Rule-based Topology Finding of Patterns

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Abstract

Form finding and other geometrical exploration strategies allow parametric exploration of architectural and structural geometries. The design parameters are defined by the connectivity of the structure, which constraints the parametric exploration of the geometrical design space, and may not contain suitable or efficient designs. Topology finding allows to break this constraint to explore the general design space by exploring multiple parametric geometrical design spaces. Unlike geometry, topology is not controlled by continuous-valued parameters, but topological modifications can be performed using a grammar of rules.

This research presents rule-based topology finding of the connectivity of patterns for shell-like structures, like gridshells and vaults. The focus is set on the topological exploration of the singularities in quad mesh patterns, whose data is encoded in a coarse quad mesh. The three challenges that are addressed are parameterisation, organisation and exploration of the topological design space of singularities [1].

Parameterisation is achieved by using the strip structure in quad meshes and introducing a low-level grammar to add and delete strips (Figure 1). Organisation is achieved by defining a rule-based discrete distance, as the minimal number of strip grammar rules to apply to go from one topology to another, which allows describing proximity and sorting topologies. Two exploration strategies are developed: an adjacency-based approach where the closest - one rule away - topologies are enumerated and combined; a gradient-based approach where transitional topologies between two or multiple topologies are generated. These contributions allow the architect or engineer to explore efficiently the topological design space

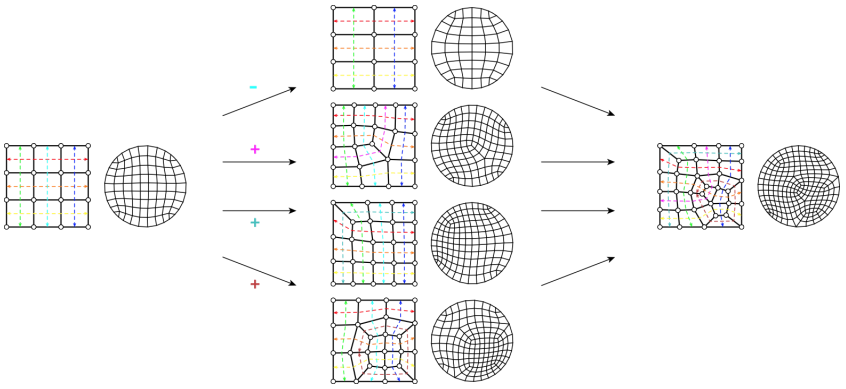

Figure 1: Rule-based exploration of coarse quad meshes by combining strip grammar rules.

References

[1] Oval, R., Rippmann, M., Mesnil, R., Van Mele, T., Baverel, O. and Block, P. *Topology Finding of Structural Patterns*. In: Kilian A., Malek S., Sorkine-Hornung O., Williams C. (eds) Proceedings of Advances in Architectural Geometry (AAG) 2018