basque center for applied mathematics

Working Seminar

(M3A – Mathematical Modeling with Multidisciplynary Applications
MMB – Mathematical Modeling in Biosciences)

Monday, July 2nd, 15:30

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An RBF-FD closest point method for solving PDEs on surfaces and applications to PDEs on moving surfaces

Partial differential equations (PDEs) on surfaces appear in many applications throughout the natural and applied sciences. The classical closest point method (Ruuth and Merriman, J. Comput. Phys. 227(3):1943-1961, [2008]) is an embedding method for solving PDEs on surfaces. Using a closest point representation of the surface, a constant-along-normal extension is employed to formulate the PDE in the embedded space, which can be solved numerically using standard finite difference schemes.

We present a closest point method that uses finite difference schemes derived from radial basis functions (RBF-FD). When compared to the standard finite difference discretization of the original closest point method, the proposed method requires a smaller computational domain surrounding the surface, resulting in a decrease in the number of sampling points on the surface. In addition, higher-order schemes can easily be constructed by increasing the number of points in the RBF-FD stencil.

Our method uses RBF centers on regular grid nodes, avoiding the ill-conditioning from point clustering on the surface. An implicit formulation that uses the least-squares method allows an easy and natural coupling with a grid based manifold evolution algorithm (Leung and Zhao, J. Comput. Phys. 228(8):2993-3024, [2009]). The method is tested in a number of applications on static and moving surfaces.