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MULTI-BLOCK DECOMPOSITION USING CROSS-FIELDS.

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ABSTRACT

The multi-block meshing strategy involves decomposing complex domains into a collection of simpler sub-regions to which structured meshes can be applied, thereby producing high quality block-structured meshes. However, the absence of effective automatic decomposition algorithms reduces the practicality of the method. In this paper a method is described for automatically generating multi-block decompositions of surfaces suitable for generating boundary aligned block-structured quadrilateral meshes with a small number of singularities far from boundaries.

The method uses a cross-field describing the local directionality of a square quadrilateral mesh, which is solved for on an existing triangular mesh. Crosses aligned with boundary components are initialised at boundary nodes. The cross-field is propagated into the interior at a constant rate with respect to distance using a smoothing method aimed at minimising its local distortion. Mesh singularities necessarily occur due to the particular nature of the local boundary alignment constraints or significant total Gaussian curvature. It is shown that they tend to appear in the cross-field solution at discrete positions near the medial axis. They are characterised by non-zero circulation of the cross-field around the edges of triangle elements. The final multi-block decomposition is generated from the cross-field simply by tracing the critical streamlines connected to singularities and boundary corners. Examples are included that demonstrate the process and showcase the final multi-block decompositions of planar and curved open surfaces, of arbitrary genus, with complex boundary edge features. The use of scratches is also explored as a means of applying additional direction constraints to produce block-structured meshes suitable for capturing important simulation solution features, such as shock waves and wakes in CFD analyses.