The International Conference on Computational Methods
NOVEMBER 15-17, 2010, Zhangjiajie, China

New variable transformations for evaluating nearly singular integrals in 2D boundary element method

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Abstract

This work presents a further development of the distance transformation technique for accurate evaluation of the nearly singular integrals arising in the 2D boundary element method (BEM). The original technique can not deal with the cases when the source point falls into the tangent line of the integration element. Moreover, for nearly hyper-singular integrals, another transformation which transforms the integral into an analytical form is required. In this paper, a number of new transformations are proposed based on the approximate distance function to deal with all possible cases of the relative location of the source point. For the nearly strong singular integral, the distance function is redefined to keep the transformation effective even when the minimum distance equals zero. For the nearly hyper-singular integral, we first analyze the transformation into five steps when the minimum distance is not zero, and four steps when it is. Then these steps are unified into a uniform formation, in which the analytical integral is avoided. Numerical examples are presented considering various positions of the projection point and values of the minimum distance. Results demonstrated that our method is very accurate and effective.

Keywords: nearly singular integrals; numerical integration; boundary element method; variable transformation