Extrapolation Methods for Improving MR Perfusion Measurements

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Stroke is a prevalent vascular disease that occurs when an artery becomes blocked, reducing blood flow to the brain tissue. Magnetic resonance (MR) perfusion imaging, by examining the dynamic signal change occurring as a gadolinium-based tracer passes through the cerebrovascular system, has been shown to provide estimates of cerebral blood flow (CBF) and mean transit time (MTT). De-convolution of the MR-measured signals can produce estimates of MTT and CBF; in practice with the introduction of noise onto signals it becomes unstable and requires additional processing, most commonly low-pass filtering. Filtering alters the frequency components of the signals and has been shown to result in flow estimate errors, principally, due to the removal of high-frequency signal components. In order to improve CBF accuracy, frequency-domain extrapolation was explored as a method for recovering the altered high-frequency signal components. Techniques such as ARMA are difficult due to the few number of data points so linear extrapolation is used. Monte Carlo simulations were undertaken to assess the performance of linear extrapolation with Gaussian noise was added to MR signal intensities to assess the stability of the extrapolation. Simulations showed that simple linear extrapolation decreased errors to <10% compared to low-pass filtered approaches which had errors >10%. The variance of extrapolated measures was also observed to increase. Patient data was processed in order to compare conventional filtering with the proposed linear extrapolation technique. Results corresponded to the simulation findings and suggested that more physiologically realistic CBF estimates could be obtained with extrapolation.