New Photoplethysmographic Signal Analysis Algorithm for Arterial Stiffness Estimation

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OBJECTIVE OF THE THESIS : new SDPPG analysis algorithm is proposed with optimal filtering and signal normalization in time.

Objective : prevention of cardiovascular diseases

- "ageing index" (AGI), which is calculated from the second derivative photoplethysmographic (SDPPG) waveform, has been used as one method for
    - arterial stiffness estimation and
    - the evaluation of cardiovascular ageing.

PPG finger sensor :

- noninvasive optical technique for measuring changes in blood circulation
- mainly used for monitoring blood perfusion in the skin.
- consists of
    - a light emitting diode (LED), which is often red or infrared
    - a photodetector (PD)
- The PPG signal consists of different components: DC and AC components and noise, which can be caused by the poor perfusion state and motion artifacts
    - AC component is synchronous with the heart rate and depends on changes in the pulsatile pressure and pulsatile blood volume.
    - AC changes with age and the waveform transforms from a wavy into a triangular-shaped signal
- Noise can be eliminated by filtering

How to obtain the AGI :
The AGI has to be calculated with low standard deviation in order to differentiate the subjects with increased stiffness from the healthy subjects.
AGI values with minimal standard deviation and to detect the waves at the same locations within one period of the PPG signal. T

Methods

- PPG signal is filtered with low- and high-pass FIR filters in order to separate DC components and high frequency noise
- the unwanted noise is located at higher frequencies for the PPG signal. Due to the reason outlined previously, the Smooth Noise Robust Differentiator (SNRD) is used

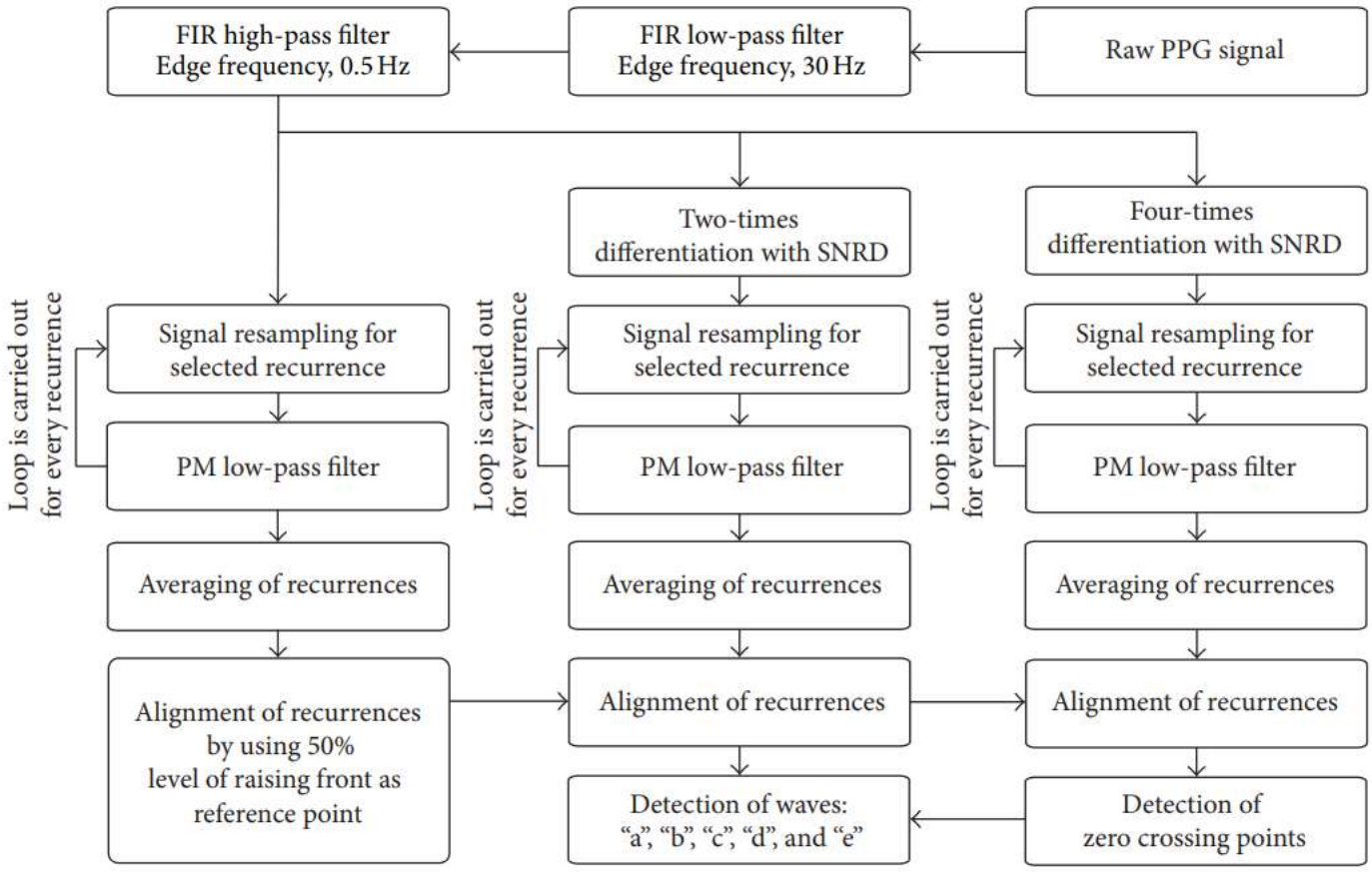

FIGURE 3: Block diagram of the signal processing for the second derivative analysis.

Results

- correlation between AGI and age among healthy subjects was shown
- Nevertheless, some of the dia betes patients have similar AGI values compared to healthy subjects. It can be caused by the early diagnosis of diabetes mellitus, which is followed with efficient therapy, and as a result premature stiffening of the arteries has been stopped.