Biological Background

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Backgrond

The cardio-vascular pulse wave travelling through the body periodically causes the vessel walls to stretch. The volumetric changes that are a result of fluctuations in the amount of blood or contained air within the human body can be measured by means of a PPG.
These fluctuations modulate the absorbance of light passing through a given tissue volume, which is detected by the mentioned measuring method.
PPG is performed with a dedicated light source and considers the ambient light as the source of noise. Recent studies have shown that some cardiovascular signals (e.g. HR, IBI) can be acquired remotely from a distance of several metres by processing a video file of a human face obtained with standard cameras with ambient light as the illumination source.

Furthermore, the studies show that the method can be extended for simultaneous HR measurements of multiple persons [39,40]. The RGB sensor of the used camera is able to pick up a mixture of the reflected plethysmographic signal with fluctuations in the amount
of reflected ambient light. This phenomenon is again caused by vol- umetric changes in the facial blood vessels during the cardiac cycle and thus indicates the timing of cardiovascular events [39,40].
The novel approach is based on automatic face tracking and localisation of measurement ROI on the one hand and recovery of underlying source signal of interest on the other. In this case, the signal in question is the cardiovascular pulse wave that spreads throughout the body. Its recovery is achieved with Blind Source Separation (BSS) by Independent Component Analysis (ICA).
The idea for distant measurement of PPG parameters was pre- sented in several papers [41–43]. However, the efforts lacked rigorous physiological and mathematical models for computation. Furthermore, motion artefact presented noise within the same fre- quency band as the signal of interest, thus rendering linear filtering Ineffective.

factors influencing the accuracy of rPPG-based HR measurement:
skin tone,
head movement,
rapid changes during recovery from exercise,
variation in ambient illumination,
facial expression changes associated with talking.

Study for combining joint blind source separation (JBSS) and a projection process based on a skin reflection model:

The results from the data obtained in our earlier study [21] show that, with sufficient illumination, POS, Project_ICA, and the proposed method, all of which are based on the skin reflection model, have better outcomes than the JBSS_EEMDapproach. This implies that the skin reflection model, which relies on the projection process to weaken the contribution ofthe specular component of the light reflected from the skin,and thus the processed signal, can better retain the pulse rate information [19, 21]

From the results on the three datasets, it is clear that the dark-skinned subjects yield less accurate HR values thanthose with lighter skins. The reason is that the absorption spectrum of melanin and that of hemoglobin coincide to some extent, so the components of the light reflected fromthe skin which has interacted with the hemoglobin will beaffected by the melanin in the skin [35]. The more melanin, the more significant the impact it has on the HR signal