74.795 Local Vision: Edge Detection

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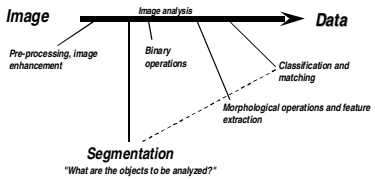
Segmentation



Segmentation

- *Full segmentation:* Individual objects are separated from the background and given individual ID numbers (labels).
- *Partial segmentation:* The amount of data is reduced (usually by separating objects from background) to speed up the further processing.
- Segmentation is often the most difficult problem to solve in the process; there is no universal solution!
- The problem can be made much easier if solved in cooperation with the constructor of the imaging system (choice of sensors, illumination, background etc) .

Three Types of Segmentation

- *Classification* – Based on some similarity measure between pixel values. The simplest form is thresholding.
- *Edge-based* – Search for edges in the image. They are then used as borders between regions
- *Region-based* – Region growing, merge & split

Common idea: search for discontinuities or/and similitudes in the image

Thresholding (Global and Local)

- Global: based on some kind of histogram: grey-level, edge, feature etc.
  - Lighting conditions are extremely important, and it will only work under very controlled circumstances.
- Fixed thresholds: the same value is used in the whole image
- Local (or dynamic thresholding): depends on the position in the image. The image is divided into overlapping sections which are thresholded one by one.

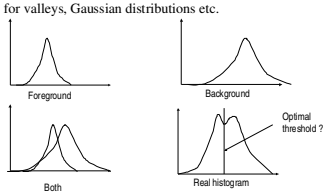
Classical Automatic Thresholding Algorithm

1. Select an initial estimate for T
2. Segment the image using T. This produces 2 groups: G_1 , pixels with value >T and G_2 , with value <T
3. Compute μ_1 and μ_2, average pixel value of G_1 and G_2
4. New threshold: $T=1/2(\mu_1+\mu_2)$
5. Repeat steps 2 to 4 until T stabilizes.

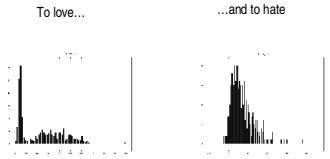
- ► Very easy + very fast
- ► Assumptions: normal dist. + low noise

Optimal Thresholding

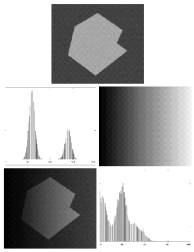
- Based on the shape of the current image histogram. Search for valleys, Gaussian distributions etc.



Histograms

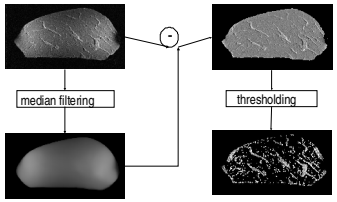


Thresholding and illumination



- Solutions:
  - Calibration of the imaging system
  - Percentile filter with very large mask
  - Morphological operators

MR non-uniformity



More thresholding

- Can also be used on other kinds of histogram: grey-level, edge, feature etc.

  Multivariate data (⇒ see next lectures)

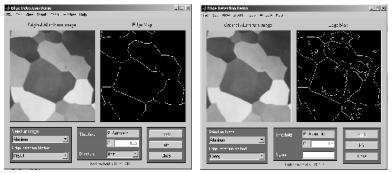
- Problems:
  - Only considers the graylevel pixel value, so it can leave "holes" in segmented objects.
    - Solution: post-processing with morphological operators
  - Requires strong assumptions to be efficient
  - Local thresholding is better ⇒ see region growing techniques

Edge-based Segmentation

Based on finding discontinuities (local variations of image intensity)

3. Apply an edge detector
   ex gradient operator (Sobel)
   second derivative (Laplace)
4. Threshold the edge image to get a binary image
5. Depending on the type of edge detector:
   - Link edges together to close shapes (using edge direction for example)
   - Remove spurious edges

Edge-based Segmentation: examples



Prewitt: needs edge linking

Canny: needs "cleaning"

Region based segmentation

- Work by extending some region based on local similarities between pixels
  - region growing (bottom-up method)
  - region splitting and merging (top-down method)

➢ Bottom-up: from data to representation

➢ Top-down: from model to data

Region growing: Bottom Up Method

1. Find starting points

3. Include neighbouring pixels with similar features (grey-level, texture, color).

5. Continue untill all pixels have been included with one of the starting points.

► Problems:
- Not trivial to find good starting points, difficult to automate
- Need good criteria for similarity.