Heart Rate and Respiratory Rate Derived from Video

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Introduction: Non-contact patient monitoring (NCM) is a rapidly growing area driven by the potential to reduce cost, reduce cabling, improve work flow, and free up the patient. We report here on technical work to extract a full range of pulse oximeter parameters from a standard camera set up, thus enabling real time contactless monitoring.

Method: Facial recognition software is used to localize regions on the body for use in extracting the parameters of interest. Figure 1 contains a screen shot of the acquisition panels. The video segmentation grid and face tracking region (pink box) are evident in the video image. The face box is used to acquire cardiac pulsatile signals from a localized forehead region. A chest box is located relative to the face box and used to collect respiratory modulation signals.

Results:
A screen shot of a Nellcor Pulse Oximeter device running concurrently with the video acquisition is shown below the video image in the lower right panel of figure 1. The left vertical panel shows both the acquisition controls at the top and the acquired signals below. A clear respiratory modulation is evident in the chest region signal and distinct cardiac pulses may be observed in the forehead region signals: these are summed to provide a single pulsatile signal shown just below the respiratory signal. The pulse and respiratory rates determined from a FFT (Fast Fourier transform) of the video acquired signals coincide with those displayed on the oximeter.

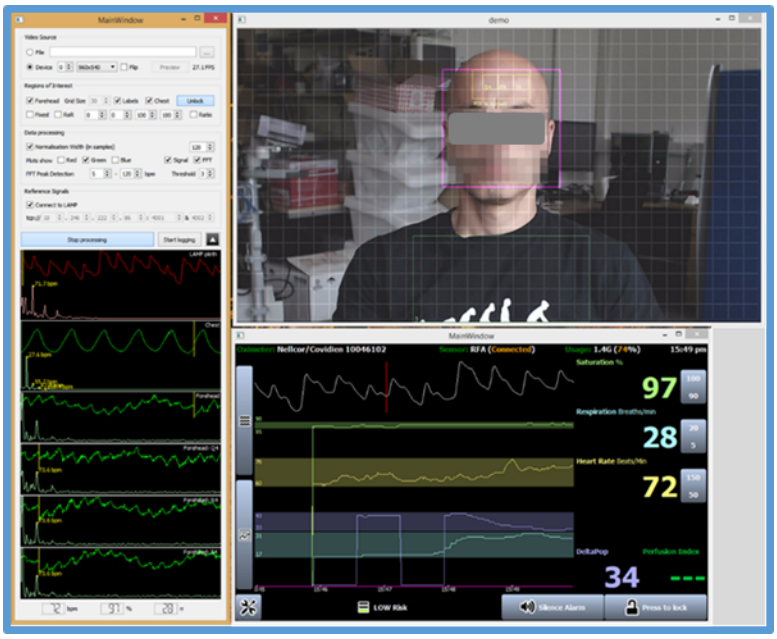

Figure 1: Screen Montage. Top: Camera Image. Bottom: Pulse Oximeter screen showing signal and SpO2, RR and HR. Vertical Panel: Control buttons at top. Signals from top to bottom: captured oximeter signal (red), video respiratory modulation (top green signal) combined forehead signal and three component forehead signals. The associated FFT spectra are plotted at the bottom left of each signal panel. Note that the spectral peak frequencies are in agreement with the pulse oximeter device RR and HR.

Conclusions: Respiratory rate (RR) and heart rate (HR) may be easily extracted from standard video signals during non-challenging conditions using relatively simple signal extraction and processing algorithms. This confirms the findings of others in this regard [1-6]. Current work focuses on simultaneously determining RR from the chest signal and HR from the forehead region signals in more challenging conditions. This will be followed by work to determine the feasibility of calculating SpO_2 [7]. A number of sophisticated signal analysis methods will be assessed for these tasks (e.g. continuous wavelet transforms, independent component analysis etc.) in order to enhance the extraction of subtle physiological information from these relatively noisy signals. Future work will involve animal models and human breathe-down studies, utilizing enhanced hardware (including scientific cameras) and automated calibration methods for color, greyscale, orientation, etc.

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