Scaling Personal Stress Assistance in Natural Environments

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Stress is a growing epidemic in developed societies. While traditional diseases caused by malnutrition or poor hygiene are becoming rarer, stress is only growing. Stress causes or worsens many diseases such as heart diseases, ulcer, cancer, migraine, depression, among several others. Consequently, coping with daily stress is becoming critical to health and well-being in developed societies. A variety of applications can be developed on the smart phone to help individuals cope with stress when and where it may occur if stress can be measured reliably in their natural environment.

Recently developed wearable sensors that wirelessly integrate with smart phones facilitate the monitoring of stress in the natural environment from physiological measurements. But, they require wearing of sensors which can't scale across the larger population. Smart phones, on the other hand, are pervasive, but do not have sensors that can reliably measure stress in the natural environment.

Vision. One approach for enabling the monitoring of stress at scale is to create a stress metric that can be attached to various daily activities. A variety of daily activities that potentially impact stress level (e.g., changing lanes during driving, conversation, watching TV/Video, etc.) can be associated with their impact on the stress level of the individual. The problem of stress monitoring will then reduce to identifying various stress-mediating activities that have an associated stress metric. Identification of such activities can be done reliably using the sensors on the smart phone such as accelerometer, compass, GPS, and microphone.

Evidence. As an example, consider the development of a personal navigation app to suggest least stressful route for commuting. Given that commuting is a major source of daily stress for the working population, such an application can help improve public health. Developing this application requires computation of stress for various road segments. In a study we are conducting as part of our NIH-sponsored AutoSense project and NSF-sponsored FieldStream project, participants wear the AutoSense sensors and carry a smartphone. From physiological sensors, we infer the subject's stress level that matches their perception. From the sensors on the smart phone, we measure various driving events that could be potentially stressful such as lane changes (from accelerometer and compass), sudden brakes (from GPS), stops at traffic lights, etc. Since these inferences are time synchronized on the smart phone, we determine the change in stress level in response to each of these traffic events for each subject. By collecting this measure from tens of subjects, we develop a stress metric for each traffic event that is detectable if it has significant impact on the stress level for a majority of subjects.

A navigation app for suggesting least stressful route can now be developed by measuring the frequency of occurrence of stressful traffic events on various route segments by just detecting those events on the smart phone carried by various participants, who could be recruited for a crowd-sourcing study via, say, Amazon's Turk. The navigation app can be personalized after sufficient history has been collected on the personal experience of the owner of the app herself.

Several other similar apps can be developed (e.g., least stressful neighborhood, least stressful county office, etc.) using a similar approach. Significant effort from the scientific community is, however, needed to pursue this promising direction of research to realize this noble vision.

Credentials: I am leading two large multidisciplinary projects in the area of Mobile Health, involving 15 faculty members from seven different disciplines, spread across eight universities (CMU, Georgia Tech, UCLA, UMass, UMN Medical School, OSU, Pittsburgh, and Memphis) and National Institute on Drug Abuse (NIDA) Intramural Research Program. In the AutoSense project (http://sites.google.com/site/autosenseproject/), sponsored by the National Institutes of Health (NIH) under its Genes Environment & Health Initiative (GEI), my team has developed a wearable sensor suite for collecting physiological measurements from the natural environment. In the FieldStream project (http://www.fieldstream.org/), sponsored by the National Science Foundation (NSF) under its NeTS program, my team has developed models of various human behaviors and a software framework on the smartphone to infer various psychological, behavioral, and social contexts in teal-time that includes stress, smoking, drinking, conversation, physical activity, commuting, etc. The entire AutoSense system has been used in three scientific user studies involving 60+ participants who have worn the entire system in their natural environment for 2,000+ hours.

From these experiences, I have firsthand experience in conducting scientific behavioral user studies on the monitoring and inference of stress in the natural environment. Having built a comprehensive sensor suite and a software framework that supports the continuous collection of measurements from five wearable sensors and concurrent inferencing of more than five complex human behaviors from sensory measurements, I bring insights into the development of behavior inferencing systems that are meant for and used in the natural environment.