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FACULTY OF EGINEERING

Digital Image Processing
LECTURE-35

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OUTLINE

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Greylevel thresholding

This simple threshold test begs the obvious question how do we determine the threshold ?

Many approaches possible

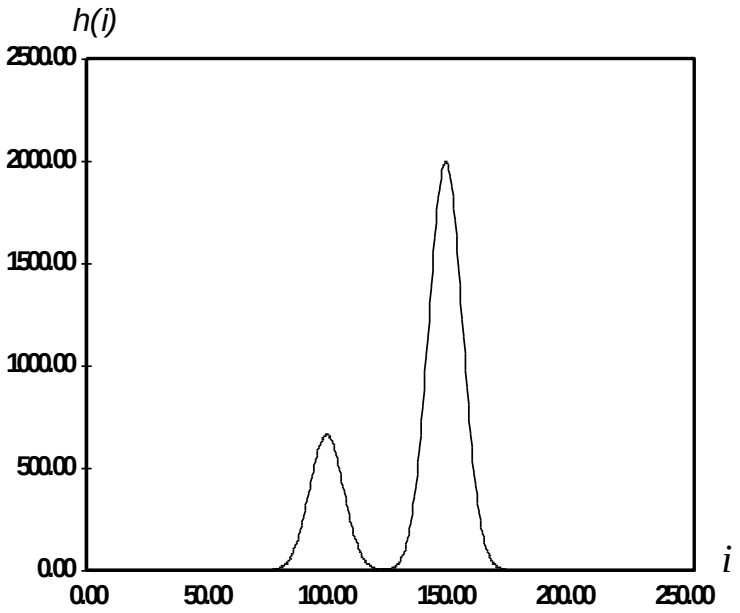
- Interactive threshold
- Adaptive threshold
- Minimisation method

We will consider in detail a minimisation method for determining the threshold

- Minimisation of the within group variance
- Robot Vision, Haralick & Shapiro, volume 1, page 20

Greylevel thresholding

•Idealized object/background image histogram



Greylevel thresholding

•Any threshold separates the histogram into 2 groups with each group having its own statistics (mean, variance)

• The homogeneity of each group is measured by the within group variance

•The optimum threshold is that threshold which minimizes the within group variance thus maximizing the homogeneity of each group

•Let group o (object) be those pixels with greylevel <=T

•Let group b (background) be those pixels with greylevel >T

•The prior probability of group o is po(T)

•The prior probability of group b is pb(T)

Greylevel thresholding

The following expressions can easily be derived for prior probabilities of object and background

$$p_o(T) = \sum_{i=0}^{T} P(i)$$

$$p_b(T) = \sum_{i=T+1}^{255} P(i)$$

$$P(i) = h(i) / N$$

where *h(i)* is the histogram of an N pixel image

Greylevel thresholding

The mean and variance of each group are as follows :

