Caring is Sharing – Exploiting the Value in Data for Health and Innovation
M. Hägglund et al. (Eds.)

doi:10.3233/SHTI230339

On-Site Visualization of Ballistocardiography Data

Urs-Vito ALBRECHT[a,1] and Ulf KULAU[b]
[a] *Department of Digital Medicine, Medical Faculty OWL, Bielefeld University, Bielefeld, Germany*
[b] *Smart Sensors Group, Hamburg University of Technology (TUHH), Hamburg, Germany*
ORCiD ID Urs-Vito Albrecht https://orcid.org/0000-0002-8989-6696,
Ulf Kulau https://orcid.org/0000-0002-1662-880X

Abstract. We describe the background, features and functions of a custom application for the acquisition, live presentation, and convenient recording of ballistocardiography data acquired by external accelerometric sensors.

Keywords. software, ballistocardiography, data recording

1. Introduction

During increments 66 and 67, we conducted Ballistocardiography (BCG) experiments aboard the International Space Station (ISS) [1]. This article focuses on software that was developed to allow on-site live monitoring during pre- and post-flight measurements in preparation for the experiments.

2. Method

The hardware used for the BCG measurements has been described in [2,3]. The software is designed to perform BCG measurements quickly and with high data quality. After a requirements analysis and pen-and-paper development, the application prototype was written in C++, using the QT 5.12 framework in Q1.2021. After several iterations of testing and modification, version 1.0 was ready at the end of Q2 2021.

3. Results

The interface functions as a virtual COM port via USB, with the data being sent as a binary stream in a fixed format. The data is received in the software from the interface and written directly to a file without conversion. Thus, in addition to the later decoded

[1] Corresponding Author: Urs-Vito Albrecht, Department of Digital Medicine, Medical Faculty OWL, Bielefeld University, Universitätsstraße 25, 33615 Bielefeld, Germany; E-mail: urs-vito.albrecht@uni-bielefeld.de.

data, the original binary data is also recorded, which can be useful for debugging if necessary. The binary data stream is then decoded, splitting the data into frames and thus making all BCG data available as composite objects. This decoded data and corresponding timestamp can also be stored in a CSV file if required. However, most importantly, the data can be visualized in real-time. All BCG data can be viewed graphically in freely selectable configurations. The graphs also offer features such as pause or zoom. Since BCG data is often located near the noise floor, signal processing with filters is usually necessary. These features are directly integrated into the live view. Moving mean and bandpass filters are implemented, and their depth or cutoff frequencies are also freely configurable in real-time. This allows the data to be viewed directly during the measurement, and the display can be optimized by setting filters individually. If everything is configured and the setup for the measurement process is correct, data recording can be started via the record button. In addition, markers can be set to tag events directly in the recorded data during the measurement. Of course, all measured values are timestamped (Unix time stamp format), and the file is once again saved as CSV. In addition to the live view, all recorded data acquired since the software was started can also be displayed visually.

4. Discussion

The Ballistocardiography (BCG) method utilizes high-precision accelerometers to measure the heart's motion on the body surface and to non-invasively obtain physiological information of the cardiac function [4]. For sufficient on-site analysis, customized software was developed. The software can be extended by further features in the future. The replay of collected data is planned, as well as the automatic annotation of signal features for easy collection of training data for neural networks.

5. Conclusions

In combination with external sensors, the software was successfully used to obtain BCG measurements for two ESA astronauts.

References

[1] Drobczyk M, Lubken A, Strowik C, Albrecht UV, Rust J, Beringer J, et al. A Wireless Communication Network With a Ballistocardiography Experiment on the ISS: Scenario, Components and Preflight Demonstration. IEEE Journal of Radio Frequency Identification. 2022;6:258-68.

[2] Kulau U, Rust J, Szafranski D, Drobczyk M, Albrecht UV. A Differential BCG Sensor System for Long Term Health Monitoring Experiment on the ISS. In: 2022 18th International Conference on Distributed Computing in Sensor Systems (DCOSS); 2022. p. 85-92.

[3] Kulau U, Rust J, Albrecht UV. Demo: BCG Measurement by differential Sensing in Real-Time. In: 2022 18th International Conference on Distributed Computing in Sensor Systems (DCOSS); 2022. p. 75-8.

[4] Albrecht UV, Drobczyk M, Strowik C, Lubken A, Beringer J, Rust J, et al. Beat to BEAT - non-invasive investigation of cardiac function on the International Space Station. Stud Health Technol Inform. 2022 Jun;295:95-9.