The Chinese University of Hong Kong
Non-confidential Abstract of Technology Disclosure

Title: Method for Flattening Freeform Surfaces with Length-Preserved Feature Curves

CUHK Ref. No.: 08/ENG/287/ITF

Patent Status: US Patent Pending

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Non-confidential abstract:

For designers in industries whose products are fabricated from planar pieces of sheet material (e.g., metal in ship industry, fabric in apparel industry and toy industry, and leather in shoe industry and furniture industry), how to determine the shape of 2D pieces from designed 3D surface patches now becomes the bottleneck in the design and manufacturing cycle. Ideally, a flattened 2D piece is expected to have an isometric mapping to its corresponding 3D patch in the representation of a piecewise linear surface. However, from differential geometry, we know that only those developable surfaces satisfy this properly. Therefore, the existing approaches in the computer-aided design area for surface flattening and the computer graphics literature for mesh parameterization adopt various criteria (including the length variation criterion) to minimize the difference between the 3D surface patch and its corresponding 2D region which is time consuming.

On the other hand, for surface flattening under a constrained optimization framework, the resultant 3D patch generally is not a developable surface and length variation is always found in the flattening results which will lead to many problems in shape (e.g., unexpected wrinkles formed on the fabricated product) and designed fit for an engineering application such as the 3D garment design and manufacturing where good garment shape and fit (i.e. without unexpected wrinkles) are two necessary criteria to evaluate whether a suit is a high-end garment product. Therefore, designers in these industries desire a surface flattening tool which can preserve the length of boundaries and feature curves on a 2D piece according to its 3D surface patch as it is very important to control the shape and dimension of products fabricated from planar pieces. In view of these, a novel approach – WireWarping for computing a flattened planar piece with length-reserved features curves from a 3D piecewise linear surface patch is invented.

WireWarping simulates warping a given 3D surfaces patch onto plane with the feature curves as tendon wires to preserve the length of their edges. Surface-angle variations between edges on wires are minimized so that the shape of a planar piece is similar to its corresponding 3D patch during warping. Two schemes – the progressive warping and the global warping schemes are developed, where the progressive scheme is flexible for local shape control and the global scheme gives good performance on highly distorted patches.

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