Lab 11

Basic Image Processing Algorithms
Fall 2016

Assignments

- assignment-points:
  - required minimum level: 50 points
  - necessary condition to Offered Final Grade: 80 points
- Assignment3:
  - will be published today,
  - 20 points,
  - deadline 23:59, 08/December/2016 (Thursday midnight)
- Assignment4:
  - will be published today,
  - 40 points,
  - deadline 18:00, 15/December/2016 (Thursday evening)
- Assignment5:
  - will be published tomorrow (Friday),
  - 10 points,
  - deadline 23:59, 11/December/2016 (Sunday evening)
- Assignment6:
  - will be published Sunday (04/12/2016),
  - 30 (or 40) points,
  - deadline 18:00, 15/December/2016 (Thursday evening)

Lab practices

- today: last regular lab-practice
- next week: 08/December is holiday at our University
- 15/December: optional consultation if you have any question either with Assignment 4 or with Assignment 6
  be careful: 18:00 on 15/December is the deadline for those exercises

Lab 11: still image segmentation

- with Otsu's method
- with MATLAB's built-in **`multithresh`** and **`imquantize`**
- deadline (if you do not finish until the end of the lab): 23:59, 08/12/2016;
  please send it to: bipa2016fall@gmail.com
  with the subject: LAB11
  please send only a script

Intensity Level Based Segmentation

- Otsu's method:
  - Automatically determines the optimal global threshold by minimizing the intra-class variance.
  - The intra-class variance is defined as follows:

$$\sigma_w^2(k) = \omega_1(k)\sigma_1^2(k) + \omega_2(k)\sigma_2^2(k)$$

where ω_i and σ_i are the probability and the variance of the two classes separated by the threshold k.

  - Otsu showed that ***minimizing the intra-class variance is the same as maximizing inter-class variance***:

$$\sigma_b^2(k) = \sigma^2 - \sigma_w^2(k) = \omega_1(k)\omega_2(k)(\mu_1(k) - \mu_2(k))^2$$

where μ_i are the means of the two classes separated by threshold k.

Nobuyuki Otsu (1979). "A threshold selection method from gray-level histograms". *IEEE Trans. Sys., Man., Cyber.* **9** (1): 62–66.

Intensity Level Based Segmentation

- Otsu's method:

$$\sigma_b^2(k) = \sigma^2 - \sigma_w^2(k) = \omega_1(k)\omega_2(k)(\mu_1(k) - \mu_2(k))^2$$

  - To calculate ω_i and μ_i the normalized histogram of the image is used:

$$\omega_1(k) = \sum_{i=0}^{k} p_i \qquad \omega_2(k) = \sum_{i=k+1}^{L-1} p_i$$

$$\mu_1(k) = \left(\sum_{i=0}^{k} i p_i \right) \Big/ \omega_1 \qquad \mu_2(k) = \left(\sum_{i=k+1}^{L-1} i p_i \right) \Big/ \omega_2$$

where p_i is the *i*-th entry in the normalized histogram of the image (probability of the *i*-th intensity level).

The Otsu threshold is the value that maximizes the inter-class variance.

* Nobuyuki Otsu (1979). "A threshold selection method from gray-level histograms". *IEEE Trans. Sys., Man., Cyber.* **9** (1): 62–66.

Exercises

Implement in a script:

- the original, two-class segmentation method of Otsu;
- try multi-class segmentation with the MATLAB built-in methods **`multithresh`** and **`imquantize`**;
- please use the example image **`fox.jpg`**.

original

standard Otsu method, Otsu th: 168

the built-in multithresh with 4 threshold-levels