StressBar: A System for Stress Information Collection

Dajun Lu, Guoxing Zhan, Shinan Wang, Weisong Shi
Dept. of Computer Science
Wayne State University
Detroit, MI, USA
{ei8449|dw1911|shinan|weisong}@wayne.edu

Clairy Wiholm
Dept.of Public Health and Caring Sciences
Uppsala University
Sweden
Clairy.wiholm@med.wayne.edu

Bengt B.Arnetz
Dept. of Family Medicine and Public Health Sciences
Wayne State University
Detroit, MI, USA
barnetz@wayne.edu

ABSTRACT

The causes of stress and how it affects our behaviors are generally not well understood. The stress research usually requires a large amount of data to analyze possible stress-related factors. The data collection process traditionally is time-consuming and cost-ineffective. To help medical researchers collect the stress information, we propose a tool named StressBar utilizing the powerful data collection capacity of smart phones. In this paper, we will show our design and implementation considerations of StressBar.

1. INTRODUCTION

Stress is an increasing challenge to the health, well-being, and productivity of the urban dwellers[1][3]. World Health Organization, as well as numerous other organizations and researchers have pointed out that stress-related disorders are on the rise and will be one of the most challenging public health threats in the decades to follow[4]. Although the awareness of stress and its negative impact on health and productivity is growing, there is a lack of cost-efficient and easily assessable tools for the public to deal with stress. Medical and psychological approaches available are costly, lack sustained effects or are hampered due to limited availability of trained professionals to deliver the stress treatments.

In order to fundamentally change the way we assess and manage stress, we have launched the StressBar project. StressBar will dramatically improve the assessment of stress in people's daily life as well as offering cost-efficient and easy-to-use effective treatment. Furthermore, the StressBar project will provide stress researchers with an entire new and rapid way to study stress as well as assess the impact from various stress interventions. We believe that participatory sensing is an important method to the research. StressBar will allow us to collect information about individuals and in the future make personalized recommendations. The collective data also allow us to analyze the stress status of a region, such as Metro-Detroit. This will help the government to make more accurate decisions. For example, in more stressed areas, there should be more medical services.

In this paper, we propose the design of our stress collection system named StressBar. Section 2 presents the architecture of StressBar. In Section 3, we discuss its implementation details. A case study is introduced in Section 4 to demonstrate an application based on the StressBar Project.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.
Copyright 20XX ACM X-XXXXX-XX-X/XX/XX ...$10.00.

2. SYSTEM DESIGN

StressBar uses a typical client-server mode, which is illustrated in Figure 1.

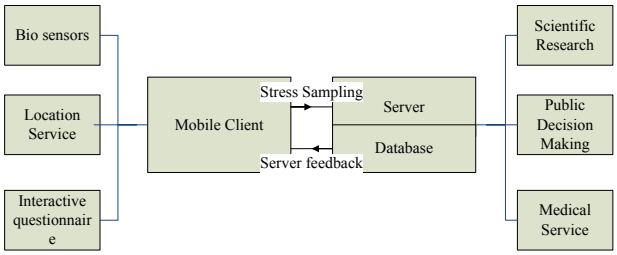


Figure 1: System Design of StressBar

The server receives requests from a mobile client, processes them, visits database and then gives responses back to the client. From the rightmost part of the figure, we see that it also provides services for scientific research, public decision making and medical service.

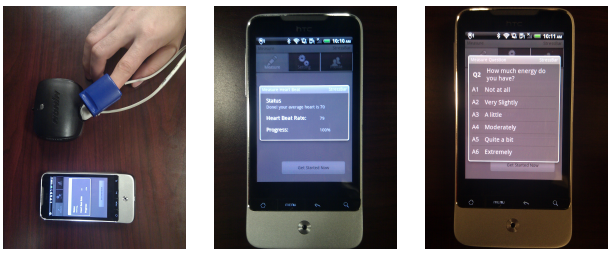
We have two kinds of clients. One is a mobile client, which is used for patients to collect their stress information and receive medical suggestions from doctors. A mobile client supports user interactive questions, Bio-sensor and location information collection. We collect location information, as we mentioned in the Introduction part, is mainly used for governments to do public decisions like to supply more medical services in more stressed areas. The other client is used for scientific researchers to do data analysis and for doctors to give feedback to patients. Also, the government is able to use the part of the information to do public decision makings.

To make the system flexible to the future implementation change, we design interfaces for all the modules in Figure 1. The server provides basic functions or APIs, it is the responsibilities for clients to combine those APIs together to finish their work.