$$\mu_o(T) = \sum_{i=0}^{T} iP(i) / p_o(T)$$

$$\mu_b(T) = \sum_{i=T+1}^{255} iP(i) / p_b(T)$$

$$\sigma_o^2(T) = \sum_{i=0}^{T} [i - \mu_o(T)]^2 P(i) / p_o(T)$$

$$\sigma_b^2(T) = \sum_{i=T+1}^{255} [i - \mu_b(T)]^2 P(i) / p_b(T)$$

Greylevel thresholding

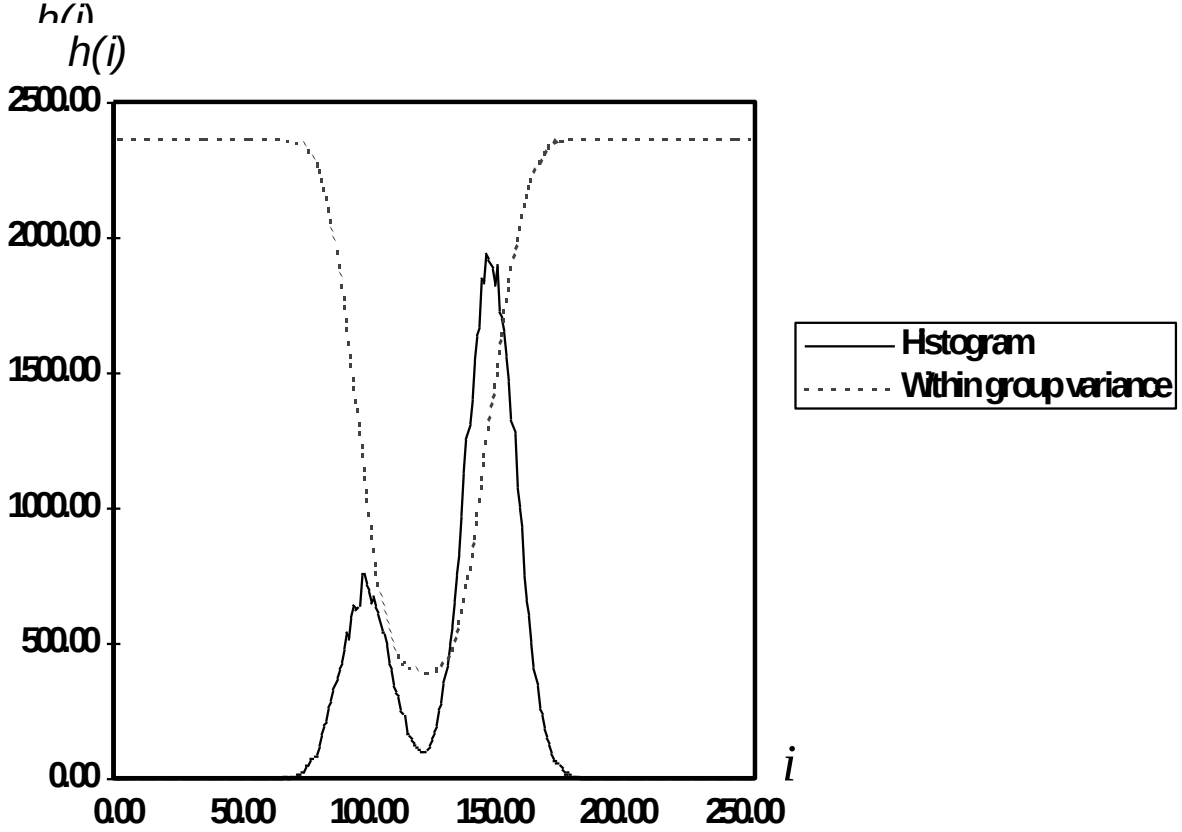
•The within group variance is defined as :

$$\sigma_w^2(T) = \sigma_o^2(T)p_o(T) + \sigma_b^2(T)p_b(T)$$

•We determine the optimum T by minimizing this expression with respect to T

•Only requires 256 comparisons for and 8-bit greylevel image

Greylevel thresholding



MCQ

1. A transformation function of particular importance in image processing is represented in which of the following form?
   a) s=T(r)=∫0 (2r)pr (ω)dω
   b) s=T(r)=∫0 (r-1)pr (ω)dω
   c) s=T(r)=∫0 (r/2)pr (ω)dω
   d) s=T(r)=∫0 pr (ω)dω

2. 2. Histogram equalization or Histogram linearization is represented by of the following equation:
   a) sk =∑k j =1 nj/n k=0,1,2,……,L-1
   b) sk =∑k j =0 nj/n k=0,1,2,……,L-1
   c) sk =∑k j =0 n/nj k=0,1,2,……,L-1
   d) sk =∑k j =n nj/n k=0,1,2,……,L-1

3. What is the method that is used to generate a processed image that have a specified histogram?
   a) Histogram linearization
   b) Histogram equalization
   c) Histogram matching
   d) Histogram processing

MCQ

4. Histograms are the basis for numerous spatial domain processing techniques.

   a) True

   b) False

5. In a dark image, the components of histogram are concentrated on which side of the grey scale?

   a) High

   b) Medium

   c) Low

   d) Evenly distributed

References

•Dr. Mike Spann m.spann@bham.ac.uk http://www.eee.bham.ac.uk/spannm

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▪Digital Image Processing 2nd Edition, Rafael C. Gonzalvez and Richard E. Woods. Published by: Pearson Education.

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▪ Fundamentals of Digital Image Processing, A.K. Jain. Published by Prentice Hall,Upper Saddle River, NJ.