Overview

- **Research Topic:** Query-by-Sketch is an intuitive scheme; promising in game design, 3D animation and human-computer interaction, etc.
- **Problem:** Big semantic gap exists between human-drawn sketches and 3D models
  - 2D human-drawn sketch: an iconic representation of an object; several simplified and exaggerated curves; arbitrary styles; high-level abstraction; drastic simplification
- **3D model of an object:** accurate representation of the geometry information
- **Consequence:** Such big semantic gap makes the search based on a direct 2D-3D comparison suffer low accuracy and high computational cost
- **Motivation:** Bridge the semantic gap
- **Our Semantic Sketch-Based 3D Model Retrieval Approach:** First recognizing the potential semantic meanings of the user sketch and then performing 2D-3D matching for the 3D models within the predicted categories
- **Overview of Our Results:** Significant improvements in both search accuracy and efficiency

Algorithm (Cont.)

- **(2) Sketch classifier/training.** Support Vector Machine; adopt same parameter settings as [2] including local feature definitions, "soft" kernel-codebook coding choice, vocabulary size, and 3-fold cross-validation selection except for RBF kernel (gamma=0.1 and C=20)
- **Stage 2: Sketch-Based Retrieval**
  - **(3) Sketch classification.** Predict all the possibilities of the input sketch belonging to all the categories
  - **(4) 2D-3D matching.** The state-of-the-art sketch-based retrieval approach SBR-2D-3D (4) is applied on all the models in the top C candidate categories, which makes our approach SBR-SVM-2D-3D. The distances between the models and the input sketch, named \( D_o \), are calculated
  - **(5) Distance vector generation.** Assign distances between the input sketch and the models in the left categories as the second part of \( D \), named \( D_l \), set to be the ranking orders of their respective categories. Concatenate \( D_o \) and \( D_l \) into \( D \)
  - **(6) Ranking and output.** All the distances in \( D \) are sorted and the relevant models are listed accordingly

Framework

- **Stage 1: Sketch Recognition Training**
  - **(1) Sketch feature extraction.** Hybrid features: Eltz et al.’s [2] 500-dimensional local feature vector + our proposed 119-dimensional vector + our proposed 119-dimensional histograms: \( 5 \) radial distance histograms of the sketch pixels with respect to 5 selected reference points/lines
  - 2 radial distance histograms of the first intersection points
  - 2 radial angle histograms of the sketch pixels with respect to the two centers C and FPC

Algorithms (Cont.)

- **Stage 1: Sketch Recognition Training**
  - **(1) Sketch feature extraction.** Hybrid features: Eltz et al.’s [2] 500-dimensional local feature vector + our proposed 119-dimensional global feature vector, which comprises 9 distance histograms:
    - 5 radial distance histograms of the sketch pixels with respect to 5 selected reference points/lines
    - 2 radial distance histograms of the first intersection points
    - 2 radial angle histograms of the sketch pixels with respect to the two centers C and FPC

Experiments

- **SHREC’13 Sketch Track Benchmark:** A large-scale sketch-based shape retrieval benchmark
  - 7250 hand-drawn sketches: uniformly distributed on 90 classes
  - 1258 relevant 3D models: selected from the PI3 benchmark, as the target 3D dataset
  - "Training" and "Testing" datasets: randomly selecting 50 sketches per class for training and the rest 30 sketches for testing, while the complete target model dataset is remained as a whole for both training and testing purpose

- **Sketch Recognition Results**

  Table 1. Average classification performance comparison in terms of eight metrics. The first two rows are for the SHREC’13 Sketch Track Benchmark; the last two rows (* *) are for the Eltz et al.’s [2] complete sketch benchmark.

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<th>Method</th>
<th>TP</th>
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</table>

- **Timing:** averagely 0.1 second is needed to classify a sketch

- **Sketch-Based Retrieval Results**

  ![Precision-Recall diagram performance comparison between our SBR SVM-2D-3D (different L values) and the participating approaches in the SHREC’13 Sketch Track Contest on the “Testing” dataset.](image)

- **Other performance metrics comparison between our semantic algorithm SBR SVM-2D-3D**
  - SHREC’13 Sketch Track Contest: Sketch-Based 3D Shape Retrieval. 3DOR 2012: 109-118

- **Future work:** study the integration of unsupervised or semi-supervised sketch recognition module when the label information of the target 3D model is not available

Conclusions

- Our semantic sketch-based 3D model retrieval algorithm is an important improvement to encompass the semantic gap between the sketches and models.
- It achieves the significant improvements in both retrieval accuracy and computationally efficiency.
- Future work: study the integration of unsupervised or semi-supervised sketch recognition module when the label information of the target 3D model dataset is not available

References


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