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Meshfree Analysis based on Boundary Interpolatable Moving Least Squares Method

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Summary

In the past decade, a considerable attention has been given to a new paradigm of meshfree analysis to overcome the drawbacks frequently encountered in the finite element method, such as human labor-intensive meshing, element distortions, re-meshing during large deformation and others. As a result, various meshless methods have been proposed to get rid of the dependency on well-defined mesh, and the problem of element dependency is alleviated.

However, due to the diffuse character of methless approximations including the moving least squares scheme, the meshless approximations lose the exact interpolation property, differing from the Lagrange interpolation functions. And the lack of exact interpolation property leads to the difficulty in enforcement of essential boundary conditions when we apply the methless methods. Although several approaches have been proposed to resolve this unexpected problem related to the treatment of essential boundary conditions, the problem has not been solved completely.

In this paper, we proposed a novel way to completely eliminate the problem in enforcing the essential boundary conditions in meshfree methods by using boundary interpolatable(BI) moving least square method which satisfies Kronecker Delta Condition along the boundary edges. In the proposed scheme, the original MLS weight is modified to BI weight based on the observation that the support of weight function is exactly the same as the support of MLS nodal shape function. The BI weight is zero along the boundary edges except the edges containing the nodal point associated with the concerned weight. In order to construct the BI weight from the original weight, concept of edge distance function is introduced, and several edge distance functions are investigated.

Various numerical tests have been performed to investigate the validity of proposed method. From the tests, it is identified that the proposed method passes the patch test and guarantees the convergence. Furthermore, it is confirmed that one can handle the essential and natural boundary conditions through the proposed BI MLS scheme in exactly the same manner used in traditional finite element methods.

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