Exploring Seismocardiogram Biometrics with Wavelet Transform

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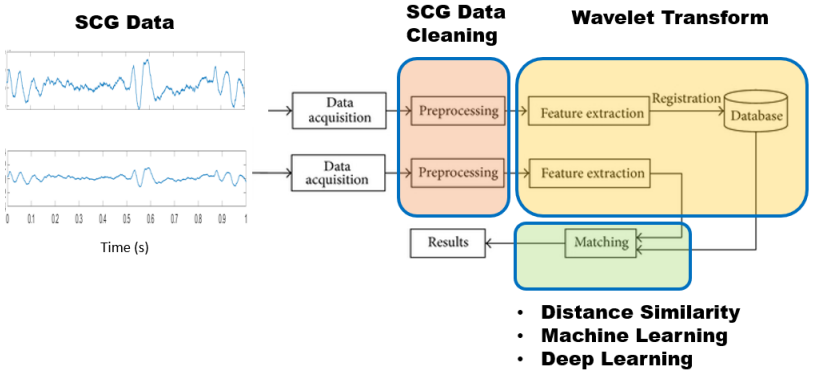

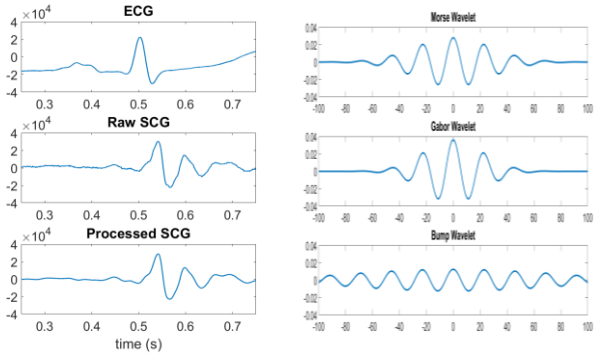

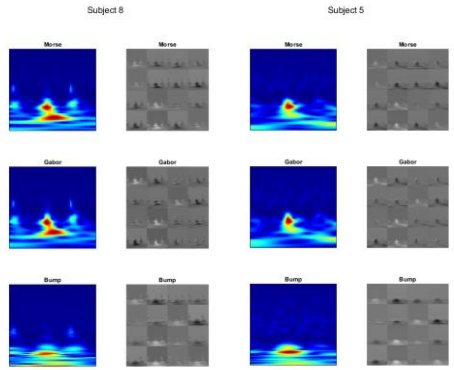

Abstract

Seismocardiogram (SCG) has become easily accessible in the past decade owing to the advance of sensor technology. However, SCG biometric has not been widely explored. In this paper, we propose combining wavelet transform together with deep learning models, machine learning classifiers, or distance metric to perform SCG biometric matching tasks. We validate the proposed methods on the publicly available dataset from PhysioNet database. The dataset contains one hour long electrocardiogram, breathing, and SCG data of 20 subjects. We train the models on the first five minute SCG and conduct identification on the last five minute SCG. We evaluate the identification and authentication performance with recognition rate and equal error rate, respectively. Based on the results, we show that wavelet transformed SCG biometric can achieve state-of-the-art performance when combined with deep learning models, machine learning classifiers, or structural similarity metric.

Methods

Our SCG biometric system is composed of three blocks: **1) SCG Data Cleaning:** We perform signal processing and heartbeat detection in data cleaning process. To remove the artifacts, we filter the raw SCG data with the Savitzky-Golay filter with the order of three. Moreover, we remove the baseline drift through detrending. For heartbeat detection, we run the peak detection algorithm quasi-periodically on SCG data. **2) Wavelet Transform:** We conduct continuous wavelet transform on the processed SCG to generate a 2D SCG feature map. **3) Data Matching:** We run different machine learning algorithms, convolutional neural network models and various distance metrics to perform SCG matching tasks.

Results & Conclusion

We considered continuous wavelet transform along with the ResNet-50 model as the best SCG biometric model. Moreover, machine learning classifiers produce fairly good results with <0.01% EER.

Work	EER (%)
PCA [Bui et al.]	≈1
Ours	**<0.01**

Structural similarity index is a good metric for comparing wavelet transformed SCG. For future work, artifact motion resilient SCG biometric model is highly required for a more generalized SCG biometric system.