time (a signal) into the frequencies that make it up
Figure 1. Gyroscope data exported from PACE app after two laryngoscopy attempts.
Figure 2. Fourier Transform of the two signals generated from the gyroscope data
Next steps

• Simulation studies
• Software is on Google Play, download and use with your android watch
• Let us know about errors
• Lets shrink this ‘BIG DATA’ to ‘big data’ and learn about what we do
Clinical application

- The clinical application of this project is broad
- Placing accelerometer on different patient anatomy (head, mandible, ear)
- Assistance with IV/arterial line placement and regional anesthesia