Cardiopulmonary signal processing of users of wheelchairs with embedded sensors

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Abstract:
Biomedical signals are difficult to detach from noise during daily activities. Classical linear techniques attenuate noise, but frequently are based on strict assumptions. Impedance plethysmogram (IPG) and dual-wavelength reflection photoplethysmogram (PPG) sensing units were developed and inconspicuously embedded in a wheelchair to avoid further diminution of the subject's autonomy and mobility. It is of interest to gather these signals, since often wheelchair users need permanent monitoring of their cardiopulmonary system. However, IPG and PPG are sensitive to the wheelchair user's movements, which produce significant baseline fluctuations. To lessen such problems, real-time signal processing techniques have to be hastily applied before any cardiovascular evaluation to ensure its accuracy. This paper presents a study on the combination of several procedures (PCA, SWT, and EMD) to enable adaptive selection of signal-related components, for a described hardware implementation on a manually powered wheelchair.

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Contents

Preserving a wheelchair user's autonomy and mobility is of his supreme interest. However, it was reported that the first cause of wheelchair or scooter usage, in 2000 in the US, was cerebrovascular disease [1]. So, given the generalized increase in its occurrence [2], it is also very important to continuously monitor the cardiovascular condition of wheelchair users. The preference of the subjects, and of the medical staff, will always be unobtrusive signals [3], [4]. Inconspicuously and wearable monitoring solutions are viewed with growing interest, e.g. those based on ballistocardiography, electrocardiography, photo and impedance plethysmography [4]–[8]. These signals may be acquired by unremarkably embedding the sensing devices in daily used objects such as wheelchairs.