TECHNISCHE UNIVERSITÄT
ILMENAU

Fakultät für Maschinenbau

Fachgebiet Qualitätssicherung und Industrielle Bildverarbeitung

Thesis-Nr.: 279

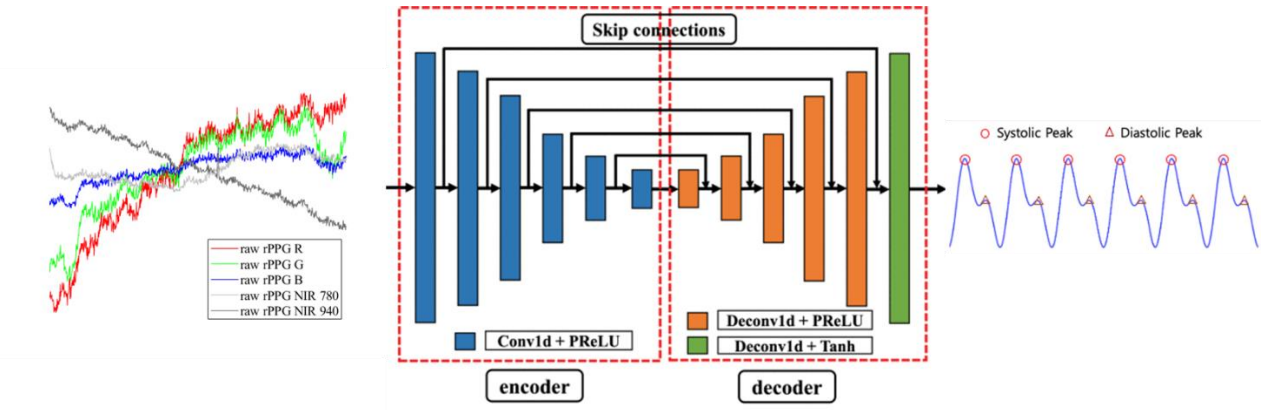
Task Description for the Master Thesis

of N. N. and N. N.

Investigation on Deep Learning based rPPG Waveform Restoration from 3D VIS-NIR Facial Video Data

General Description:

Optical methods for acquiring Photoplethysmography (PPG) signals involve continuous skin reflectance measurement across various wavelengths, particularly in the visible [1] and NIR spectral ranges [2]. Previous work at TU Ilmenau QBV has enabled rPPG reconstruction based on both visible and infrared light [3]. However, current filtering techniques (e.g. analytical digital filters) based skin reflectance signals processing for rPPG reconstruction, meets challenges like lower camera sampling rates, signal-to-noise ratio (SNR) issues, and motion artifacts. To address the challenges concerning camera sampling rate and SNR, researchers propose correlating camera data with contact-based PPG sensors using machine and deep learning [4]. Besides, motion artifacts, causing illumination changes and signal distortions, are expected to be mitigated through advanced techniques such as 3D face tracking and neural network-based motion cancellation of rPPG signals.



Task:

To improve the waveform of captured rPPG signals, this work will explore various machine learning approaches, particularly deep learning methods, along with different training strategies to achieve super-resolution reconstruction of rPPG signals based on 3D VIS-NIR multimodal videos. A multispectral contact PPG sensor will be constructed to capture the ground truth waveform, providing labels for supervised learning. Furthermore, an approach for the elimination of rPPG signal distortions caused by motion-induced local illumination changes in skin measurement area will be developed. The developed super-resolution and motion cancellation approaches will be validated regarding measurement of HR and SpO2.

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In the context of this work, the following tasks arise in particular:

- Literature research on camera-based rPPG restoration and rPPG based vital signs estimation
- Building a multispectral contact PPG sensor system for camera-based rPPG restoration waveform ground truth acquisition
- Implementation and selection of supervised deep learning methods for rPPG waveform super-resolution restoration
- Evaluation of the rPPG restoration with appropriate metrics e.g. cosine similarity, concordance correlation coefficient, signal-to-noise ratio, and dynamic time warping
- Documentation and presentation

1. Verkruysse W; Svaasand LO; Nelson JS. Remote plethysmographic imaging using ambient light. Optics Express 2008, 26:21434-21445.
2. Rapczynski M; Zhang C; Al-Hamadi A; Notni G. A Multi-Spectral Database for NIR Heart Rate Estimation, in Proc. of 25th IEEE International Conference on Image Processing (ICIP), 2018; 2022-2026.
3. Zhang, Chen, et al. "Real-time multimodal 3D imaging system for remote estimation of vital signs." Multimodal Sensing and Artificial Intelligence: Technologies and Applications II. Vol. 11785. SPIE, 2021.
4. Kim, So-Eui, et al. "Restoration of remote PPG signal through correspondence with contact sensor signal." Sensors 21.17 (2021): 5910.

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