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Discrete differential geometry of quad meshes with applications in computational design

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Discrete differential geometry of quad meshes has so far mainly been confined to discrete counterparts of special parameterizations of surfaces. Arbitrary quad meshes received much less interest, although they are very useful for a variety of applications. In the present talk we present a discrete first fundamental form and basics of curvature theory using the diagonal meshes of a quad mesh. This approach is well suited for discrete representations of mappings between surfaces. Our focus will be on isometric maps and their usage to model developable surfaces and to solve paneling problems in architectural geometry. For the latter, we assume bendable material and work with surfaces of constant Gaussian curvature. Surprisingly, one can achieve high quality results with only a very small number of molds. Moreover, we show how easily one can handle further constraints on meshes and present results on shape morphing with mechanical metamaterials.

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