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# Isogeometric Immersed Boundary Method using B++ Splines

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An isogeometric immersed boundary method using B++ splines (Boundary Plus Plus Splines) is proposed in this paper. We show that any trimmed NURBS surface with complex topologies can be converted into B++ splines which incorporate the control points of the trimmed curves and a set of enriched control points. Each B++ spline basis function is a linear combination of the standard NURBS basis functions. The displacement function shares the same B++ spline basis function. Thus, nonconforming control variables related with enriched control points are introduced to enrich the approximated space. The present method is an enhanced immersed boundary method, which stays within the standard Ritz-Galerkin framework, fulfills Dirichlet boundary conditions. Emphasis is placed on the construction an invertible transformation matrix that related the control points of the trimmed NURBS surfaces to those of the trimming curves at the boundaries. In so doing, the resulting B++ spline basis functions associated with the control variables of the trimming curves interpolate the Dirichlet boundary while the control variables of the enriched basis functions vanish at the boundaries. With the examples of complex topology that could be described by employing B++ splines, effectiveness and robustness of present method are demonstrated.

**Keywords:** B++ splines, Isogeometric Analysis, Immerse spline method, Dirichlet boundary conditions, Euler finite element method.