Developable surfaces: capture and reconstruction

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A developable surface is a surface, which can be unfolded (developed) into a plane without stretching or tearing. Because of this property, developable surfaces possess a variety of applications in manufacturing with materials that are not amenable to stretching (leather for shoes or hand bags, skins of aircrafts, sails). In computer graphics developable surfaces are very popular to model, simulate or animate clothes or folded papers in virtual environments. Existent algorithms optimize a triangular surface mesh following some non-linear criteria in order to converge to a quasi-developable surface. Others reconstruct a developable triangle surface mesh from some given arbitrary boundary curves using a branch & bound approach. These approaches are very time consuming.

The goal of the M2 project is to develop a new method, which takes as input not only a set of boundary curves, but also tangent planes along these curves. Both, curves and tangent planes are supposed to belong to a developable surface. Our approach is based on a hierarchical surfaces construction. Similar to standard subdivision surface algorithms [1,2] we start with a very coarse grid, and compute a series of refined developable grids, which at the end results in a smooth developable surface.

![Figure taken from [1]: three iterations of subdivision and resulting smooth limit surface. The green input curve is interpolated.](image1)

![Figure taken from [3]: modified Catmull-Clark subdivision surface converging to a developable surface.](image2)

**Work plan**

Study first relevant literature on subdivision surfaces [1,2] and on developable surface approximation algorithms [3,4]. Propose and implement at least one algorithm computing the hierarchy of developable grids. Choose a geometric criterion to ensure developability of the grids. Apply your criterion at each grid level.

**2 options** are possible

- extension to time-varying (animated) input data in order to compute a deforming dev. surface.
- study geometrical properties of the proposed new surface scheme.

The whole project is a “math-info” project. It can either be oriented more to computer graphics or to applied mathematics aspects.

**Poursuite en these --- Contexte scientifique**

Poursuite en these possible. La thèse pourrait même s’intégrer dans la thématique d’une collaboration avec le CEA/Leti, ou dans un projet européen. La thèse pourrait se faire en co-tutelle avec un partenaire européen. Durant le stage de M2R un séjour dans un laboratoire de recherche allemand est envisageable.

[3] Liu, Potmann et al. : SIGGRAPH’06