

Overview of the Technical Challenges faced when using Consumer Mobile Biosensors within Telemedical Applications

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Introduction

Over the last years, the use of consumer sensor devices in research and medical care has become increasingly popular. Due to their high acceptance and availability, these devices provide an unprecedented opportunity to collect objective biomedical and behavioral data at no cost continuously for an extended period of time. They are thus ideally suited for telemedicine applications and research under real-life conditions. However, the use of consumer devices also poses several technical challenges. These include the availability of raw sensor data for 3rd-party developers, accessing different types of software interfaces, the reliability and usability of the hardware interface between sensor and mobile device, quality of sensor data and battery-life. Furthermore, a number of data privacy and medical certification issues arise from the difference between producer-intended and actual use of the sensor device.

Aim

The overall goal was to create an evaluation framework which allows researchers and developers to systematically identify which mobile sensor device is best suited for their specific application. As a result the challenges are addressed, evaluated and valid solutions are discussed in this poster. For the wearable sensor devices, various quality criteria are introduced based upon which a use case specific catalog of requirements may be written. As an example, we consider the three common use cases of fitness, health and medical applications.

Methods

In order to qualify how well a mobile sensor device is suited for a specific application, such as a medical study or a consumer application, a list of selection criteria has been determined. This list had to be as general and complete as possible so that it could be applied to all biosensor devices on the consumer, the research and the medical market. Most of the criteria in this list are highly dependent on the wearer target group, on who will have access to the acquired data, what data-privacy restrictions apply, etc. In short: These criteria are highly context-dependent and have to be assigned to a specific use case. Based upon a profound literature research we have identified three general, common use cases which cover virtually all applications that deal with mobile biosensor-devices: 1) Fitness, 2) Health and 3) (Tele-) Medicine. Specific to each use-case scenario, the selection criteria have subsequently been sorted according to importance into the following three groups: A) Drop-out criterion, B) Important and C) Nice to have. For each use-case a table was created with all the considered sensor devices on the one axis and all selection criteria sorted by importance on the other axis. Finally weights were assigned to each criterion.

Results

Hereafter, all determined selection criteria are listed.

Usability:

- within target price range?
- water resistant?
- battery life sufficient?
- Comfortable enough to wear for target time-span?
- Can the device cause allergies / rashes when worn for extended periods?

Technical aspects:

- do you need RAW-data access? Can you get it?
- developer SDK or web-API available for data access?
- supported by OS of mobile device?
- interface type (Bluetooth, cable, SD-card,...)
- data quality sufficient? sample rate sufficient?
- hardware and software sufficiently documented?
- are all the sensors required for your application included in mobile sensor device?
- Enough storage space on mobile device available?
- Do you require buffer space on sensor device?
- Data time-stamps required? How precise?

Legal/Safety aspects:

- CE/FCC certified?
- medically certified? which class?
- certification match that of your final use case?
- Is further certification of the final system required?
- sufficient encryption possible for your use case?
- Will be the use 3rd-party code / applications required? Will you need a license?
- Will 3rd party applications store user specific data on servers you have no control over? Can you avoid it? Do you still fulfill data privacy regulations if they do?

In Figure 1 some of the listed selection criteria have been assigned to three use-case scenarios. Drop-out criteria are marked in red and important criteria are highlighted in orange. Nice-to-have criteria were omitted since it is almost always nice to have additional features but no additional value was attributed to them. As can be seen, the demands on hardware and software become more stringent from left to right. Thus, access to raw data is the greatest challenge to overcome for health and telemedicine applications. For instance, jawbone and Fitbit - two of the major manufacturers of mobile consumer devices – only provide access to coarse time averaged and preprocessed data. Unfortunately, documentation of communication protocols, hardware and preprocessing software is scant. Moreover, data access is only possible via a web API. As a consequence, the data is always stored on a third party server. Another obstacle is the medical certification. None of the end consumer devices we reviewed was medically certified. Unlike the drop-out criteria, the important criteria remain the same for all three use cases.

Fitness

- above consumer price range
- not supported by OS on target device
- no CE/FCC certificate

- long battery life
- water resistant
- large storage/buffer capacity
- many different biosensors
- developer SDK



Health

- no RAW-data access
- undocumented hardware/algorithms
- above target price range
- required sensors not included
- data quality/sampling rate too bad
- not supported by OS on target device
- data privacy issues
- no CE/FCC certificate
- no medical certification

- long battery life
- water resistant
- large storage/buffer capacity
- many different biosensors
- developer SDK



Telemedicine

- no RAW-data access
- undocumented hardware/algorithms
- above target price range
- required sensors not included
- data quality/sampling rate too bad
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- data privacy issues
- no medical certification

- long battery life
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Fig 1.: Selection criteria assigned to three specific use cases, i.e. Fitness, Health, and (Tele-)Medicine.

Conclusion

In conclusion, the use case determines which mobile sensor device is best suited for an application. For obvious reasons, telemedicine systems have higher demands on hardware and software. However, in some cases, end consumer devices may be used in research and medicine provided, of course, a sufficient data quality.

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