Poster Abstract: SADSense: Personalized Mobile Sensing for Seasonal Effects on Health

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***Abstract*—People's moods and activities are heavily affected by their environment, which changes significantly throughout the year. The variable of daylight hours is huge for countries in extreme latitudes, impacting the population's health and well-being. In this paper, we present a smartphone application that efficiently and accurately measures a person's light exposure, mood and activity levels. We performed a preliminary study to show effective data collection using on-board sensors in the mobile phones.**

I. INTRODUCTION

People's environment, sunlight exposure and activity levels significantly affect their health and well-being. Natural light synchronises diurnal rhythms in physiology, sleep, muscle and cardiovascular function. It can also elevate one's alertness, cognitive performance and mood. Measuring, reflecting on and understanding a patient's light exposure and activity levels is crucial when attempting to diagnose and remedy seasonal disorders. With access to this data, users can then better understand and control their health and well-being, so as to give early warnings for those who may benefit from further diagnosis or medical treatment. A seasonality monitoring system should be able to provide user-friendly and stable long-term monitoring. It has to be unobtrusive and yet still provide accurate sensing measurements that lead to meaningful interpretation.

This paper presents *SADSense*, an application to run indefinitely on mobile phones, collecting data on the user's activity level and light exposure without the use of any external sensing devices. It exploits the sensing capabilities of a smartphone in providing adequate and accurate data for monitoring seasonality effects. We observe that seasonality monitoring only requires coarse-grained information to characterise the general trend of a user's environment and activities. We explore the light sensor on the mobile phones to measure light exposure of individuals and its impact on our mood and activities. We perform a preliminary study on the system's efficacy, reliability and usability to ensure that a long-term study is achievable over multiple seasons and will be able to gather valid data on human seasonality.

II. RELATED WORK

Wireless sensors and mobile phones have been widely used for healthcare applications [1]. Healthwear [2] has presented the adoption of sensors and mobile phones as wearable computers to monitor the users' health. Wireless Body Area Networks (WBANs) of sensors around the human body have also been studied for medical, e-health and sport applications [3]. Affective healthcare [4] has been proposed as a mobile service for people to understand and recognize their emotions and their level of stress. Our SADSense system aims at combining multidimensional sensing data for a comprehensive understanding of human health and well-being with regard to seasonality.

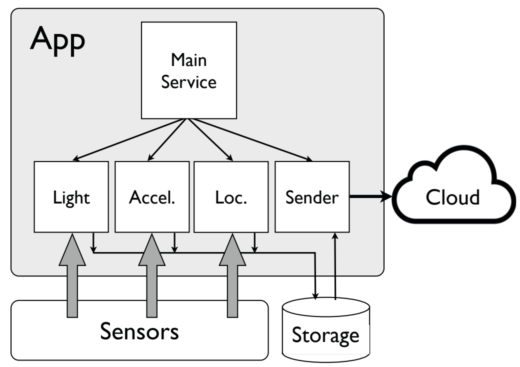

Fig. 1. System diagram on the main units of the app and their interaction.

III. THE SADSENSE SYSTEM

A. System Design

In SADSense, users only need to install an application and have occasional Internet access for uploading their data to the server. The structure of the app and how it interacts with the external hardware and our Internet cloud server is depicted in Figure 1. We utilise the proximity sensor, light sensor, accelerometer, WiFi/Network localisation on the smartphone to collect light, activity and location data of individual users. Apart from the physical activities, our application also includes an optional questionnaire to record the mood and feelings of the mobile users.

B. Mobile Sensing Application

The SADSense mobile application is designed to be simple, informative and user-friendly. Users require zero knowledge to use the application and interferences as little as possible to the

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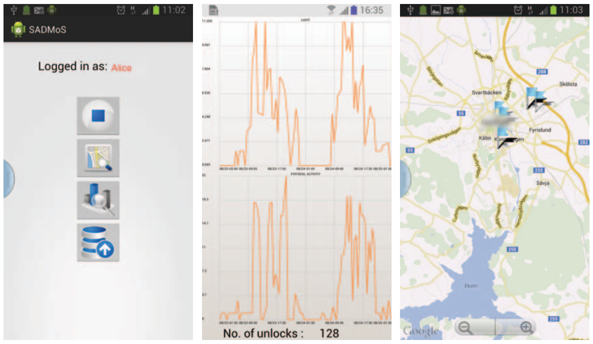


(a) User login page. (b) User activity and light exposure. (c) user locations.

