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Advances in mesh optimization based on algebraic quality metrics

J.M. Escobar [*+], R. Montenegro[+], G. Montero[+], E. Rodríguez[+] and
J.M. González-Yuste[+]
[*]Department of Signal and Communications, University of Las Palmas de Gran Canaria, Campus Universitario de Tafira, 35017 Las Palmas, Spain.
[+]University Institute for Intelligent Systems and Numerical Applications in Engineering, University of Las Palmas de Gran Canaria, Edificio Central del Parque Científico-Tecnológico, Campus Universitario de Tafira, 35017 Las Palmas, Spain.

University Institute for Intelligent Systems and Numerical Applications in Engineering, University of Las Palmas de Gran Canaria, Edificio Central del Parque Científico-Tecnológico, Campus Universitario de Tafira, 35017 Las Palmas, Spain,
e-mail: rafa@dma.ulpgc.es, gustavo@dma.ulpgc.es, jescobar@dsc.ulpgc.es, barrera@dma.ulpgc.es, josem@sinf.ulpgc.es

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In this work we focus our attention on two aspects related to the node movement in surface meshes: smoothing of triangular meshes defined on surfaces and the adaption of these meshes to match given curves or contours.

The quality improvement of the mesh is obtained by an iterative process in which each node of the mesh is moved to a new position that minimizes a certain objective function. The objective function is derived from some algebraic quality measure [1, 2] of the *local submesh*, that is, the set of triangles connected to the adjustable or *free node*.

When we deal with meshes defined on surfaces we have to impose some restrictions to the movement of the free node. Firstly, is clear that such node must be sited on the surface after optimizing. But, this is not the only constraint. If we allow the free node to move on the surface without imposing any other restriction, only guided by the improvement of the quality, the optimization procedure can construct a high-quality local mesh, but with this node in an *unacceptable* position. To avoid this problem the optimization is done in the *parametric mesh*, where the presence of barriers in the objective function maintains the free node inside the feasible region. In this way, the original problem on the surface is transformed into a two-dimensional one on the *parametric space*. In our case, the parametric space is a plane, chosen in terms of the local mesh, in such a way that this mesh can be optimally projected performing a *valid* mesh, that is, without inverted elements.

We use the flexibility that provides this techniques to adapt a given surface mesh to a curve defined on it. The idea consists on displacing the nodes close to the curve to positions sited on the curve. The process is repeated until the it is correctly approximated (interpolated) by a set of linked edges of the mesh.

The determination of which nodes can be projected on the curve is accomplished by analyzing if there is a position on the curve on which the free node can be projected without inverting any triangle of its local submesh. The optimal position of the free node on the curve is determined attending to the quality of the local submesh.

Sometimes we lack an analytic expression of the curve to be interpolated and, instead, it is given by a set of aligned points with a density high enough. This is the case, for example, of data supplied by digitalized maps describing coastal shores or river banks.

All these questions will be conveniently supported by examples.

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