Browsing Shape Collections

CS 294 (Visualization) – Final Project

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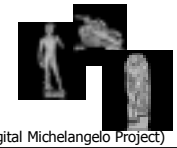
Problem

Shape modeling or acquisition technology has become more accessible and 3D shape collections are now commonly found. There is a growing need for a browsing interface to explore a shape database and quickly understand its content.



(Digital Michelangelo Project)

(Princeton Shape Benchmark)

Motivation

A shape browser has several technical uses:

1. Survey a given shape collection to get an overview and obtain the types of shapes in the collection
2. Quickly observe trends in the shape data: clusters, outliers etc.
3. Appraise a given shape evaluation function: unexpected clusters that do not match how humans perceive shape similarities can indicate loss of information in the shape evaluation.

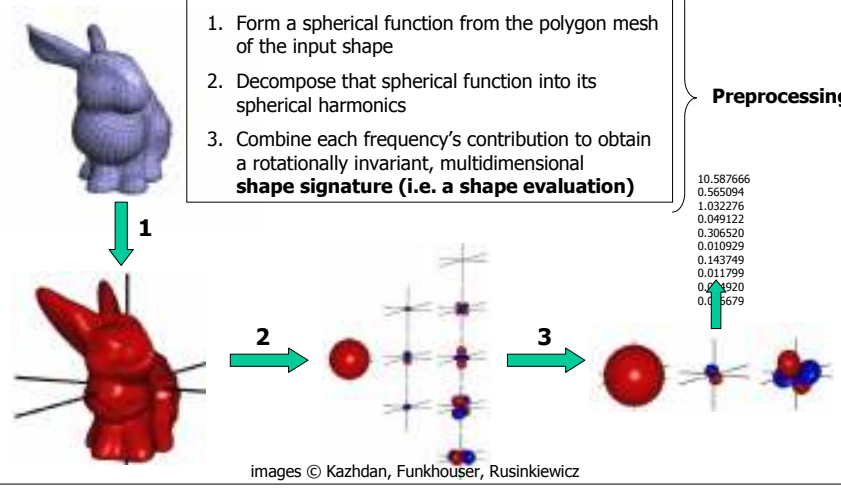
Overview

Goal To develop an interactive interface that shows the internal clustering of shapes, allows to select one cluster (zoom in), and provides a scatter plot of the contents of that cluster.

We use rotationally invariant spherical harmonics to produce a fixed-length shape signature for each shape. We use Principal Components Analysis (PCA) for projecting the multi-dimensional shape data down to two dimensions. Our system is flexible and is designed to easily incorporate various shape signature functions and dimensionality reduction algorithms.

Approach

For Every Input Shape:



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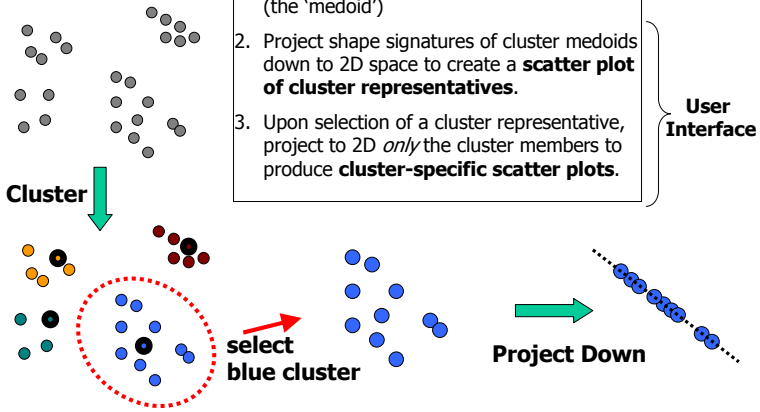
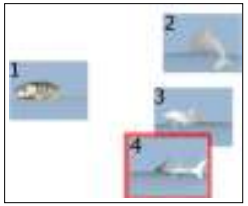
For Collection of Shape Signatures:



Results



Global overview of database with icons of cluster representatives

Local scatter plot of shapes in selected cluster; distances in scatter plots usually correspond to shape similarity.

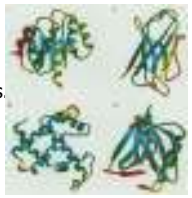
Future Work

General Shape Collections

1. Use information obtained from unexpected outliers to improve the shape evaluation function
   (possibly consider additional structural data)
2. Allow users to specify 'similar' and 'different' shapes and use that information to learn a better distance metric

Specific Types of Shape Collections (e.g. Proteins)

We can use a *specialized* shape evaluation function to organize protein shapes. Such a shape plot can provide insight into the shape space spanned by protein molecules. This can help researchers develop a suitable metric for protein shape (which is a significant research problem).



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