PACE Intubation Effort Android Wear Application

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Background: The goal of the Society for Technology in Anesthesia’s 2015 engineering challenge was to use commercially available technologies to show that the effort is greater during difficult intubations. As wearable devices have become commonplace amongst Anesthesiologists, in participation in this challenge we developed an Android smart watch application and an algorithm to measure the amount of effort required for various intubations.

Methods: In order to collect data from the intubation process, we used sensor data from an Android watch worn on the left wrist of the person doing the intubation. The sensor data reflects changes in the movements of the left hand over time. The characteristics of an intubation lie in those changes. There are multiple sensors on an Android watch, but we only focused on the signals from the Gyroscope and Rotation sensors (as they reflect more significant changes compared to other sensors, e.g., the Accelerometer).

Results: From empirical data we gathered from a set of intubations, we learned that hand movements in any type of intubation occur with a frequency component of less than 10 Hz. In other words, we saw at most 10 movements per second when an intubation was in progress. As a result, and according to Nyquist-Shannon Sampling Theorem, we only needed to sample the sensor signal at a rate of 20 Hz (20 samples per second). Using a Fourier transform algorithm, we obtained the frequency components of all signals, (from the X, Y, and Z axis of the two sensors) and constructed a score for each intubation.

We included 5 metrics in constructing a score:
(i) The frequency components of the Y-axis data from the Gyroscope sensor
(ii) The frequency components of the X-axis data from the Gyroscope sensor
(iii) The frequency components of the Y-axis data from the Rotation sensor
(iv) The frequency components of the X-axis data from the Rotation sensor
(v) The length of the intubation

The threshold, which we used to distinguish between difficult and easy intubations, was found based on a supervised machine learning technique called Classification. We ran the measurements multiple times and minimized the output error by gauging the threshold as well as the weights we assigned to each metric.

Conclusion: Our hypothesis was that a difficult intubation would have 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, we were able to construct a score. If the score was above a certain threshold, we called the intubation difficult, otherwise, we called it easy. The Android smart watch application that we developed can be downloaded at http://play.google.com/store/apps/details?id=com.hassanpour.pace.intubation

Figure 1. Fourier Transform of the two signals generated from the Gyroscope data