# Remote wireless sensing network for the assessment of emotion dysregulation and craving for substance use

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**ABSTRACT**

Excessive alcohol use has many negative health consequences, including higher risk of mortality. In addition, in 2006, the estimated economic cost of excessive drinking was $223.5 billion when the combined costs of lost productivity, health and health care, and crime are considered. Survey studies provide evidence consistent with the affect regulation theory of drinking. Most of these studies are cross-sectional, rely on retrospective reports and cannot address *within-person, drinking/mood relationships over time."* In order to better understand the physiological effects of substance craving and abuse, we propose, train and test, a model for perceived craving through the use of physiological sensors and an android's internal sensors. While the smartphone collects near real-time data of the body's physiological state, participants will also answer survey questions about their emotional state to better assess subjective factors of substance craving. A smartphone application was developed that collects accelerometer data from an android smartphone and affective Q-sensor and then uses machine learning to differentiate the data. So far the program is able to differentiate between three different classes of accelerometer data, that of walking, standing and climbing stairs with 97% accuracy. This data represents how we will classify other types of data such as states of agitation and calm in the wake of substance craving.

## INTRODUCTION

### Background

This project is a merging of two disciplines: Psychology and Computer Science. Smartphone technology has made the monitoring and gathering of behavioral data much more accessible due to the smartphone's widespread appeal and use for so many daily activities. In psychology, smartphones could also replace a wide range of conventional research methods: paper- and pencil surveys, mail surveys, phone surveys, and, if connected to the right peripherals, many lab studies, field studies, and Internet studies.[2] As the demand for smartphones rises so will the demand for people with the skills to make applications for them and those who can make use of the smartphone's multi-functionality.

## Materials and Methods

### Application Overview

The program we are developing for the Body Sensor network will have two main functions. In order to monitor alcohol craving we connect two sensors to research participants: the Affectiva Q-Sensor and the Equivital Sensor. While the sensors collect data, the application will at random intervals ask the participant questions about their emotional state and levels of substance craving. According to certain physiological and survey data, the program can then be used to forward the user to another program.

### The Sensors

The physiological sensors used for this project, the Q-Sensor and Equivital Sensor, were chosen for their functionality and wearability. The Affectiva Q Sensor is a wireless biosensor that measures emotional arousal via skin conductance. The sensor also measures body temperature and activity through an accelerometer.[3] This sensor is worn on the wrist and looks like a common watch. It was chosen for its wearability as participants would be more likely to wear the sensor during daily activities if the sensor appeared inconspicuous. The Equivital Sensor is a chest sensor that was designed to gather more extensive physiological data like respiration, heart rate/variability, oxygen saturation and a host of other physiological indicators. However, at this stage the program, development kits from Equivital are needed to produce any results with this sensor. These sensors communicate the android devices using Bluetooth file transfer protocol.

### The Sensor Service

The Android application we developed, dubbed "Sensor Service", was put onto several Google Nexus One android phones for testing. For testing purposes, the Sensor Service currently schedules a random set of survey questions every five seconds from a list of five sets. The answers to these survey questions are then used to classify the sensor data.

### Results

We were able to use the sensors to do basic machine learning. Accelerometer data was collected from the Q-Sensor and truncated data from the Nexus One's internal accelerometer. We truncated the data from the phone because of its high sample rate compared to the Q-sensor and the fact that the phone was kept in a pocket during the measurements. The following data is collected from the Affectiva Q-Sensor. Weka machine learning software was used to differentiate between three states of activity: idle, walking, and climbing stairs. The naïve-Bayes model was used to classify the data.

```
Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances        1122               97.3958 %
Incorrectly Classified Instances        30                2.6042 %
Kappa statistic                          0.96
Mean absolute error                      0.024
Root mean squared error                  0.1185
Relative absolute error                  5.5268 %
Root relative squared error             25.4542 %
Total Number of Instances             1152

=== Confusion Matrix ===

   a   b   c   <-- classified as
 340   0   6 |   a = walking
   0 490  11 |   b = idle
   0  13 292 |   c = stairs
```

The Discretized data above was correctly classified with approximately 97% accuracy. We used from 1000 – 1500 instances of each class of data for machine learning.

## FUTURE WORK

The work presented here only touches the surface of the requirements needed to get the experiment fully functional.

An obvious area for future work is refinement of the data classifiers. The program currently associates between different types of accelerometer data, but the sensors are capable of gathering vast amounts of physiological data like skin conductance, temperature, respiration and heart rate.

Classifying this data based off of survey data instead of the predefined classifiers is also a necessary step. This can be achieved through the use of time stamps for the launching and submission of a survey questions and matching the responses of the time stamps with those of the sensor time stamps.

Although the results collected for this project were done solely for testing purposes there still exists some file I/O and Bluetooth connectivity issues that will need to be addressed to avoid data corruption.

On a final note, there exist many possibilities for the distribution of the program's surveys. The current scheduling mechanism in place for the different types of surveys is not suitable for the experiment at hand and was developed only for testing purposes. For example, of the five sets of survey questions, the Morning Report set should only be scheduled once at the beginning of the day and the Random Mood Assessors should be scheduled randomly within a six hour interval. Graphical elements of the surveys may benefit from additional formatting as well to insure that participants complete the surveys in their entirety.

## CONCLUSION

In the information age, smartphones have become a way of life. We have only begun to tap into the true potential of this smartphone technology. This project's experiment will see the use of participants answering survey questions about their daily activities while wearing the physiological sensors. This way we can identify the physiological and emotional states of emotional dysregulation as well as alcohol craving and use.[1]

## REFERENCES

[1] Trull, T. Grant Proposal *Remote wireless sensing network for the assessment of emotion dysregulation and craving for substance use. 2012*

[2] Miller, G. *The Smartphone Psychology Manifesto* Perspectives on Psychological Science *2012.*

[3]. *Affectiva Inc. 2012 Q-Sensors.* *http://www.affectiva.com/q-sensor/*.