Bayesian Particle Filters Applied to Heat Transfer and Biomedical Problems

M. J. Colaço

Federal University of Rio de Janeiro – UFRJ, Department of Mechanical Engineering – PEM/COPPE
Biofuels and Energy Efficiency Program, Brazilian National Agency of Oil, Gas and Biofuels, Brazil

colaco@ufrj.br

Sequential Monte Carlo (SMC) or Particle Filter Methods, which have been originally introduced in the beginning of the 50's, became very popular in the last few years in the statistical and engineering communities. Such methods have been widely used to deal with sequential Bayesian inference problems in fields like economics, signal processing, and robotics, among others. SMC methods are an approximation of sequences of probability distributions of interest, using a large set of random samples, named particles. These particles are propagated along time with a simple Sampling Importance distribution. Two advantages of this method are: they do not require the restrictive hypotheses of the Kalman filter, and they can be applied to nonlinear models with non-Gaussian errors. This presentation shows some applications of SMC Particle Filters in heat transfer and biomedical problems, which include: (i) heat flux estimation on the walls of a cavity undergoing natural convection [1]; (ii) heat transfer coefficient estimation on the combustion chamber walls of a spark-ignition internal combustion engine [2]; (iii) wildfire propagation [3]; (iv) solidification front in phase change problems [4]; and (v) action potential in Purkinje fibers, which are related to identification of some heart anomalies [5]. In the problems presented, simulated or real measurements were used, where the influence of experimental errors was examined. Results show that Particle Filters can be a reliable tool to the state estimation of complex problems, even in the presence of uncertainties.

Keywords: Inverse Problems, Particle Filters, Bayesian Estimate.

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