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Extraction of surface topological skeletons

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Surface meshes are usually generated from surface models which are created by means of CAD systems. To build a conforming mesh of such a surface, it is necessary to know its topological skeleton precisely. The latter indicates how the different entities composing the surface must be "glued together". This topological skeleton (see the example of fig. 1) is made up of three levels:

- the surface topology: a surface is composed of a conforming assembly of parametric patches; each link between two adjacent patches represents an interface curve;
- the patch topology: a patch is delimited by a conforming assembly of curve segments; each link between two adjacent curves represents a common extremity;
- the curve topology: a curve is delimited by its two extremities.

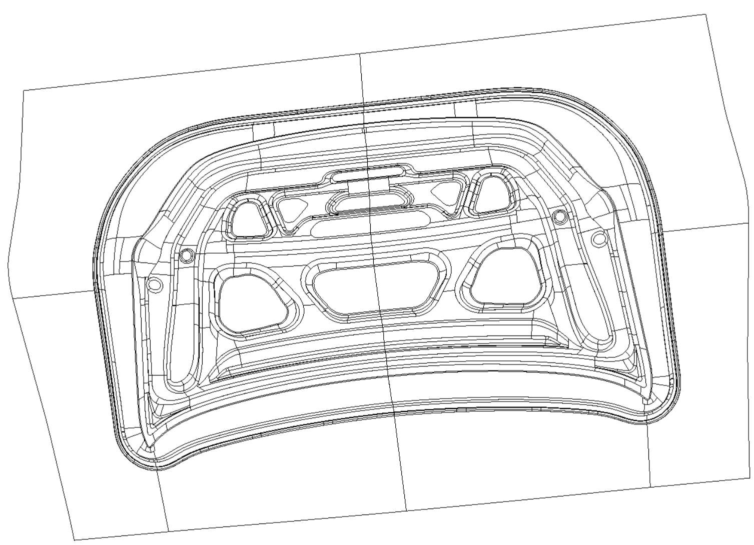

Figure 1: Topological skeleton of a CAD model.

Frequently, this topological representation is totally or partially missing in the CAD system used. If the patch topology and the curve topology are only known, the surface topology reconstruction requires to search for the adjacency relations between the patches.

Since the middle of the 90s, reconstruction methods have been proposed in the case of manifold surfaces. A first idea consists in bringing geometric entities closer, using tolerance distances [1]. This approach underlines the fact that the problem complexity depends on the local geometric configuration of the patches which compose the surface: this is a multiscale geometry problem. To improve the robustness of the reconstruction, it is possible to enhance the method by using discrete [2] or ranking [3] techniques. Experience shows that, in the case of complex CAD surfaces, these methods are unable to reconstruct the topology without the intervention of an external user.

Our approach consists in obtaining the topological skeleton in a fully automatic manner. The surface topology is found in two steps. Let us assume that the topology of each individual patch is already given. First of all, we associate the extremities (for the surface topology) relying on the known curve topology. In the topological skeleton, to each curve belonging to a given patch must correspond one associated curve belonging to a different (adjacent) patch. If the extremities of this associated curve do not match, an appropriate splitting of both curves must be done to ensure the conformity of the skeleton. The second step associates the curves in order to build the whole surface topology: curves whose extremities are associated two by two are joined together. Finally, the topological skeleton which is constructed following this method must define valid domains. Sample results on complex surfaces show the efficiency of our approach.

References

[1] Xuejun Sheng and Ingo R. Meier. *Generating Topological Structures for Surface Models.* IEEE Computer Graphics and Applications, vol. 15, no. 6, p. 35-41, Nov. 1995.

[2] Karsten Weihe and Thomas Willhalm. *Why CAD Data Repair Requires Discrete Algorithmic Techniques.* 2^{nd} Workshop on Algorithm Engineering, Saarbrucken, Germany, WAE 1998.

[3] Gill Barequet and Subodh Kumar. *Repairing CAD Models.* In IEEE Visualization '97, Conference Proceedings, p. 363-370, 1997.