Fabrication-aware design of architectural envelopes using surfaces with planar curvature lines

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Abstract

The fabrication of free-form architectural envelopes is a complex task, that often result in higher-than-expected construction costs. In most projects, the geometry is post-rationalized to facilitate fabrication, but this approach often yields limited results.
This paper introduces a bottom-up methodology to generate doubly-curved meshes that satisfy many practical fabrication constraints, including torsion-free nodes, covering with planar facets, node offset and construction with planar arches made of straight of circular elements.
The topic of surfaces with planar curvature lines, in one direction only, was previously explored in [3]. In this paper, we consider surfaces where all curvature lines are planar. Our method is based on the discretization of the Gauss map of smooth surfaces with planar curvatures lines, that were originally studied in [1] and [2]. The discretization yields quadrangular circular meshes. Shape generation is intuitive, as the user controls the shape via two planar guide curves (as shown in Figure 1), and offers access to the whole design space of circular meshes with planar lines. The efficiency of the algorithm allows a manipulation in real-time.
A particular technological application is for steel-glass for gridshells built with curved members: those can be built with planar piecewise-circular beams, and identical nodes if beams have circular cross-section.

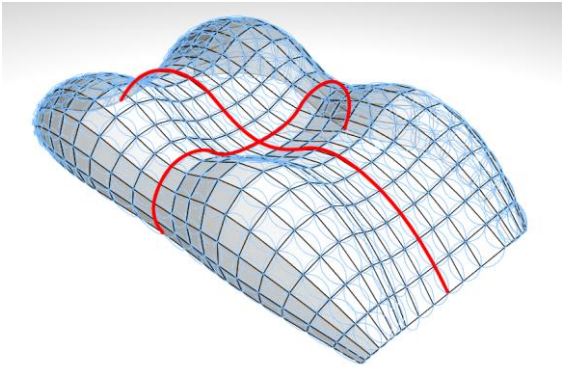

Figure 1 – Circular mesh with planar lines generated from two guide curves

References

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