A DUAL PARTICLE COMPUTATIONAL METHOD FOR CONTINUA

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Summary A brief history of particle methods will be presented towards assessing the promise offered by these techniques for computational continuum dynamics. We will then discuss recent progress in Dual Particle Dynamics (DPD), a spatially staggered particle discretization of the strong form. Particular attention will be given to stability, boundary conditions, and neighbor searching. We demonstrate stability for Eulerian kernels resulting from the coupling of linear completeness in spatial derivative estimates and two-step Predictor-Corrector time derivative approximations. Boundary conditions are formulated in a unified and consistent way using constrained MLS fits. Several test problems are shown and conclusions drawn.

Stability of Lagrangian numerical methods is a critical and unresolved issue. Important recent contributions have come from [1,2,3] after the original identification of the SPH tensile instability [4]. The tremendous appeal of particle methods is the hope of treating large deformations in a Lagrangian framework. However, if Eulerian kernels which allow for change of connectivity (acquiring new neighbors) cannot be made stable, much of the appeal is lost. It appears that stability can be maintained for Eulerian kernels if certain rules are followed [3]. Fig. 1 results from a stability analysis of DPD and shows a basin of stability in complex eigenvalue space for a Predictor-Corrector time update scheme. The boundary of the basin defines a curve on which the growth rate of the instability is unity. Neighborhoods can be found that allow for a particle time step to satisfy this condition.

Boundary conditions are implemented with constrained moving least squares approximations for derivatives on boundary particles. This can be done quite generally within the context of the particle method used for interior derivatives. Both boundary conditions and neighborhood configurations couple closely with the stability and general accuracy requirements. Complex dynamical interactions occur that are peculiar to the discrete numerical approximations. These issues are addressed to the extent that they are now understood.

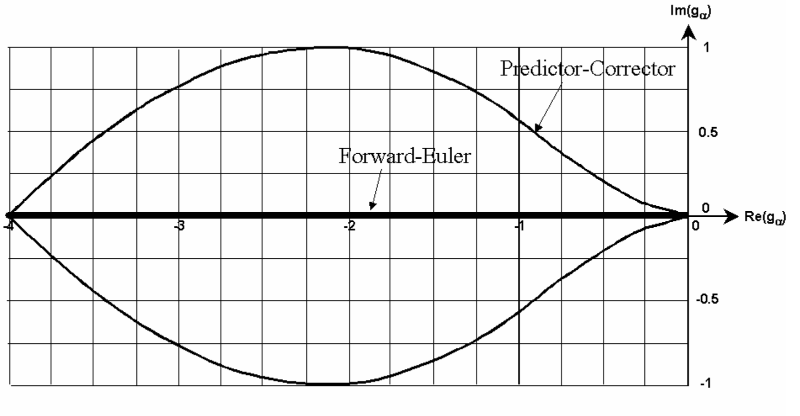

Figure 1. Basins of stability for DPD with Eulerian kernel.

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