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Advancing the remote Photoplethysmography Signal Extraction Using Hybrid ConvLSTM Autoencoder and Signal Fusion.

Information

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(1) remote photoplethysmography
(2) ConvLSTM
(3) Autoencoder
(4) Health monitoring

Résumé (Abstract)

Remote photoplethysmography (rPPG) facilitates the non-invasive measurement of vital signs like heart rate and respiratory rate through facial video analysis, presenting a promising avenue for discreet health monitoring. Current rPPG techniques either depend on manually crafted signal processing methods, which are prone to issues with motion and lighting changes, or on deep learning models that often overlook physiological principles and struggle with generalization. To overcome these limitations, this paper introduces a hybrid ConvLSTM autoencoder framework designed to effectively merge raw RGB facial sequences with Plane-Orthogonal-to-Skin (POS) signals. This model leverages spatial-temporal representations derived from RGB data alongside physiologically informed POS signals within a cohesive reconstruction-based learning framework. The ConvLSTM encoder identifies dynamic spatiotemporal patterns linked to blood volume pulse fluctuations, while the autoencoder structure facilitates implicit noise reduction and maintains temporal consistency in the reconstructed rPPG waveform under challenging conditions. The proposed method's effectiveness is assessed based on rPPG signal quality, utilizing time-domain and frequency-domain metrics, such as correlation with reference photoplethysmography, reconstruction error, and signal-to-noise ratio. Comprehensive experiments on three public datasets, PURE, UBFC, and COHFACE, reveal that the proposed fusion strategy consistently surpasses traditional POS-based methods and RGB-only in terms of accuracy and robustness.