Estimating spatial and temporal factors in optical diffusion tomography

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We apply state space estimation techniques to the time-varying reconstruction problem in optical tomography. We develop a stochastic model for describing the evolution of quasi-sinusoidal medical signals such as the heartbeat, assuming these are represented as a known frequency with randomly varying amplitude and phase. We use the extended Kalman filter in combination with spatial regularization techniques to reconstruct images from highly underdetermined time-series data. We also investigate unsupervised learning of spatial correlations using a modified factor analysis model. We present reconstructions of simulated data and of real data recorded from the human motor cortex. It is argued that the application of these spatial and temporal techniques improves the fidelity of reconstruction in optical tomography.