CARDIORPPG: CARDIOVASCULAR RISK ASSESSMENT USING REMOTE PHOTOPLETHYSMOGRAPHY SIGNAL

Ranepurage Dilanka Yasith Pemarathne

A dissertation submitted in partial fulfilment of the requirement for Bachelor of Science (Honours) degree in Software Engineering

School of Computing

Informatics Institute of Technology, Sri Lanka in collaboration with University of Westminster, UK

2025

ABSTRACT

Cardiovascular diseases (CVDs) are a leading health risk in the world, and accurate and convenient monitoring of cardiovascular parameters such as heart rate (HR) and oxygen saturation (SpO_2) is required. Contact-based methods such as pulse oximeters, however, are not feasible in patients with burns, cognitive impairments, or in pandemics such as COVID-19. Due to these limitations, there is a need for non-invasive contactless alternatives like remote photoplethysmography (rPPG) that estimate vital signs through light variation analysis from facial video.

This study proposes a contact-free method for monitoring heart rate (HR) and blood oxygen saturation (SpO_2) using a standard ambient light camera. The author utilized the Plane-Orthogonal-to-Skin (POS) algorithm to extract rPPG signals from facial videos. Both frequency domain (via Fast Fourier Transform) and time domain analyses were applied to estimate HR, while SpO_2 was derived using red and blue channel BVP signal ratios. Signal preprocessing, including normalization and bandpass filtering, was employed to improve signal quality and reduce noise.

An experimental evaluation on a dataset of 20 participants aged 20 to 50 years showed that the proposed system achieved a mean absolute error (MAE) of 3.66 beats per minute (BPM) and a root mean square error (RMSE) of 5.11 BPM in heart rate (HR) estimation. Bland-Altman analysis was employed to assess the algorithm's performance. The mean difference between the predicted HR, SpO_2, and the actual values is -2.16BPM and -5.98%, respectively. Bland-Altman analysis showed minimal bias, confirming the system's reliability in non-contact cardiovascular monitoring.

Keywords: Remote photoplethysmography, Heart rate estimation, Signal processing, Computer Vision, Facial video analysis, ROI detection, OpenCV, MediaPipe, Non-contact monitoring, Biomedical signal analysis

Subject Descriptors:

Computing methodologies -> Signal processing -> Physiological signal processing

Applied computing -> Life and medical sciences -> Health informatics -> Remote monitoring

Computing methodologies → Image processing and computer vision → Motion tracking and face analysis