Bézier tilings of the sphere and their applications in benchmarking multipatch IGA methods

Sander Dedoncker*†‡, Laurens Coox†‡, Florian Maurin†‡, Francesco Greco†‡ and Wim Desmet†‡

† KU Leuven, Department of Mechanical Engineering, Division PMA
Celestijnenlaan 300, B-3001 Leuven, Belgium
e-mail: sander.dedoncker@kuleuven.be

‡ Member of Flanders Make

ABSTRACT

We propose a number of geometrically exact models of a sphere with various mesh topologies, obtained using the composite mapping method introduced by Cobb [1]. The geometry is represented as a spherical tesselation, where the tiles are degeneracy-free Bézier surfaces. The topologies of the tilings are inspired by some well known objects in geometry, namely the Platonic and Catalan solids.

As IGA advances, more realistic geometries are subject to analysis. Staying true to the basic paradigm of IGA, the goal is to use the CAD model – typically consisting of multiple (trimmed) NURBS patches – as the basis for analysis. One of the critical challenges that arise is to mathematically couple the different patches in an accurate and efficient manner. Despite the importance of the patch coupling issue and the multitude of proposed solutions, there seems to be a lack of standard benchmark problems in the literature.

For verification purposes, problems with spherical geometry make excellent test problems since they are typically challenging to solve numerically and since many such problems have analytical solutions. As an application of the novel sphere representations, we therefore propose a number of benchmark cases for multipatch IGA methods in different problem settings.

REFERENCES

[1] Cobb, J.E. Tiling the sphere with rational Bézier patches. Technical report, University of Utah (1988).