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The Boundary Face Method with Variable Approximation by B-spline Basis Functions

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Abstract

B-spline basis functions as a new approximate method is introduced in the framework of Boundary Face Method (BFM) to attain numerical solutions of Boundary Integral Equations (BIEs) of the 3-D potential problems. In BIEs, both boundary integration and variable approximation are performed in the parametric space, all of the boundary geometric information used for integral is from exact geometry, these are based on the conception of BFM. Basis functions defined in global intervals are translated into local forms defined in local nonzero subintervals. In the construction of approximation functions, local forms of basis functions are employed to perform the bivariate B-spline and NURBS fitting functions. To ensure of interpolating the node values on the surface, fitting functions are modified to bivariate B-spline and NURBS interpolation functions with the invert transformation. In this process, surfaces of geometric bodies in the 3D Cartesian coordinates are mapped to normalized 2D parametric planes. Basis functions are built on the corner points of elements in the discrete normalized planes, and boundary values in the 3-D Cartesian coordinates are used for control points, the approximation functions can be evaluated. Numerical tests for 3D potential problems show that the B-spline basis functions as approximation functions have advantages on the accuracy, computational time and stability, contrasted with the Moving Least Square (MLS) method which is well-known as the basic tool for meshless analysis.

Keywords: B-spline basis function; NURBS; boundary face method; BIE