Computer Vision - Exercise 3

Segmentation and Grouping

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**Master/Diploma Thesis**

**Topic:** Estimation of Human Pose and Motion using Nonparametric Belief Propagation

**Requirements**
1. Strong mathematical background
2. Knowledge in Computer Vision
3. Knowledge in Machine Learning
4. Programming experience in C++/Matlab

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Recap: Recognition Using Histograms

- Histogram comparison

Test image

Known objects
Recap: Comparison Measures

- Vector space interpretation
  - Euclidean distance

- Statistical motivation
  - Chi-square
  - Bhattacharyya

- Information-theoretic motivation
  - Kullback-Leibler divergence, Jeffreys divergence

- Histogram motivation
  - Histogram intersection

- Ground distance
  - Earth Movers Distance (EMD)
Recap: Recognition Using Histograms

• Simple algorithm
  1. Build a set of histograms $H=\{h_i\}$ for each known object
     ➢ More exactly, for each view of each object
  2. Build a histogram $h_t$ for the test image.
  3. Compare $h_t$ to each $h_i \in H$
     ➢ Using a suitable comparison measure
  4. Select the object with the best matching score
     ➢ Or reject the test image if no object is similar enough.

“Nearest-Neighbor” strategy
Recap: Mean-Shift Segmentation

- An advanced and versatile technique for clustering-based segmentation

<table>
<thead>
<tr>
<th>Segmented &quot;landscape 1&quot;</th>
<th>Segmented &quot;landscape 2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Segmented Landscape 1" /></td>
<td><img src="image2" alt="Segmented Landscape 2" /></td>
</tr>
</tbody>
</table>

http://www.caip.rutgers.edu/~comanici/MSPAMI/msPamiResults.html


Slide credit: Svetlana Lazebnik
Recap: Mean-Shift Algorithm

- **Iterative Mode Search**
  1. Initialize random seed, and window W
  2. Calculate center of gravity (the “mean”) of W: \[ \sum_{x \in W} x H(x) \]
  3. Shift the search window to the mean
  4. Repeat Step 2 until convergence
Mean-Shift

Region of interest
Center of mass
Mean Shift vector

Slide by Y. Ukrainitz & B. Sarel
Mean-Shift

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Mean-Shift

Region of interest

Center of mass
Real Modality Analysis

Tessellate the space with windows

Run the procedure in parallel

Slide by Y. Ukrainitz & B. Sarel
The blue data points were traversed by the windows towards the mode.
Mean-Shift Clustering

- Cluster: all data points in the attraction basin of a mode
- Attraction basin: the region for which all trajectories lead to the same mode
Mean-Shift Clustering/Segmentation

- Find features (color, gradients, texture, etc)
- Initialize windows at individual pixel locations
- Perform mean shift for each window until convergence
- Merge windows that end up near the same “peak” or mode

Slide credit: Svetlana Lazebnik
Mean-Shift Segmentation Results

http://www.caip.rutgers.edu/~comanici/MSPAMI/msPamiResults.html

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