The null-field method of Dirichlet problems of Laplace's equation on circular domains with circular holes

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Abstract

In this paper, the boundary errors are defined for the null-field method (NFM) to explore the convergence rates, and the condition numbers are derived for simple cases to explore numerical stability. The optimal convergence (or exponential) rates are discovered numerically. This paper is also devoted to seek better choice of locations for the field nodes of the fundamental solutions (FS) expansions. It is found that the location of field nodes Q does not affect much on convergence rates, but do have influence on stability. Let d denote the distance of Q to @S. The larger d is chosen, the worse the instability of the NFM occurs. As a result, d ¼ 0 (i.e., Q A@S) is the best for stability. However, when d40, the errors are slightly smaller. Therefore, small d is a favorable choice for both high accuracy and good stability. This new discovery enhances the proper application of the NFM.

Keyword：null field method, circular domain, fundamental solutions, error analysis, stability analysis, Dirichlet condition