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Decomposition and hex meshing of quasi-axisymmetric models

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Increasing demand to analyse higher fidelity models in shorter timeframes has resulted in significant advances in engineering analysis tools and computational hardware. Nevertheless, complicated component definitions and huge assembly configurations, e.g. such as whole-engine aero models, alongside the desire for more advanced simulations has created a need for efficient methods to prepare geometric models for analysis. This necessity is exacerbated further when hexahedral elements are required for certain types of geometries (e.g. thin-walled components) and specific analyses (e.g. to allow larger time-steps for transient studies).

Aerospace components are often quasi-axisymmetric as large portions of the model boundary is considered axisymmetric surrounded by cyclic symmetric and non-axisymmetric features. Whilst, common industrial practice is to exploit symmetry properties for analysis purposes it has not been exploited for mesh generation. In this work symmetry analysis is carried out on the geometric definition of components and assemblies to detect cyclic symmetric and axisymmetric regions. Identifying and exploiting symmetric properties in quasi-axisymmetric components is utilised to simplify and automate the creation of FE volume meshes, especially hexahedral meshes.

The ability to identify symmetry properties enables the partitioning of a complex model into simpler, repeatable sub-domains and asymmetric residuals. The decomposition contains a set of meshable sub-domains where axisymmetric regions can be quad meshed and revolved to form hex elements and cyclic symmetric regions can be meshed once and repeated. Attaching symmetry transformation operators to cells in the decomposition generates an equivalent meshable representation. Therefore, only a portion of the original model is meshed, with the remaining portion generated by applying the associated symmetry transformation operators. The approach shows a major reduction in the overall time to hex mesh quasi-axisymmetric components and assemblies, thus leading to less manual intervention from the user and the potential for more automated analysis workflows.

REFERENCE

[1] F. Boussuge, C. M. Tierney, T. T. Robinson and C. G. Armstrong, "Symmetry-based decomposition for meshing quasi-axisymmetric components," *Procedia Engineeering*, 203, 2017, pp 375-387.