Shape Signatures

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Shape signatures

Idea
represent shape by a 1D function derived from boundary points

Centroid distance

Curvature

Area, cumulative angles, ...

Similarity between two shapes: difference integrated over $t$

Images: A. Zweng;  Zhang and Lu
Shape signatures

Cope with challenges
+ invariance to translation
+ invariance to scale (if normalize shape beforehand)
+ invariance to rotation (for tangent angle need orientation normalization)
+ point correspondences (if solve for alignment)
* handles shape deformations to some degree

Advantages
+ quite informative
+ deformations affect signature locally

Disadvantages
- where to start? → high matching cost (e.g. DTW)
- sensitive to noise (especially when derivatives involved)

Images: S. Manay
Shape Contexts

Belongie et al. PAMI 2002

What points on these two sampled contours are most similar? How do you know?
Shape context descriptor

Count the number of points inside each bin, e.g.:

Count = 4

... 

Count = 10

Compact representation of distribution of points relative to each point

Slide: Grauman / Belongie
Shape context descriptor
Comparing shape contexts

$C_{ij} = \frac{1}{2} \sum_{k=1}^{K} \left[ \frac{h_i(k) - h_j(k)}{h_i(k) + h_j(k)} \right]^2$

Recover correspondences by solving for least cost assignment, using costs $C_{ij}$ (e.g. by the Hungarian algorithm)

Slide edited from: Grauman / Belongie
Shape Signature Discussion

Shape Signatures cope with challenges
+ invariance to translation
+ invariance to scale (if normalize shape beforehand)
- no invariance to rotation (but could be added)
+ some point correspondences
+ handles some shape deformations

Advantages
+ informative: describe points in the context of overall shape
+ deformations handled well: descriptor more sensitive near a point than far from it

Disadvantages
- many parameters (# and size of bins, # iterations, etc.)
- computationally expensive (especially with iterations)
Lecture Overview

- Method for describing and matching complex shapes
- Doesn’t need segmentation
- Based on local point distributions
- Computationally expensive
Further readings

*Rothwell et al. ECCV 1992*, Canonical frames
(+ historical relevance)

*Manay and Soatto ECCV 2004*, Integral Signatures
(+ avoid derivative noise)

*Ling and Jacobs PAMI 2007*, Inner distance
(+ articulations)

*Felzenszwalb and Schwartz CVPR 2007*, Hierarchical shape models
(+ excellent on the MPEG-7)