Statistical approach to electrical impedance process tomography

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We consider the process tomography problem of the following kind: based on electromagnetic measurements on the surface of a pipe, describe the concentration distribution of a given substance in a fluid moving in the pipeline. We view the problem as a state estimation problem. The concentration distribution is treated as a stochastic process satisfying a stochastic differential equation referred to as the state evolution equation. The measurements are described in terms of an observation equation containing the measurement noise. The time evolution is modelled by a stochastic convection-diffusion equation. The measurement situation is represented by the most realistic model for electrical impedance tomography, the complete electrode model. We give the mathematical formulation of the state evolution and observation equations and then we derive the discrete infinite dimensional state estimation system. Since our motive is to monitor the flow in the pipeline in real time, we are dealing with a filtering problem in which the estimator is based on the current history of the measurement process. For computational reasons we present a discretized state estimation system where the discretization error is taken into account. The discretized filtering problem is solved by the Bayesian filtering method.