



Danmarks Tekniske Universitet

TERM PAPER

COURSE:
02238: Biometric Systems

AUTHOR(S):
Stephan Thordal Larsen (s146907)

DTU Compute
Institut for Matematik og Computer Science

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Contents

1 Introduction

The minimization of computing hardware which spawned the smartphone era, has also allowed for the development of powerful smartwatches filled with sensors. These sensors can continuously observe the wearers bodily functions, which in theory can be utilized for biometric identification of the wearer. This could allow for a strong link between the user and smartwatch, resulting in unobtrusive and ubiquitous user authentication.

This paper will analyse the first generation of smartwatches, more specifically the *Apple Watch*, to find which biometric capabilities that can be utilized for user identification and authentication. The analysis will look into the available sensors and the *Software Development Kit (SDK)* provided by Apple, in order to find which biometric observations can be performed. The paper will try to identify both possibilities and limitations of the system, and try to utilize the possibilities in a prototype, to see how this in practice could be implemented. The prototype will include feature extraction from biometric measurements and a comparison of these, in order to identify the wearing individuals. Lastly the prototype will be tested on 10 subjects, to evaluate the prototypes performance.

2 Analysis

This section will analyze the potential for biometric measurements on the *Apple Watch*. The analysis will cover both the hardware and software, i.e. which sensors are included in the watch and how they are utilized by the SDK. The sensors will also be evaluated on their usefulness for biometric identification. Finally the analysis should result in a selection of sensors found appropriate for the prototype.

2.1 Sensors

The *Apple Watch* includes a multitude of sensors [?], which are used mainly for usability, activity, fitness and health tracking, but they are also used for some security functionalities, such as using the heart rate sensor, to ensure the owner who unlocked the watch, has not removed the watch since authorization occurred.

2.1.1 Heart rate sensor

The integrated heart rate sensor uses the technology *photoplethysmography*. Which functions by using green LED's to illuminate the veins in the wrist and photodiodes to detect the amount of blood flowing in said veins. This allows the watch to detect the wearers heart rate [?]. The quality of measurements rely on the wearers fit of the watch, but when fitted correctly heart rate data is provided through Apple's *HealthKit* API. The heart rate data can be fetched as a stream through an instance of *HKHealthStore*, and can both be fetched as a calculated heart rate, and as raw sensor data. Heart rate data for biometric identification has been explored by other vendors than Apple [?], but this has been done with different sensors and raw sensor data. It has been found possible with raw sensor data to identify individuals from photoplethysmography signals, like the ones obtained from the Apple Watch sensor [?]. A photoplethysmography sensor therefore seems like a potential biometric characteristic capture device.

2.1.2 Accelerometer & Gyroscope

Both an accelerometer and a gyroscope are located in the watch, and these are used for features like activity tracking and rotation detection for screen auto-on. Raw data is accessible from both sensors through the `CoreMotion` framework.

2.1.3 Gyroscope

2.1.4 Microphone

2.1.5 NFC

The potential of an NFC chip in the watch seems promising for access control, as it could allow for interaction with third-party devices, i.e. NFC readers. This could be utilized for doors which rely on NFC key cards, where the watch could function as a secure device containing the NFC key cards. Unfortunately this is simply not possible, as Apple has restricted developer access to the NFC chip, only allowing it to be used with their own *Apple Pay* service.

2.2 Limitations

The SDK does not allow for full control of all aspects of the watch. There are some limitations to the way Apple runs third-party applications on the platform. Most of the limitations are of course present due to user experience and battery lifetime. The watch does not allow for continuous background services, it is dependent on having an iPhone connected to enable internet connections, apps can not hinder the screen in automatically shutting off and the processing power is of course limited in comparison to smartphones and laptops.

The main limitations affecting the development of the prototype are the lacking ability to run background services and the One limitation is the watches ability to run background services,

2.3

3 Prototype

3.1 Design

3.1.1 Modality

3.2 Implementation

3.3 Evaluation

References

- [1] Apple Inc. Apple watch - technical specifications, 2016. URL: https://support.apple.com/kb/SP735?locale=en_US.
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