THE DUAL BOUNDARY ELEMENT METHOD: EFFECTIVE IMPLEMENTATION FOR CRACK PROBLEMS

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SUMMARY
The present paper is concerned with the effective numerical implementation of the two-dimensional dual boundary element method, for linear elastic crack problems. The dual equations of the method are the displacement and the traction boundary integral equations. When the displacement equation is applied on one of the crack surfaces and the traction equation on the other, general mixed-mode crack problems can be solved with a single-region formulation. Both crack surfaces are discretized with discontinuous quadratic boundary elements; this strategy not only automatically satisfies the necessary conditions for the existence of the finite-part integrals, which occur naturally, but also circumvents the problem of collocation at crack tips, crack kinks and crack-edge corners. Examples of geometries with edge, and embedded crack are analysed with the present method. Highly accurate results are obtained, when the stress intensity factor is evaluated with the J-integral technique. The accuracy and efficiency of the implementation described herein make this formulation ideal for the study of crack growth problems under mixed-mode conditions.

INTRODUCTION
The boundary element method (BEM) is a well established numerical technique in the engineering community, see Brebbia and Dominguez. Its formulation in elastostatics can be based either on Betti's reciprocity theorem, or simply based on the classical work theorem. In both cases, a single boundary integral equation is obtained. The BEM has been successfully applied to linear elastic problems in domains containing no degenerated geometries. These degeneracies, either internal or edge surfaces which include no area or volume and across which the displacement field is discontinuous, are defined as mathematical cracks. For symmetric crack problems only one side of the crack need be modelled and a single-region BEM analysis may be used. However, in a single-region analysis, the solution of general crack problems cannot be achieved with the direct application of the BEM, because the coincidence of the crack surfaces gives rise to a singular system of algebraic equations. The equations for a point located at one of the surfaces of the crack are identical to those equations for the point, with the same co-ordinates, but on the opposite surface, because the same integral equation is collocated with the same integration path, at both coincident points.

Some special techniques have been devised to overcome this difficulty. Among these the most important are: the crack Green's function method, the displacement discontinuity method, the subregions method, and the dual boundary element method. The crack Green's function method...