SleepyLab: An Extendable Mobile Sleeplab Based On Wearable Sensors

Poster Abstract

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KEYWORDS

Consumer health informatics, Medical informatics

ACM Reference format:
Andreas Burgdorf, Jó Ágila Bitsch, and Stephan M Jonas. 2017. SleepyLab: An Extendable Mobile Sleeplab Based On Wearable Sensors. In *Proceedings of Informatics for Health 2017, Manchester, UK, April 2017,* 1 pages.
https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

According to the Robert Koch-Institute, 25 percent of German adults suffer from sleep disorders. Consequences of sleep disorders are dangerous and costly. A common sleep examination is the in-clinic polysomnography, which records vital, activity and other parameters. These examinations are costly and usually limited to a few nights per patient.

A possibility to perform cheap, long-time monitoring of patients are smart wearable devices. Many consumer-grade smartwatches or fitness trackers are equipped with sleep monitoring applications. However, these applications are not based on scientific publications and are limited to vendor applications. Thus, data access or aggregation across multiple devices, which would be required for a clinical assessment, is limited or impossible.

2 METHOD

To close this information gap, we developed the modular Android application SleepyLab: a mobile sleep laboratory based on wearable devices. The modular architecture allows for different hardware, and processing or visualization algorithms in one solution. Therefore, SleepyLab consists of a Core Application and three plugin-types: 1) monitor, 2) processing and 3) presentation plugins. Recorded data is stored and communicated by the core application in an interoperable format using the Medical Subject Headings (MeSH) to classify devices and body regions.

Monitor plugins measure data from smartphone-internal or connected sensors. For each device or characteristic, a separate plugin can be installed and integrates seamlessly into SleepyLab. Inspired by polysomnography, the following monitoring plugins have been realized: 1-3) movement (smartphone, smartwatch, TI SensorTag), 4-5) cardiac activity (chest belt, smartwatch), 6) sound (smartphone), 7) brightness (smartphone) and 8) EEG (Emotiv Epoc+).

Processing plugins analyze recorded (or already processed) sleep data with arbitrary algorithms. Algorithms can potentially detect of sleep stages, activity or snoring based on recorded signals. A first realized plugin aggregates movement data into activity.

Finally, presentation plugins display recorded or analyzed data or are other data endpoints. One implemented plugin allows users to view graphs of raw data. Another plugin exports data into csv files for further processing.

3 RESULTS

SleepyLab was evaluated in two different phases. First, the suitability of the developed plugins and corresponding sensors was evaluated. Second, several full-night recording were performed in self-tests.

The plugin evaluations showed that most plugins were suitable to perform their task. The smartwatch performed best in detecting movements, while the chest belt measured a more accurate heart rate. The sound plugin performed best with external microphones and the brightness plugin?s quality strongly depended on the used device. The EEG plugin could store the recorded data as EDF+ files but the sampling rate was too high to directly communicate data to the core application.

The full night records were performed without the EEG device due to its form-factor. Nevertheless, the visualization of movements, sounds and heart rates allowed the manual detection of different sleep phases without further processing. Disadvantages were high energy consumption of the smartwatch and the heat development of the smartphone, if charger wirelessly.

4 CONCLUSION

The mobile Application SleepyLab records, processes and visualizes sleep-related data from wearable devices to supports sleep research and clinical practice with inexpensive and unobtrusive long-term monitoring.

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Informatics for Health 2017, April 2017, Manchester, UK
2017. ACM ISBN 978-x-xxxx-xxxx-x/YY/MM.
https://doi.org/10.1145/nnnnnnn.nnnnnnn