Sketch based 3D Model Retrieval Using a 2D Image

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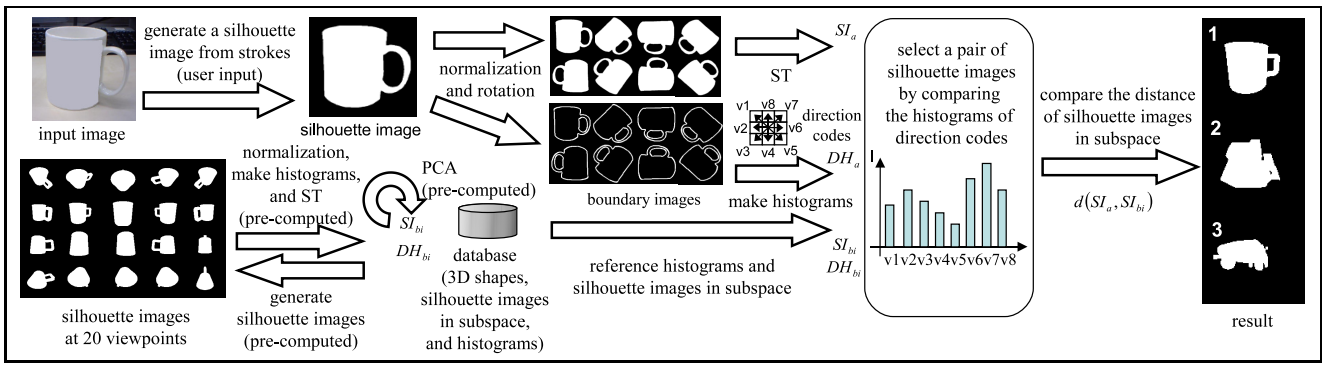

Figure 1: Our 3D model retrieval process using a 2D image.

1 Introduction

Recently, Computer Graphics and Augmented Reality applications are increasing. Therefore, there is growing needs to model real objects for these contents. But real object modeling is difficult because it needs special equipments to measure its shape and particular operations to match feature points in image-based modeling.

Sketch based modeling provides the modeling method with instinctive operation to create, deform, and augment 3D models by user input strokes. There is also a 3D model retrieval method using user input strokes from existing 3D models for the laborsaving of modeling. Funkhouser proposed the 3D model retrieval method using the 2D image of user drawn sketch to calculate the distance distribution from the contour lines of user input stroke [Funkhouser et al. 2003]. However, the retrieval result depends on how to draw contour lines because user can draw different inner contour lines even so outer contour line is same.

In this paper, we propose a sketch based 3D model retrieval method based on the features of silhouette images. We show the retrieval result by using scale, shift, and rotation invariant image comparison algorithm with fast calculation.

2 Our Approach

In our method, the similarity between an input image and 3D models is calculated by the comparison of silhouette images that are generated from an input image and 3D models. We use scale, shift, and rotation invariant IMage Euclidean Distance (IMED) [Wang et al. 2005] with simple calculation to compare silhouette images.

Figure 1 shows our 3D model retrieval process using a 2D image. In advance, the database is constructed by 3D models, silhouette images in subspace SI_{bi}, $i = 0, ..., N$, and the histograms of direction codes DH_{bi}, $i = 0, ..., N$. Silhouette images of 3D models are generated from each viewpoint setting at 20 vertices of a regular dodecahedron and are normalized for scale and shift. SI_{bi} are generated from silhouette images, normalized for scale and shift and are applied transformation matrix $G^{1/2}$ for Standardizing Transform (ST), and are stored on the database after reducing dimensional space by Principal Component Analysis (PCA). DH_{bi} generated from contour lines in normalized images are also stored on the database. At first, a silhouette image is generated from contour lines of user input stroke on an input image. Second, the silhouette image is normalized for scale and shift, and 8 rotation images are generated by rotating the silhouette image 45 degrees. The histograms of direction codes DH_a are constructed from contour lines of the boundary images that is generated from each rotation images. Third, IMED $d(SI_a, SI_{bi})$ is calculated by comparing SI_{bi} with the rotation image SI_a applied $G^{1/2}$ at the most similar rotation angle that is found in comparison of DH_a with DH_{bi}. At last, the user sees 3D models by a short distance of IMED.

The contributions of our work are the following:

1. Calculating simply for the distance between a 2D image and a 3D model using scale, shift, rotation invariant IMED.
2. Providing retrieval result that is unaffected by how to draw inner contour because of comparing silhouette images.

In our experiment, the database is constructed of 1,814 3D models from Princeton Shape Benchmark. We compare our method with the method using Ring Projection (RP) that is commonly-used in traditional pattern matching. Experimental results on 3 kinds of cup and 2 kinds of glass show average highest-ranking similar model being 9th using our method against 41st using RP. Both methods using our method and RP finish retrieving in a few seconds.

In conclusion, we proposed a sketch based 3D model retrieval method based on the features of silhouette image generated from a 2D image. In future work, we plan to add interactive retrieval every 3D parts modeling time after retrieval using 2D strokes.

References

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