Fuzzy Image Processing and Machine Vision Applications

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Image Processing and Machine Vision

- Gray tone images posses ambiguity within each pixel: multivalued levels of brightness
- degree of brightness
- regions, features, primitives, properties, etc. that are not crisply defined are (maybe) fuzzy sets.
- topological concepts of connectedness, adjacency, surroundness, convexity, area, perimeter, compactness, height, width, extent, diameter, length, breadth, area coverage, density, major (minor) axis, etc.

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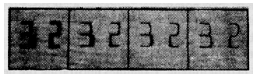
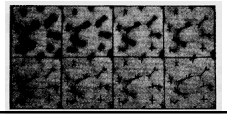
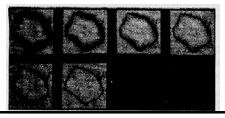
Image Enhancement (Pal & Rosenfeld, 1986)

Recall contrast intensifier
brightness is adjusted accordingly
neighbors of points are smoothed using:
- averaging
- defocussing
- max-min rule







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Color Image Segmentation (Lim & Lee, 1990)

- Segmentation groups an image into units that are homogenous wrt some characteristics
- Where specific object colors are not known in advance, clustering techniques can be used
- Colors tend to form clusters in the histogram, one for each object in the image
- Coarse segmentation first
  then fine segmentation for pixels which cannot be grouped into any region

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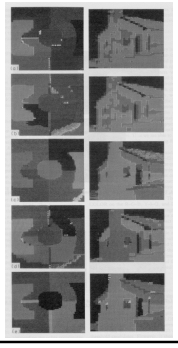
Lim & Lee Example



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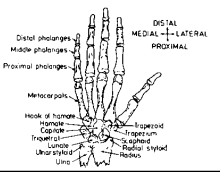
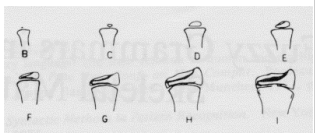
Syntactic Recognition of Skeletal Maturity from X-Rays (Pathak & Pal, 1986)

- Interpret the structural development of epiphysis and metaphysis of a child
  - extract edges from X-ray
  - extract primitives (dot, line, arc)
  - classify into stages of skeletal maturity





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Representation of Uncertainty in Computer Vision (Huntsberger et al., 1986)

Identification of attributes has associated uncertainty

Low level portion returns image segmentation based on clustering in image color space using c-means.

Steps:

- Color Image Segmentation
- Color Edge Detection
- Shape Representation
- Interpretation of Shapes

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Color Image Segmentation & Edge Detection

•Color Image Segmentation
- Similarity between pixels are encoded as cluster centers which represent global color characteristics using fuzzy c-means
- Feature space is RGB color
- Regions are expressed as fuzzy sets
- Texture incorporation: future work

•Color Edge Detection
- Behavior of fuzzy membership in the transition between color region
- Use information about relative homogeneity of colors within regions and mixing of colors across the digitized transitions between regions

$$HOMOG_k(\mu_i, \mu_k) = \mu_i - \mu_k$$

- where
- μ_i and μ_j are membership values associated with pixel k to sets i and j
- Spatial location determined by zero crossings

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Shape Representation

•Need to understand interrelationships between regions

•Link edges or grow regions based on connectivity

•Due to noise, occlusion, degradation during digitization, etc. there are irregularities and spurious contents in the region boundaries
- corners where there are none
- miss corners which ought to be there

•Comparison to Models
- shape rarely matches models in data base
- fuzzy membership for approximate rectangle trapezoid-like, etc.

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Reference(s)

Fuzzy Models for Pattern Recognition, Bezdek & Pal, eds., 1992.

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