Fig. 2. Screen shots of mobile app.

users' activities. A simple authentication system with username and password has been implemented in the application to protect the user's data from unauthorised access.

Figure 2(a) shows the user interface of the app after login. The four buttons provide different functions: starting/stopping the app (top), displaying the location data (second), showing the light and accelerometer data (third), and uploading data to server (bottom), respectively. A user can visualize their light and activity data as shown in Figure 2(b). These graphs allow the user to keep track of their light exposure and activity level over time. Similarly, they can see the places that they has visited recently on a map (see Figure 2(c)). From the above data, the user can easily observe the trend of his behaviour and environment change. This sensing data can be further analysed by classification and data mining methods to give more formal interpretation.

IV. Experiments

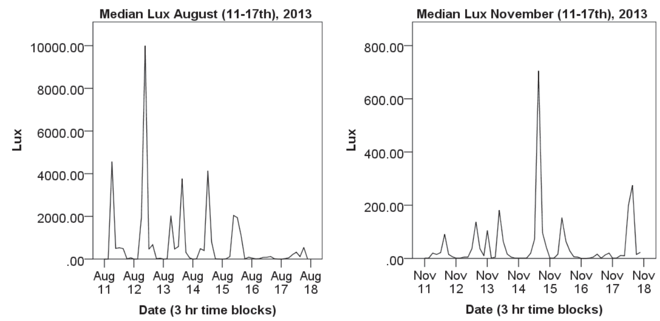
The first experiment examines SADSense's intermittent light measurement process by comparing to a baseline light exposure that users experience. This was recorded by subjects wearing an external light sensing device, the *HOBO* sensor[1]. This small sensor can be attached to person's clothing and set to permanently monitor and record the exposed light levels.

We compare the readings collected by the light sensor on the mobile phone and the HOBO sensor. The Spearman's coefficient between the datasets is $\rho = 0.78$ indicating a strong correlation between both mechanisms of light monitoring. It would not be expected to gain perfect correlation, as both methods are affected by different biases, and can only indirectly measure the light exposure a person experiences.

In the next experiment, we recruited five mobile users to carry our app in Uppsala for five months. Figure 3 shows the median value of light exposures among the active users. We can see that our users were exposed to much stronger sunlight in August compared with November.

Finally, Figure 4 shows the relation between average mood and light exposure of our users in November. We observe that the mood of users tend to be better when they receive more sunlight in the day.

[1]HOBO Data Loggers: http://www.onsetcomp.com/



(a) August. (b) November.

Fig. 3. The median light readings among users in Uppsala.

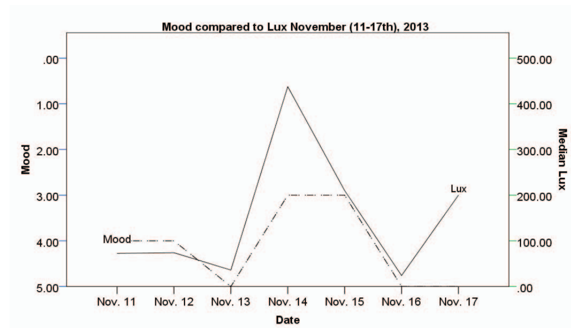


Fig. 4. Mood and light readings in November.

V. Conclusions

This paper presented a mobile sensing system for mobile users who are concerned with their response to seasonal variations in their environments. An unobtrusive and frugal Android application was developed and a preliminary study performed to measure light exposure, activities and mood of mobile users. Initial results showed that measurements from the light sensor on the phones can provide adequate quality light measurements comparable to an external wearable sensor. We are currently performing a full study, collecting data from a wider group of users over a much longer period, aiming to have a complete year's cycle to analyse.

Acknowledgment

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