The Parameter Space of Cups: Cluster-based Exploration of a Geometry Generator’s Parameter Space
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Motivation
Evaluation of computer vision systems
- Real-world test-cases → expensive!

Idea: Simulate test-case
- Automatic test-case generation
- Using computer graphics

Application Area: household robot

Geometry Generators
- Generate 3D shapes
- Large variations
- Sample parameter space

Tasks
- Find similar 3D shapes and corresponding parameter settings.
  T1: Categorization
- Find errors and unwanted 3D shapes
  T2: Errors

- Determine sensitivity and influence of parameters on the resulting 3D shapes.
  T3: Influence & Sensitivity

Cupid[1]

Parameter Space
- Parameter
  - Name
  - Type
  - Sampling range
- Settings
  - Number of objects
  - Sampling type (Random, Halton, ...)

3D Shapes
- Cup Generator
  - 11 parameters
  - E.g., handle-type, convexity side, center width...
- Physically invalid detected categories
- Beer mug

Clusters
- Similarity Calculation
  - Iterative closest point algorithm
  - Closest point measurement
- Hierarchical clustering:
  - Agglomerative technique
  - Depending on similarity
  - User-adjustable

Visualization
- Composite Parallel Coordinates
  - Visualize parameter space
  - Embed spatial information
  - Hierarchical clustering of similar 3D shapes
  - Clusters represented by edge bundling and polygons
  - Detail window depicts all members of clusters

- Composite Radial Tree
  - Visualize hierarchical clustering
  - Modifying hierarchical clustering by split and merge

Optional
- Scatterplot Matrix Vis.
- Shape browser

Result

Feedback
- From domain experts of testing computer vision systems
  - Biologically-technique
  - Integration of shapes & clusters
  - Highlighting & brushing
  - T1: Categorization, T2: Errors

Conclusion
- Novel combination using well-known techniques
  - Composite visualization that combines the abstract parameter space with the resulting 3D shapes
  - Iterative techniques
  - Hierarchical clustering
  - Positive domain feedback

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