Particle Filtering on Riemannian Manifolds

Hichem Snoussi and Ali Mohammad-Djafari

Particle filtering is an approximate Monte Carlo method implementing the Bayesian Sequential Estimation. It consists in online estimating the a posteriori distribution of the system state given a flow of observed data. The popularity of the particle filter method stems from its simplicity and flexibility to deal with non linear/non Gaussian dynamical models. However, this method suffers from the curse of dimensionality. In general, the system state lies in a constrained subspace which dimension is much lower than the whole space dimension. In this contribution, we propose an implementation of the particle filter with the constraint that the system state lies in a low dimensional Riemannian manifold. The sequential Bayesian updating consists in drawing state samples while moving on the manifold geodesics. We illustrate the effectiveness of the proposed solution on synthetic examples and we show that it compares favorably with classical unconstrained particle filter.