Scale-Space and Reeb Graph Based Shape Retrieval for CAD

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Project Goals

• Develop algorithms to compare CAD models in polyhedral representation (easiest to obtain)
• Integrate these algorithms into the National Design Repository (www.designrepository.org)

Model Representation

• Only simple geometric information is stored
• The shortest path between two points is used as a measurement function

The measurement function between two points of the model is illustrated in red.

Summary and Future Work

• Capable of performing topology matching
• Scale-space technique provides feature decomposition
• In future work we will try to improve these techniques by introducing new node similarity measurements. We also intend to integrate them into the National Design Repository.

Experiments

Sample views from 10 Groups of 3D models

SHAFTS (1)  PART (2)  LINKAGE-ARMS (3)  TEAM (4)  SPRINGS (5)  SPACER (6)  HOUSINGS (7)  GOODPARTS (8)  SWIVEL (9)  SOCKET (10)

• We have obtained a total of 40 CAD models in polyhedral representation.
• Models were manually clustered in 10 groups.
• Similarities for all possible pairs of models were computed using both algorithms and similarity matrices were constructed to visualize the results.

Scale-Space Decomposition based algorithm for matching CAD models

Polyhedral representations of CAD models are calculated. Clustering is based on the angle between a vector (g) and each of the two most significant basis vectors (u, v, w).

Binary trees are obtained by recursively applying feature decomposition routine.

Binary trees that represent models are compared from bottom up. Parents are match only if their children matched.

Arrangement of matching nodes for both models. Total similarity value is calculated based on the similarity between each matched pair of nodes.

Multiresolutional Reeb Graph (MRG) based algorithm for matching CAD models

The value of the \( \mu \) function is calculated for each vertex, meshes are partitioned based on normalized \( \mu \) values and finest resolution graphs are created.

Graphs of coarser resolutions are created by unifying adjacent levels of \( \mu \) values.

MRGs of models are compared from coarsest to finest resolution.

Arrangement of matching nodes for both models. Total similarity value is calculated based on the similarity between each matched pair of nodes.

Scale-Space Decomposition based algorithm

Multiresolutional Reeb Graph based algorithm

Each pixel in the matrices correspond to similarity value of a pair of models. Darker color represents higher similarity.