Morphological and Temporal Variations of Seismocardiograms across the Chest: A Guide for Single Channel Sensor Placement

Deboleena Sadhukhan, Christian Dorme, Mathias Fink, Ros Kiri Ing

Institut Langevin, Université de Paris / CNRS UMR 7587 / ESPCI Paris, France

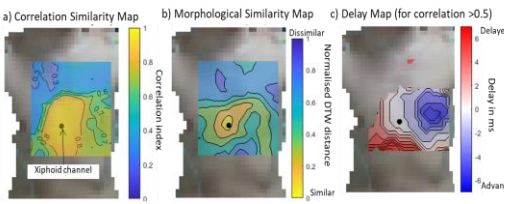
Context: Seismocardiogram (SCG), the non-invasive recording of the cardiac induced chest surface vibrations, has currently emerged as a promising technique for cardiac monitoring and diagnosis. Utility and accuracy of single channel SCG data relies on sensor placement due to change in morphology caused by signal attenuation and time delay introduced by propagation effects on the chest.

Aims: This study comprehensively evaluates the morphological and time delay variation in SCG data across the chest in comparison with the conventionally used xiphoid channel SCG (xSCG).

Methods: Multichannel SCG (mSCG) were recorded with a high-fidelity non-contact air-borne ultrasound based Surface Motion Camera from 15 healthy volunteers at a spatial resolution of 1 cm on the chest surface over the heart, along with synchronous single lead ECG. Cross-correlation analysis were performed between the mSCG and xSCG (separately over systolic and diastolic phases of a cardiac cycle) to quantify the correlation and delay. Discrete Time Warping (DTW) based distance was used to measure the morphological dissimilarity. The delay and similarity metrics were mapped on the chest surface to visualize the spatial variations.

Results: The cross-correlation similarity is preserved (>0.7) over channels localized over the heart around the xiphoid process. However, morphological dissimilarity increases while moving away from the xiphoid with the DTW distance over 50% near the aortic and pulmonary auscultation point. This might be indicative of morphological variations due to location specific events. For all subjects, channels near the apex of the heart were ahead of the xSCG with a time advancement of 8 ± 7 ms, indicating the usability of these channels for accurate time estimation of fiducial events.

Conclusions: These findings will be of significance in guiding the sensor placement problem for SCG based cardiac monitoring applications to allow for better accuracy and robustness.



Correlation, morphological similarity and delay map for a representative subject.