

MEASUREMENTS OF HUMAN CEREBRAL BLOOD FLOW CHANGES WITH SPECKLE CONTRAST OPTICAL SPECTROSCOPY

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We have developed a fiber-based speckle contrast optical spectroscopy (SCOS) system to measure cerebral blood flow (CBF) changes due to brain activation in humans. SCOS uses relatively low-cost complementary metal–oxide–semiconductor (CMOS) cameras as detectors as compared to diffuse correlation spectroscopy (DCS). A pulsing strategy for the input laser light source has been implemented to improve the photon flux within a measurement window while keeping the average incident light power to still be within the maximum exposure power. The data analysis pipeline is established to correct for the bias in the measured contrast induced by noise sources such as shot noise and read noise to obtain a blood flow index (BFi). We have validated our data analysis pipeline with SCOS measurements using incoherent LED light as input light source to show that the residue contrast is negligible after correction for the bias. We have then demonstrated measurements of human brain BFi using our newly developed SCOS system and compared with our existing single-channel and multi-channel DCS systems. We found that SCOS outperforms DCS in terms of contrast to noise ratio (CNR) both numerically using our newly developed noise model, and experimentally with phantom and human forehead measurements. We have also shown human brain function measurements at a source-detector separation of 30 mm during the cognitive task of mental subtraction using SCOS.

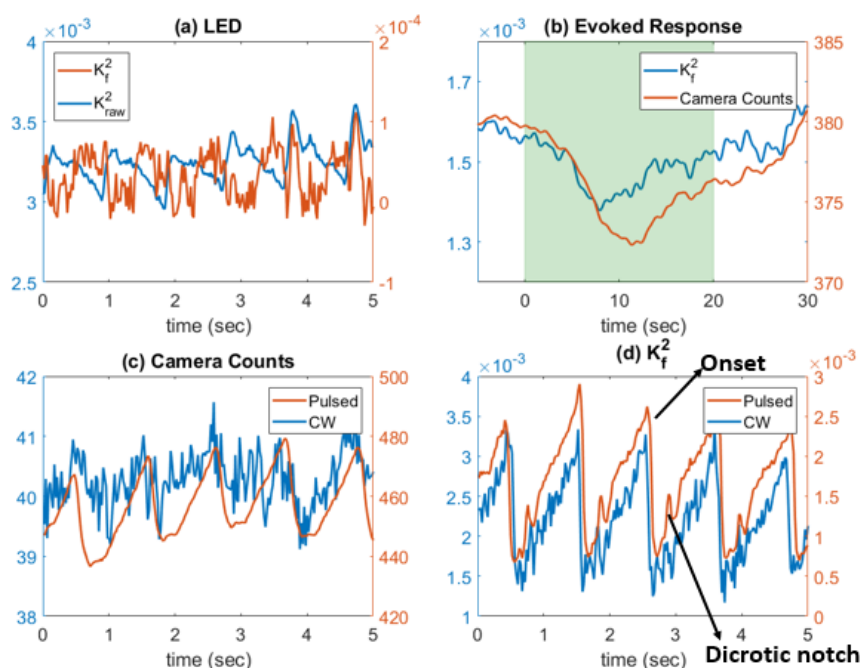


Figure 1. (a) Human forehead measurement using incoherent LED light source. The residue K_f^2 after noise correction is negligible ($K_{res}^2 \sim 10^{-5} - 10^{-4}$) as expected. (b) Preliminary human brain function measurement during mental subtraction of one subject using our prototype SCOS system, trial averaged (5 trials, 1 subject) contrast squared. Green shade indicates time when mental subtraction task is given. (c)-(d) The example measurements of light intensity and K_f^2 of using (c) CW and (d) pulsed (10% duty cycle) laser light sources, $T_{exp} = 2.1$ ms, SDS of 30 mm.