On the exponential convergence of method of fundamental solutions

Chia-Cheng Tsai[1]*, Po-Ho Lin[2]

[1]*Corresponding author, Department of Marine Environmental Engineering, National Kaohsiung Marine University, Kaohsiung 811, Taiwan, E-mail: tsaichiacheng@mail.nkmu.edu.tw

[2]Department of Marine Environmental Engineering, National Kaohsiung Marine University, Kaohsiung 811, Taiwan

Abstract

It is well known that the method of fundamental solutions (MFS) is an numerical method of exponential convergence. In other words, the logarithmic error is proportional to the node number of spatial discretization. In this study, the exponential convergence of MFS is demonstrated by solving Laplace equation in domains of rectangles, ellipses, amoeba-like shapes, and rectangular cuboids. In the solution procedure, the sources of the MFS are located as far as possible and the instability resulted from the ill-conditioning of system matrix is avoided by using the multiple precision floating-point reliable (MPFR) library. The results show that the convergence are faster for the cases of smoother boundary conditions and larger area/perimeter ratios. For problems with discontinuous boundary data, the exponential convergence is also accomplished using the enriched method of fundamental solutions (EMFS), which is constructed by the fundamental solutions and singular solutions.

Keywords: exponential convergence, method of fundamental solutions, corner singularity, multiple precision floating-point reliable library