Small project in the course
Fuzzy sets and fuzzy techniques

Fuzzy Timber

Kristin Norell

8 of March 2007
Motivation

- I use a grey level image as a cost function in a distance transform. Can it be improved using fuzzy techniques?
- The images are not ideal for thresholding, but is it possible to get a usable cost image by *fuzzy thresholding* and *fuzzy morphology*?

To do

1. Try to cluster the pixels in RGB-space to perform a fuzzy thresholding.
2. Apply fuzzy morphology on the result to “improve” it.
3. Apply the grey weighted polar distance transform on the fuzzy image.
Figure: A part of an image and a scatter plot of the intensity values in RGB-space.
crisp vs fuzzy c-means

crisp c-means: Cluster the $n$ data points into $g$ different clusters by minimizing the distance between the data points and the center of the cluster.

$$J = \sum_{i=1}^{n} \sum_{j=1}^{g} |x_i - c_j|^2$$

fuzzy c-means:

$$J_r = \sum_{i=1}^{n} \sum_{j=1}^{g} y_{ji} |x_i - c_j|^2$$

$$y_{ji} = \frac{1}{\sum_{k=1}^{g} \left( \frac{|x_i - c_j|}{|x_i - c_k|} \right)^{r-1}}$$
Thresholding

The crisp and the fuzzy clustering give approximately the same cluster centers:

\[
c = \begin{bmatrix}
202.9944 & 219.9061 \\
177.8469 & 201.6841 \\
150.9165 & 177.6348
\end{bmatrix} \quad c = \begin{bmatrix}
203.3558 & 219.4919 \\
178.3370 & 201.1685 \\
151.4840 & 177.0192
\end{bmatrix}
\]

Figure: Crisp

Figure: Fuzzy, \( r = 3, g = 2 \)
Definitions of erosion and dilation

**t-norm:** \( \max(0, x + y - 1) \)

**t-conorm:** \( \min(1, x + y) \)

**Definition**

\[
D_\nu(\mu)(x) = \sup_{y \in S} \max[0, \mu(y) + \nu(y - x) - 1] \tag{1}
\]

\[
E_\nu(\mu)(x) = \inf_{y \in S} \min[1, 1 + \mu(y) - \nu(y - x)] \tag{2}
\]
Results

(a) Dilation

(b) Erosion

(c) Closing

(d) Opening
Grey weighted polar distance transform

(e) Closed image
(f) Grey level image
Grey weighted polar distance transform

(g) Closed image  (h) Squared grey level image.
Questions

- I have a question... If I find a threshold using Huang Wangs membership function and minimization of entropy, how can I perform a fuzzy thresholding?

Figure: A log end and the entropy.

- How about you? Any questions?