Scale-Space Representation of 3D Models and Topological Matching

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1. CONTROLLING DECOMPOSITION PROCESS

So far, we were using a constant to control the depth of the feature trees. Decomposition process stopped when a feature tree reached a certain constant number. Even though the results of our experiments show that this approach is rather effective, we would like to be able to make this feature extraction process fully automated. In other words, construction of a decomposition tree should terminate only when all significant features were extracted.

We assign a measurement to each iteration of Feature-Decomposition algorithm. Let $\mathcal{M}$ be the original model's point set and E be a set of all edges connecting points in $\mathcal{M}$; $\mathcal{M}_1$ be some partition from $\mathcal{M}$; $\mathcal{M}_2$ and $\mathcal{M}_3$ denote the partitions of $\mathcal{M}_1$ after bisection. The measurement is defined as follows:

$$f(\mathcal{M}_1) = \frac{\text{CutEdges}}{\text{InEdges} + \text{CutEdges}},$$

where

$$\text{CutEdges} = \sum_{\substack{(u,v) \in E, \\ u \in \mathcal{M}_2, v \in \mathcal{M}_3}} \mathcal{D}(u,v),$$

$$\text{InEdges} = \sum_{\substack{(u,v) \in E, \\ u \in \mathcal{M}_2, v \in \mathcal{M}_2}} \mathcal{D}(u,v) + \sum_{\substack{(u,v) \in E, \\ u \in \mathcal{M}_3, v \in \mathcal{M}_3}} \mathcal{D}(u,v).$$

We say that bisection of M_1 into M_2 and M_3 is good if $f(\mathcal{M}_1) < 0.5$ and decomposition process continues for M_2 and M_3, otherwise it stops with the set M_1. The rationale for this technique is that we want to control what ratio of the overall weight in our bisection lie between M_2 and M_3. If that percentage is less than 50%, then we continue with decomposition. Several sample feature trees obtained using this technique can be found in Figure 1.

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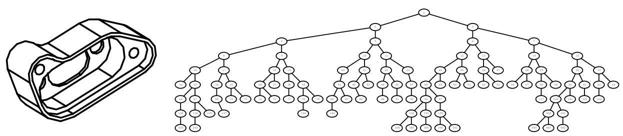
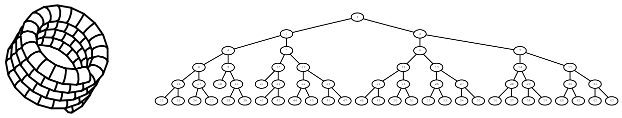
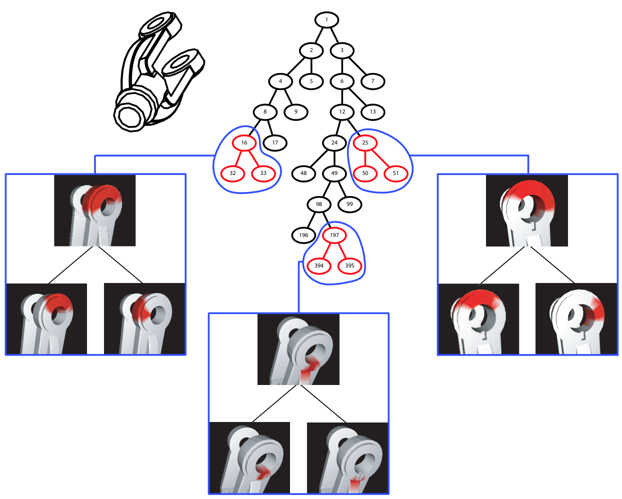


(a)



(b)



(c)

Figure 1: Feature trees for the sample models. (a), (b) Models Part 10 and Spring respectively. Views of these models are presented on the left. (c) Illustrates decomposition process for Fork model (view is presented). Pictures of the point sets for three bisections are presented. Note that technique extracted a pin on one side of the Fork (pin is not present on the other side).