Volumetric Untrimming: Precise Decomposition of Trimmed Trivariates Into Tensor Products

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ABSTRACT

3D objects, modeled using Computer Aided Geometric Design (CAGD) tools, are traditionally represented using a boundary representation (B-rep), and typically use spline functions to parameterize these boundary surfaces. However, recent development in physical analysis, in isogeometric analysis (IGA) in specific, necessitates a volumetric parametrization of the interior of the object. IGA is performed directly by integrating over the spline spaces of the volumetric spline representation of the object. Typically, tensor-product B-spline trivariates are used to parameterize the volumetric domain.

A general 3D object, that can be modeled in contemporary B-rep CAD tools, is typically represented using trimmed B-spline surfaces. In order to capture the generality of the contemporary B-rep modeling space, while supporting IGA needs, [1] proposed the use of trimmed trivariates volumetric elements. However, the use of trimmed geometry makes the integration process more difficult since integration over trimmed B-spline basis functions is a highly challenging task [3]. In this talk and based on [2], we propose an algorithm that precisely decomposes a trimmed B-spline trivariate into a set of (singular only on the boundary) tensor-product B-spline trivariates, that can be utilized to simplify the integration process, in IGA. The trimmed B-spline trivariate is first subdivided into a set of trimmed Bézier trivariates, at all its internal knots. Then, each trimmed Bézier trivariate, is decomposed into a set of mutually exclusive tensor-product B-spline trivariates, that precisely cover the entire trimmed domain. This process, denoted *untrimming*, can be performed in either the Euclidean space or the parametric space of the trivariate. We present examples of the algorithm on complex trimmed trivariates' based geometry, and we demonstrate the effectiveness of the method by applying IGA over the (untrimmed) results.

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REFERENCES

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