

Title: Contact-Free Measurement of Cardiac Pulse Based on the Analysis of Thermal Imagery

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Abstract: We have developed a novel method to measure human cardiac pulse at a distance. It is based on the information contained in the thermal signal emitted from major superficial vessels. This signal is acquired through a highly sensitive thermal imaging system. Temperature on the vessel is modulated by pulsative blood flow. To compute the frequency of modulation (pulse), we extract a line-based region along the vessel. Then, we apply Fast Fourier Transform (FFT) to individual points along this line of interest to capitalize on the pulse propagation effect. Finally, we use an adaptive estimation function on the average FFT outcome to quantify the pulse. We have carried out experiments on 5 subjects and compared the pulse computed from our thermal signal analysis method to concomitant ground-truth measurements obtained through a standard contact instrument (PowerLab/4SP from AD Instruments). Statistical analysis reveals that the results from the two modalities are highly correlated, (high Pearson product moment correlation measure $\rho_c = 0.994$). To the best of our knowledge, it is the first time that cardiac pulse has been measured accurately several feet away from a subject with passive means. The technology is expected to find applications among others in sustained physiological monitoring of cardiopulmonary diseases, sport training, sleep studies, and psychophysiology (polygraph).