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Optimized ruled surfaces with an application to thin-walled concrete shells. (English)

Zbl 1400.51021

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Summary: For lightweight structures in the field of architecture and civil engineering, concrete shells with negative Gaussian curvature are frequently used. One class of such surfaces are the skew ruled surfaces. To model such surfaces for the purpose of form-finding, we use the line geometry model of the Study sphere in the space of dual vectors. It allows the mapping of lines of the three-dimensional Euclidean space into points of the four-dimensional model space. The correspondence of minimal ruled surfaces, which are the helicoids, with geodesics on the dual unit sphere can be handled with the dual Rodrigues formula. This paper presents a proof of the formula and extends it to a general form, which avoids exceptions like parallel rulings. This approach also speeds up the interpolation algorithms for form-finding. The line geometry model, as implemented in Rhinoceros3D's plug-in Grasshopper, was used to design a small thin-walled footbridge of concrete in cooperation with the TU Berlin. The formwork was prepared with a hot-wire foam cutter at the TU Dresden.

For the entire collection see [Zbl 1403.00028].

MSC:

51M30 Line geometries and their generalizations
53A05 Surfaces in Euclidean and related spaces

Keywords:

geodesic interpolation; dual numbers; ruled surfaces; rodrigues formula; exponential mapping; footbridge; carbon-reinforced concrete

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