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Poster Session, Level 2 Foyer, September 4, 2025, 12:00 - 13:00

Deep Learning Interpretation of Single-Photon Sensor Array Cerebral Blood Flow Measurements

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Diffuse correlation spectroscopy (DCS) is an optical measurement modality for non-invasive monitoring of cerebral microvascular haemodynamics [1]. Researchers from Edinburgh University developed ATLAS, a novel integrated single-photon avalanche diode array for real-time, high-SNR DCS measurements [2]. However, clinical application of ATLAS is hampered by the computationally slow traditional curve fitting used to extract the cerebral blood flow index (cBFI) from the sensor output autocorrelation function (ACF). DL models have been trained to extract cBFI from DCS measurements using labelled ACFs generated from analytical models used in traditional curve fitting [3]. However, the use of Monte-Carlo (MC) simulations to generate labelled datasets for model training, and the application of DL for processing ATLAS data have not been explored. Multilayer MC simulations were performed to produce large, varied, labelled datasets of ATLAS-like DCS ACFs. Long Short-Term Memory DL models were implemented and trained on these datasets using PyTorch. DL model cBFI outputs were evaluated using test ACFs from MC simulations, with the best model then tested on ACFs from experimental ATLAS measurements on an adult male head. The DL model showed significant improvements in cerebral blood flow sensitivity vs traditional fitting on the MC simulated ACFs (93% vs 69%). It had a strong linear correlation (r = 0.984) and a 280-fold decrease in time-to-result compared with traditional fitting when processing the experimental ATLAS ACFs. These results showed that DL models trained on data from MC simulations are a viable method of rapidly extracting cBFI, unlocking ATLAS's clinical potential for real time monitoring.

[1] Wang et al, 2024, Neuroimage, 298, 120793
[2] Gorman et al, 2024, Biomed. Opt. Exp, 15, 6499-6515
[3] Wang et al, 2024, J Biomed. Opt, 29, 015004