Ensemble Kalman Filter adapted to particle simulations

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ABSTRACT

Data assimilation methods, and more specifically filtering, refers to a sequential estimation of the state of a system based on the incorporation of the online observations. The most complete way is given by determined the state’s posterior distribution given the observations until now.

In the case of linear Gaussian problems, one can obtain the update formula analytically by modifying the mean and covariance of the state using the Kalman Filter [1].

However, in the general case, one must approximate the distribution. A popular filter is the Ensemble Kalman Filter (EnKF) which is a Monte-Carlo version of the Kalman Filter, having the advantage of being suitable for non-linear problems and high-dimensional states [2]. This latter method uses a set of realizations (in our case, from simulation) to construct an empirical distribution of the system state. Then, the update formula is based on an approximation of the Kalman Filter to update each member state.

If this method has been extensively applied to problem based on regular Eulerian discretization (for instance in Geociences [3]), the classical filter requires adaptation in the case of more specific discretizations.

If this filter has already been adapted to problems using members with different meshes’ resolutions [4] or moving meshes simulations [5], in this work, we propose to adapt it to the case of particle-based simulations. More specifically, we need to deal with different supports of solutions and different dimension of variable vectors for each members.

We will present deferent methods that either would be based on grid transfers or be purely Lagrangian and construct criterion to adapt the new particle discretization.

We will present our developments on 2D vortex method simulations. These adaptations can then be applied to other types of problems discretizing continuous fields such as the SPH, or MPM methods.

**REFERENCES**

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