3. SYSTEM IMPLEMENTATION

This section presents some detailed information about the implementation of StressBar prototype. Not all the functions we introduced in Section 2 are included in the prototype, and we mainly focus on the server, database and mobile client design details.

The server is currently running on a Linux machine,and the client is running on the Android platform, which is responsible for data collection, including heart beat measure, stress and location information collecting. The communication protocol between them is HTTP, which provides fast and reliable solution to the system implementation. Four modules are presented in the following: *data collection module*, *communication module*, *service module*, and *data store module*.



(a) (b) (c)

Figure 2: Mobile client data collection:(a)collecting heartbeat using Nonin4100;(b)heart rate result;(c)interactive questions.

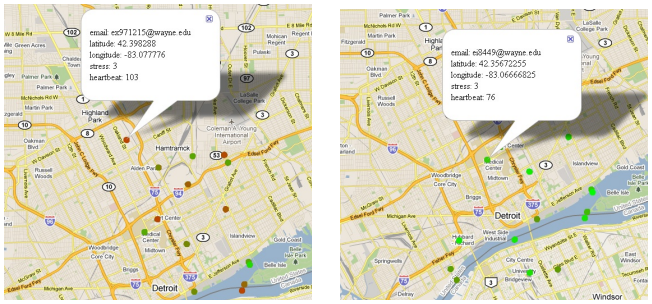
The *data collection module* is designed to collect possible user stress information while at the same time making the collection process cost-effective and easy accessible, so we choose android as the mobile client platform. The information we collected includes heart beat, location, and user interactive questions. Heart rate information is collected through Bluetooth from a Nonin 4100 sensor(Figure 2(a)) which is attached to the users' finger. After two minutes, when the heart beat measure process is finished, the program pops up questions for users to fill(Figure 2(c)). The heart rate and answers for those questions together with location information are then sent to a remote server through our communication model. Collecting location information is time consuming, so we implement it as background service updating location every 5 minutes.

The *communication module* hides the complexity of client server communication. It is implemented as background service on mobile clients. The protocol we use is XML-RPC, which is a remote procedure call using HTTP as the transport and XML as the encoding. It is flexible and easy to implement, but one disadvantage is that it increases our phone's network traffic, which may increase our cost on using StressBar.

The *service module* targets receiving client side requests and giving responses back to the client. We implement the service module as a web service since it is a fully developed technology, which will greatly reduce our efforts on building a reliable, high performance and scalable server. We can easily reconfigure it to add more services without changing the written code. StressMap, which displays the stress information on the map based on the location information collected by clients, can be easily deployed on our web server by just adding several lines on web.xml file.

The *data store module* we use currently is built on MySQL database. We use the JDBC pool as the connection between the web service and database access since it automatically help us handle concurrent database requests. MySQL database has disadvantages on constructing large scale, distributed data storage system[2]. To solve its disadvantages, we are building a highly distributed NoSQL data storage system named Woodward, which will be used for health data storing.

4. CASE STUDY: STRESSMAP



(a) (b)

Figure 3: StressMap:(a)stress data; (b)heartbeat data.

We developed StressMap, a prototype application for public decision making. It provides a visual presentation of the stress-related data on a geographic map. Two illustrations are in Figure 3. In Figure 3(a), each colored dot on the map represents a participant's data submitted at that location. The color is decided according to the stress value: green for value 1 (no stress); red for value 6 (extreme stress); color changes with a linear gradient as the stress value scales from 1 to 6. Similarly, In Figure 3(b), the dot color changes with a linear gradient as the heartbeat value scales from 60 to 140. Such visual color effects allow the public to get a quick sense of the current stress level among the local residents. Further specific data analysis can be achieved through accessing the backend database.

5. REFERENCES

[1] A. J. Arnetz BB, Lucas T. Organizational climate, occupational stress, and employee mental health: Mediating effects of organizational efficiency. *JOEM*, 53:34–42, 2011.

[2] CouchBase. Nosql database technology. `http://www.couchbase.com/sites/default/files/uploads/all/whitepapers/NoSQL-Whitepaper.pdf`, 2011.

[3] W. E. Ganzel BL, Morris PA. Allostasis and the human brain: Integrating models of stress from the social and life sciences. *Psychol rev*, 117(1):134–174, 2010.

[4] A. I. Hansson AS, Arnetz BB. Risk-factors for stress-related absence among health care employees: A biopsychosocial perspective. associations between self-rated health, working conditions and biological stress hormones. *Italian Journal of Public health*, 3:53–61, 2006.