Online Proceedings

Poster Session 2

Balcony, Easel 105

1:00 PM to 2:30 PM

Detecting Exhalations Using a Cross-Correlation Technique

Andrew Zhao Luo, Senior, Computer Science, Bioengineering

Mary Gates Scholar, Undergraduate Research Conference Travel Awardee

Mentor: Jake Garrison, engineering

Mentor: Shwetak Patel, Computer Science & Engineering

One issue in many medical applications is detecting the presence of forced exhalations or breaths through audio data. For example, analysing sleep disorder breathing or analysing a person's lung function from audio of their exhalation first requires localization of a breath event in an audio file. Past work has focused on extensive feature extraction from sound and machine learning methods to detect these events. However, these black box methods require significant feature engineering dependent on the type of exhalation and environment the audio data is recorded to find the start and end of an exhalation event. We present a novel method for detecting the start and end of forced exhalations for spirometry, a medical test of lung function, in audio files. The algorithm requires an initial set of audio files containing exhalations to be manually labelled for locations where exhalations can be heard. Then, we build an envelope which encapsulates the shape of our exhalation signal. We take the cross-correlation of this initial envelope with vast amounts of unlabelled audio data containing exhalations, and use the estimated locations of exhalation events to recalculate the envelope. We repeat this process with the new envelopes until convergence. The converged envelope is then used to autocorrelate an audio signal to detect the start and end of exhalation. While preliminary results show that this method only achieves comparable performance to ad-hoc approaches currently used compared to human labels, it has the benefit of being simpler and more interpretable, enabling easier improvements and runtime of the algorithm.

Session 2O

Biomarkers and Diagnostics

Session Moderator: Paul Yager, Bioengineering

MGH 389

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

A Ubiquitous Screening Technology for Sleep Apnea

Parker Scott (Parker) Ruth, Sophomore, Bioengineering, Computer Engineering

Mary Gates Scholar, UW Honors Program

Mentor: Shwetak Patel, Computer Science & Engineering

Mentor: Edward J. Wang

Obstructive sleep apnea (OSA) is a condition estimated to affect 5% to 15% of the population, in which individuals stop breathing for extended periods while asleep. Treatment is usually successful when provided; however, the vast majority of OSA patients go undiagnosed, in part because the superficial symptoms of OSA in a wakeful state are varied and nonspecific, including drowsiness, hypertension, heart disease, diabetes, and depression. The current diagnostic gold standard is an overnight sleep study, which is expensive and requires access to a specialized sleep medicine facility. This motivates a need for a convenient and accurate technology to screen for sleep apnea in homes and clinics. A ubiquitous screening solution must be both sensitive to slight variations, and specific to apnea in spite of many interfering physiological factors; these challenges are further complicated by the constraints of low-cost sensing devices. Our approach is to detect persistent changes in the sympathetic nervous system that are caused by frequent apnea events; although these changes cannot be measured directly, they manifest in discernible changes to heart signals. To test our system we record cardiac and respiratory signals while participants execute a series of breathing maneuvers, such as breath holding and breath rate control. We record in parallel with (1) a smartphone running a custom application and (2) a commercially available wireless biomedical recorder. Using digital signal processing, we extract informative features from the locations and amplitudes of peaks and troughs in the PPG, SCG, and ECG signals. Equipped with these extracted features and the ground truth diagnoses provided for each patient by the Harborview Sleep Medicine Center, we use existing machine

learning libraries to train a predictive model for apnea. We expect results to demonstrate a correlation between cardiac regulation and sleep apnea severity.

POSTER SESSION 3

Commons East, Easel 74

2:30 PM to 4:00 PM

2D Sense - Powerless, Paper, Interactive Touch Surface

Frank Liu, Senior, Electrical Engineering
UW Honors Program
Mentor: Hanchuan Li, Computer Science and Engineering
Mentor: Shwetak Patel, Computer Science & Engineering

There has been a research effort in exploring RFID (Radio-frequency identification) interfaces. RFID is a form of wireless communication that uses electromagnetic coupling in the radio frequencies to uniquely identify an object, person or animal. By expanding on previous work in paper and RFID technologies, we are able to create new interactive capabilities from paper and RFID. During my time with the Ubiquitous Computing Lab, my goal is to find a technique using capacitive sensing, conductive ink, and RFID tags in order to create an interactive touch surface. An RFID antenna can read an RFID tag and give information pertaining to that tag, for example, tag ID, time, a tag's doppler shift, tag's signal strength and more. My research has been exploring the relationship among these variables and creating a quantitative model that can map for continuous interactions. With such a model, one can make that surface customizable for a variety of interactions. 2D Sense strives to enable 2-dimensional touch interactions on paper by applying signal processing techniques towards existing RFID technology.