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Shape tuning in Fully Free-Form Deformation Features

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Abstract: In this paper, an approach for shape tuning and predictable surface deformation is proposed. It pertains to the development of Fully Free Form Deformation Features (delta-F-4) which have been proposed to avoid low-level manipulations of free form surfaces. In our approach, delta-F-4 are applied through the specification of higher level parameters and constraints such as curves and points to be interpolated by the resulting surfaces. From the system perspective, the deformation is performed through the modification of the static equilibrium of bar networks coupled to the control polyhedra of the trimmed patches composing the free form surfaces on which the delta-F-4 are defined. The equations system coming from the constraints specification is often underconstrained, the selection of one among the whole set of possible solutions requires the definition of an optimization problem where an objective function has to be minimized. In this paper we propose a formulation of this optimization problem where the objective function can be defined as a multiple combination of various local quantities related either to the geometry of the bar network (e.g., the length of a bar or the displacement of a node), or to its mechanical characteristics (e.g. the external force applied at a node or a bar deformation energy). Different types of combinations are also proposed and analyzed according to the induced shape behaviors. In this way the shape of a delta-F-4 can be controlled globally, with a unique minimization, or locally with different minimizations applied to subdomains of the surface.

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