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Parallel Ensemble-based Approach for the Computation of Conditional Nonlinear Optimal Perturbation

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Conditional nonlinear optimal perturbation is a kind of initial perturbations with given constraint conditions at initial time and maximum nonlinear evolution at prediction time, which is an extension of the linear singular vector (LSV) to nonlinear regimes. It has become a powerful tool to study some issues of nonlinear systems like predictability, sensitivity and so on. However, the wide application of this method has been limited to its large computational cost caused by the use of adjoint technique in its solution. To avoid the use of the adjoint technique during maximization, an assemble-based approach was proposed by Bin Wang and Xiaowei Tan to obtain conditional nonlinear optimal perturbation (CNOP), which has been published. We will apply a parallel algorithm to the assemble-based approach. A thorough analysis of the task scheduling of the parallel algorithm has been made, which shows that significantly better efficiency. This efficiency is accomplished by overlapping computation of the sequential and parallel phases of the algorithm. An attractive feature of our parallel algorithm is that it requires minor modification of the sequential algorithm.