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MOTION ROBUST PULSE-SIGNAL DETECTION FROM CAMERA

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VitalSigns Camera

PHILIPS

Abstract

Humans' pulse-signal can be remotely measured by detecting the pulse-induced colour changes on face skin using a regular camera, i.e., remote photoplethysmography (rPPG). Most state-of-the-art rPPG methods are sensitive to subject motions, so we propose a novel framework to improve its motion robustness. The basic idea of our work originates from the observation that a camera can simultaneously sample multiple skin regions in parallel, and each of them can be treated as an independent sensor for pulse measurement. To distinguish the pulse-signal from motion-induced noise, we exploit the spatial-redundancy of the camera to create local pixel-based rPPG sensors and optimize them in the spatio-temporal domain. The performance of our rPPG method is very close to that of the contact-based sensor under realistic situations. Figure 1 shows a snapshot of the real-time demonstration of our method. The green signals are the reference sampled by a contact-based PPG sensor, while the red signals are detected by a camera.

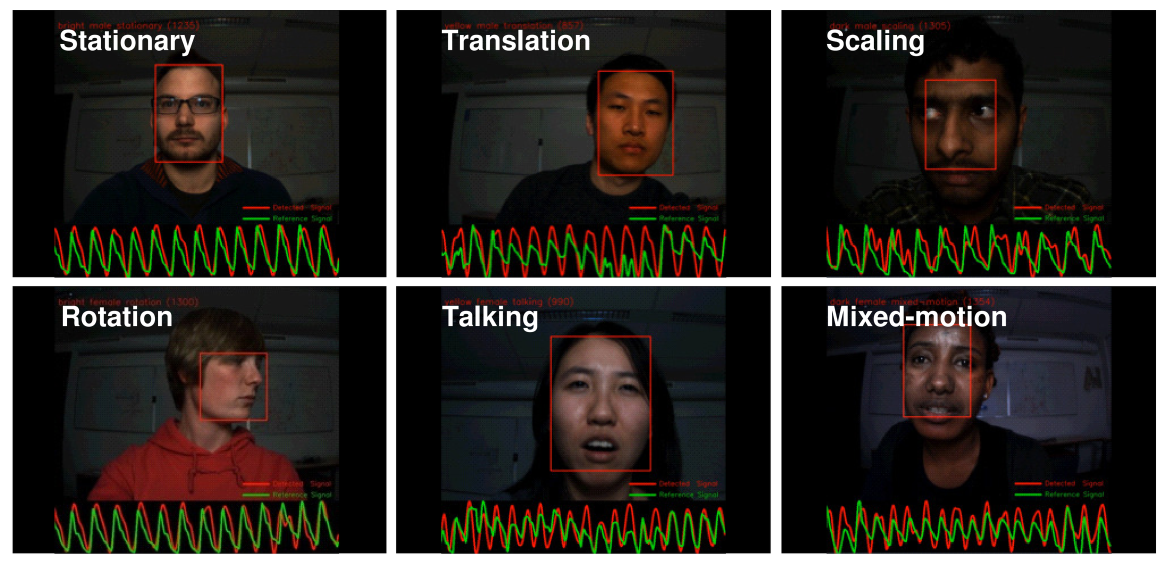


Figure 1: A snapshot of the real-time demonstration of our motion robust rPPG.

Method

The overview of our method is shown in Figure 2, which consists of three steps: (1) it takes a video sequence with a manually initialized face RoI as the input. The global and local (pixel) motions of the RoI are compensated by online object tracking and dense optical flow respectively. Based on the CHROM algorithm [1], the local rPPG sensors are created using the temporally-aligned pixels; (2) the outliers (e.g., non-skin pixels or motion-distorted pixels) among the local sensors are spatially pruned using pulse-induced chromaticity constraints; and (3) the remained local sensors are temporally chained up as long-term sensor traces, which are further filtered and refined to a single robust rPPG-signal by adaptive bandpass filtering and PCA decomposition.

