METU, Department Of Computer Engineering

Graduation Project

Proposal Form

Project Information

Title

Tracking and optimizing sleep experience

Target

Public [ ] Restricted [✓]

Proposer Information

Name(s)	Eşref Öztürk Özge Lüle Barış Özkuşlar Oğuzhan Ünlü
E-Mail(s)	esrefozturk93@gmail.com luleozge@gmail.com ozkuslarbaris@gmail.com cengoguzhanunlu@gmail.com

IP (Intellectual Property) Information

All intellectual properties of this project belongs to the project proposers.

Project Description and Background Information

Description

We will build a system that tracks, analyzes and optimizes sleep. The system will consist of a fixed and a wearable component. They will collect data from the user and the room using various sensors. The data from sensors will be analyzed in real-time. By using the results, the system will have the information about the depth of the sleep and it will raise the alarm when user has the lightest sleep in the morning. Also, the results of analysis will be provided to the user in a visualized manner from a mobile app, so that they can see how they have slept. Moreover, the system will get the feedback from the user about how they feel when they wake up and give them suggestions accordingly.

Similar Products/Projects

Below are some products that have some features similar to our projects' .

- Sleep Cycle app - http://www.sleepcycle.com
- Beddit Sleep tracker - http://misfit.com/products/beddit
- Samsung Sleep Sense http://global.samsungtomorrow.com/be-a-better-you-with-samsung-electronics-sleepsense/
- Luna Sleep http://lunasleep.com/

Justification of the proposal

The purpose of the project is to provide user a better sleep experience by waking them up on the right time and demonstrating the information about their sleep obtained by analyzing fused data coming through various sensors and user feedback about the quality of the sleep. The right time to wake the user up will be determined by real-time analyzing the REM* state of the user sleep.

People cannot analyze themselves during the sleep like they do during the day. The system will fill this need. Using the application, user will be able to examine not only their sleep quality but also their average heart rate, body temperature and the most suitable sleeping environment for them.

Standard alarms wake user up at a fixed time, mostly in their deep sleep. The system aims to wake user in their lightest sleep which will make them feel more relaxed and rested.

* During the night, our sleep states change between rapid eye movement(REM) and other states(referred to as non-REM). A typical adult will enter REM sleep roughly every 90 minutes.

Contributions, Innovation and Originality Aspects of the Project

- Although there are existing projects that focus on sleep optimization or tracking etc., none of them tracks the sleep process as detailed as our project aims for. For example, existing mobile apps recognize only the body movements with accelerometers, but our system uses various sensors to acquire comprehensive data to define users' sleep quality.
- Our system will give users more detailed and accurate data, since we use wearable technologies that lets us use on-contact sensors which other products generally can't.
- Since our system is connected to the bed, it's possible to control it according to user configuration or incoming data from sensors.
- By integrating the user feedback to our application, our system will make use of machine learning to provide recommendations to the users.
- This project can break fresh ground on smart beds.

Technical Aspects of the Project

The system has 5 sensors that tracks motion, room and body temperature, pulse and sound. Motion, pulse and body temperature sensors will be on the wearable component. Sound and room temperature sensors will be on the fixed component. All of the sensors will collect data from user and environment. The sensors on the wearable component will send the raw data to the fixed component. All computations will be done on the fixed component.

We will use accelerometer, thermometer, pulse sensor, and microphone to measure motion, body and room temperature, pulse and sound respectively. Sensors on wearable component will be connected to xbee device through a microcontroller chip. The chip will get analog output(voltage) of sensors and will output serial data to xbee. Then, this xbee device will send data to the xbee device on the fixed component. Fixed component will consist of a raspberry pi, wifi dongle and the sensors mentioned above. Our software, running on the fixed component, will fuse the data from fixed and wearable components. By analyzing the data, the software will track REM periods of the user in real time, decide when to ring the alarm and send the command to the phone via the internet. After waking up, users will be able to give feedback on the mobile application. By joining this data with users' sleep data on server, using machine learning techniques, our system will decide on which conditions the user sleeps most comfortably and inform the user via mobile application which presents users all the data in a user friendly way. Also, our system will save all of the users' data. Collected data may be used in academic studies or R&D studies like geographical sleep habits etc.

Targeted Output, Targeted User/Domain Profile

The end product will consist of a wearable and a fixed component. These components will be used to collect and process data. The user will be able to use the product through a mobile app. It will be a smart sleep tracking system capable of observing people during their sleep, logging their activities, waking them up at an appropriate time, also presenting information about their sleep. Besides all these, users will be able to share how they feel about their sleep so that our system will dynamically improve itself by looking at its predictions and user feedback.

Determining the REM stages at high accuracy is the first goal of this project. Learning the relation between the sleep data and the feedback of the user and being able to give reasonable suggestions to users is the latter goal.

Targeted user profile consists of the people who want to have a better sleep experience.

Project Development Environment

During the development, the following will be used:

- Accelerometer
- Temperature Sensor
- Pulse Sensor
- Acoustic Sensor
- Raspberry Pi
- Xbee
- Microcontroller
- C Programming Language
- Raspbian
- Android/Java
- Server side API

External Support

Development of this system highly requires energy efficient sensor nodes which will be supported by Prof. Dr. Adnan Yazıcı. We will use Metu Mobility Research Lab for our test and research purposes with the help of Dr. Selim Temizer.

There are lots of research done about sleep, we will build our analysis algorithms on the basis of this scientific information. Also, we will create a training set for sleep quality by observing people sleep and asking them rate their sleep, intending to make a correlation between our data and sleep quality.

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