Utilizing Speckleplethysmographic (SPG) Waveforms To Determine Brain Activation-Induced Blood Flow

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Speckle plethysmography (SPG) is a non-invasive optical imaging method that utilizes laser speckle contrast imaging (LSCI) to analyze blood flow rate changes generated during cardiac systole and vasodilation or constriction. SPG provides similar results as the widely used photoplethysmography (PPG) with the potential to achieve a higher signal to noise ratio (SNR). Measurements of cerebral hemodynamics taken with SPG show waveforms that indicate blood flow in the brain. They are comprised of two components: blood flow generated from cardiac contraction as well as brain activation, also known as hemodynamic response function (HRF). Here we propose a filtering and estimation model to calculate blood flow generated from cardiac contraction alone. A signal filtering model was developed to remove noises as a result of powerline interference, motion artifacts, and low amplitude signals. We determined the best parameter for estimating cardiac pulse onset timing, then scaled the amplitudes in accordance with the original signal. In addition, singular value decomposition (SVD) was employed to select for components that best accounts for pulse shape variability. The described model allows for an accurate estimation of blood flow contributed by heartbeats. After subtracting the cardiac signal, the leftover is indicative of brain activation induced blood flow. The processed SPG signal can be studied under different physical or cognitive tasks to increase our understanding of the cortical functions. Furthermore, it also has clinical implications in the detection and assessment of neurodegenerative diseases such as mild cognitive impairment (MCI) or cortical spreading depolarizations (SD).