High-resolution synchronous digital Ballistocardiography setup

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Ballisto- and Seismocardiography as an ever-growing diagnostic augmentation to ECG depends on proper synchronous measurement setups. Considering the rapid changes in the market and the increasing quality of digital sensors, a suitable system must be easy and quickly adaptable.

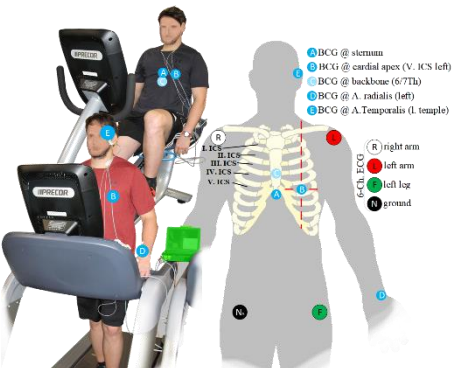

Figure 1: Sensor positions on subjects

We developed a novel HW-SW-setup with a Zedboard as core unit for clock cycle synchronous output on the upper end of the sample frequency. For the feasibility test and construction of a first data collection, three 3D-accelerometers (Kionix KX122-1037), as well as a 6-Ch.-ECG (Olimex-ECG-shield) as reference were used. After an initial assessment including a reference 12-Ch.-ECG (SmartScript BT), four different measurement scenarios were executed. First measurement was performed in a sitting, resting position (3min). The accelerometers were attached to the sternum, cardiac apex, and back (see figure, positions A, B, and C). Immediately afterwards, a measurement under physical stress was performed utilizing an ergometer (2min 40-60W, 1min 70-100W, 30s at ≥110W). The third measurement was conducted in a standing position over a duration (3min). Moreover, two of the accelerometers were repositioned (cardiac apex, temple and wrist, see figure, positions B, D and E). Subsequently, physical resistance was applied using a treadmill (2min 5km/h, 1min 10km/h, 30s 15km/h). Data was gathered from healthy 34 different subjects, including multiple measurement, which results in a total of 72 data sets. The systems data output rate for the accelerometers was 17kHz and for the reference ECG at 12,8kHz. Initial analysis of the data shows promising results in terms of accuracy.

In the near future, the huge amount of BCG data has to be analyzed and shall be accessible to the research community. Furthermore, we want to expand the current database with data sets acquired from subjects with diagnosed heart conditions.