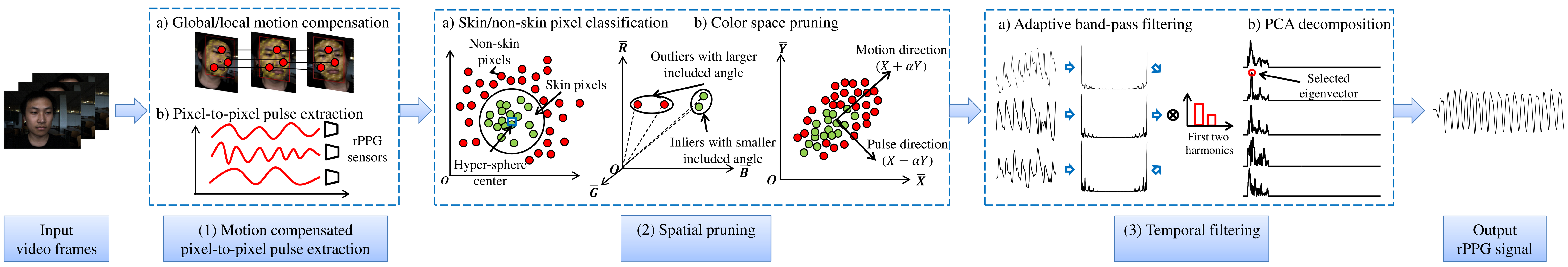
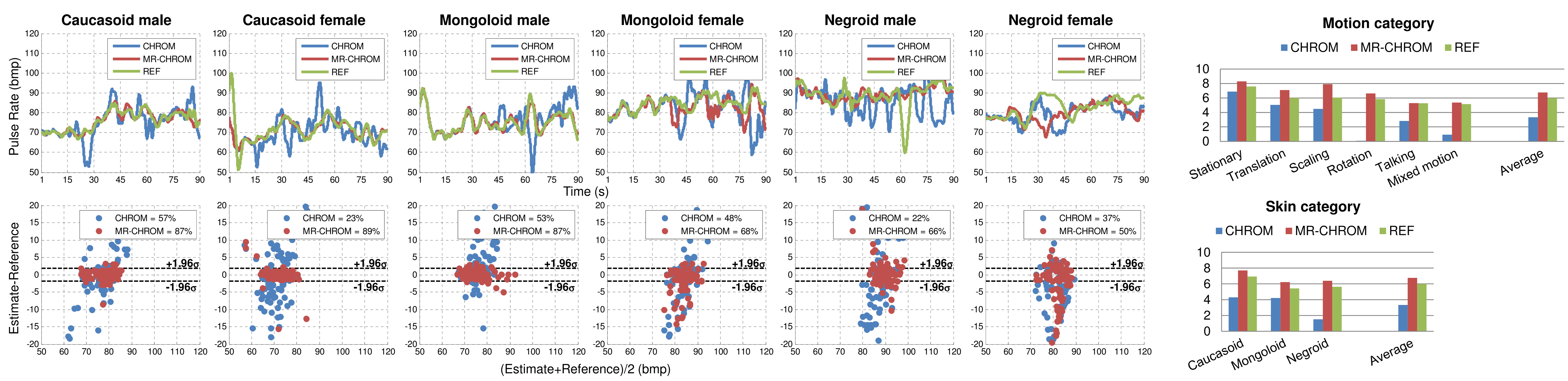


Figure 2: The flowchart of proposed motion robust rPPG method.

Result and Conclusion

The proposed solution is evaluated on 36 challenging videos with male/female subjects that differ in skin-types (caucasoid, mongoloid and negroid) and motion-types (stationary, translation, scaling, rotation, talking and mixed-motion), as an example shown in Figure 1. The quality of the rPPG-signals are measured in terms of averaged Signal-to-Noise-Ratio (SNRa) and Bland-Altman agreement. Compared to the state-of-the-art rPPG method CHROM (2013) [1], experimental results show that our method (MR-CHROM) significantly improves the SNRa of CHROM from 3.34dB to 6.76dB and the agreement ($\pm 1.96\sigma$) with instantaneous reference pulse-rate from 55% to 80% correct. Figure 3(1) shows an example of instantaneous pulse-rate and Bland-Altman plots of mixed-motion videos (most challenging motion) of six subjects in Figure 1, while Figure 3(2) compares the overall performance between our method and CHROM, contact-based sensor (REF).



(1) Instantaneous pulse-rate & Bland-Altman plots

(2) Overall SNRa comparison

Figure 3: Performance comparison of the benchmarked (r)PPG methods, which demonstrates the effectiveness of our motion robust strategy.

References

[1] G. de Haan and V. Jeanne. Robust pulse rate from chrominance-based rppg. *Biomedical Engineering, IEEE Transactions on*, 60(10):2878–2886, 2013.