

# Smartphone Based HRV Measurement – An Unobtrusive and Flexible Approach

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**Abstract** – There is an increasing number of wearable devices which measure physiological data in everyday life. Primarily, they are used in the fitness sector to monitor training intensity or progress. However, there is more information we can derive from these data as physiological parameters can reflect users' current mental state (mood, stress, emotions). One frequently used signal in this context is the heart rate variability (HRV). HRV describes slight variations between successive heartbeats. The autonomous nervous system (ANS) which responds to psychological stimuli is responsible for this variation. Therefore, HRV is a promising parameter in the context of capturing data about mental state [4].

Information about users' mental state could then be used to design highly user adaptive systems. For example, an application which is able to determine a users' state could adjust feedback adaptively or present information at a suitable time. Based on this, we presented a novel approach of using HRV as a surrogate parameter [1]. We propose that HRV levels can be used to develop a user adaptive activity tracking application.

However, to take physiological data into account, there is a need for appropriate devices which are able to perform these kinds of measurements and are suitable for unobtrusive daily use. Up-to-date wearable devices such as smartwatches or fitness tracker usually have an integrated optical pulse sensor (photoplethysmography) to measure heart rate (HR) and thereby could generally be used [3,4]. This might be practicable for users who already use such a device, but it does not seem reasonable that users will wear an additional device just to use an adaptive feature in a smartphone application.



Fig. 1: Visualization of the sensor patch. Attachment of the patch on the backside of the smartphone (left). Execution of measurement while using the smartphone (right).

It is obvious that using the smartphone as a standalone device to collect HRV data would be the most comfortable way. Also there are a lot of applications using the integrated smartphone camera to measure HR or even HRV, this kind of measurement is not suitable in our context. The main problem is the placement of the camera. An application has to ask users to place their finger on the camera to

execute a measurement. However, we want to implement an objective measurement of mental state and such a measurement could be affected when users have to get active for it. Moreover, measurement should be unobtrusive. Therefore, it would be highly beneficial if measurements were taken during normal smartphone use.

For this reason, we present a novel sensor system which enables for continuous and unobtrusive measurement of HRV during normal smartphone use. The main idea is to design a sensor patch which can be placed on the back side of a smartphone (*Fig. 1*). Hereby users are enabled to place the sensor as needed by considering their typical smartphone usage habits (e.g. vertical, horizontal, left or right hand). As a result, users will usually touch the sensor with a finger (or the palm) while using their smartphone, and thus enable the system for unobtrusive measurements.

The patch mainly consists of an optical pulse sensor to measure heartbeats and a near field communication (NFC) tag which is used for data transfer. The NFC tag also provides a power supply, thus there is no need for a battery.

We developed a demonstrator device and an Android app to capture heartbeat intervals in real time. Data transfer and power supply were tested with different types of smartphones. Therefore, the general function is approved. Additional measurements and user tests are planned to point out potentials as well as limitations of the concept.

## REFERENCES

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