

Geometric and structural analysis of existing vaults using parametric surfaces

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Abstract

Besides common geodesic techniques, 3D-laser scanning plays an increasingly important role in surveying existing structures. However, this technique creates an abundance of data, which must subsequently be analyzed, rationalized and transformed into usable geometry. In this paper we present four different methods to approximate point clouds of single or double curved historic vault structures by using parametric NURBS surfaces. The focus lies not only on the representation of the groins and ribs but mainly on the accurate geometric modelling of the webs in between. A verification of the mean distance between the points of the cloud and the generated surfaces shows adequate accuracy for three of the four approaches. In a case study of a pointed vault with lunette caps, the benefit of a continuous surface formulation is illustrated. By analyzing the Gaussian curvature we can identify critical domains of the entire surface. Finally, a structural analysis evaluates the possible impact on the global load-bearing behavior.

Keywords: reverse engineering, historical vaults, point clouds, existing geometry, geometric modelling, investigation, NURBS surface, surface fitting, least square method

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