An Implicit Integrated Polyharmonic Splines Method for PDEs

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Abstract

Meshless methods have recently attracted significant attention in many fields such as fluid dynamics, solid mechanics, and computational mathematics due to their flexibility for solving complicated problems in high-dimensional space. In the past, the multiquadric function has been considered to be one of the most effective radial basis functions (RBFs). However, the accuracy of numerical approximation using the multiquadric function or any other RBF containing shape parameters is highly affected by the choice of parameters. Thus, one of the advantages of using polyharmonic splines is that there is no shape parameter involved in the approximation process. The problem of determination of the shape parameters in the other basis naturally disappears. An implicit integrated polyharmonic splines method, the so-called meshless method, will be applied to elliptic and parabolic partial differential equations.

The presentation will start with the second order elliptic equation, for which the method shall be applied and introduced in detail. The speaker then will demonstrate how the method can be applied to the modified Helmholtz equation, biharmonic equations and diffusion-advection-reaction equations, with a focus on the main features. Furthermore, an eigenvalue distribution of the differentiation matrix and the rate of convergence shall be briefly given for some cases. Our preliminary numerical experiments show that the chosen basis for the solution space is very effective and accurate for high-dimensional PDEs. The talk should be accessible to graduate students with adequate training in computational methods.

Keywords: Radial basis function, Polyharmonic splines, Partial differential equations, Shape parameter.