1. Introduction

- What is segmentation?

- Three major ways to do.

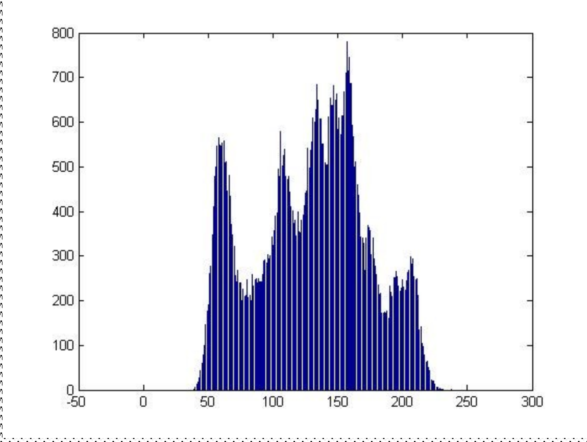
✓ Thresholding

✓ Edge-based segmentation

✓ Region-based segmentation

Thresholding

- Finding histogram of gray level intensity.



- ✓ Basic Global Thresholding
- ✓ Otsu's Method
- ✓ Multiple Threshold
- ✓ Variable Thresholding

Edge-based segmentation

- Using mask to detect edge in image by convolution.

- ✓ Basic Edge Detection
- ✓ The Marr-Hildreth edge detector(LoG)
- ✓ Watersheds

Region-based segmentation

- Finding region, but not finding edge.

✓ Region Growing

2. Thresholding
Basic Global Thresholding

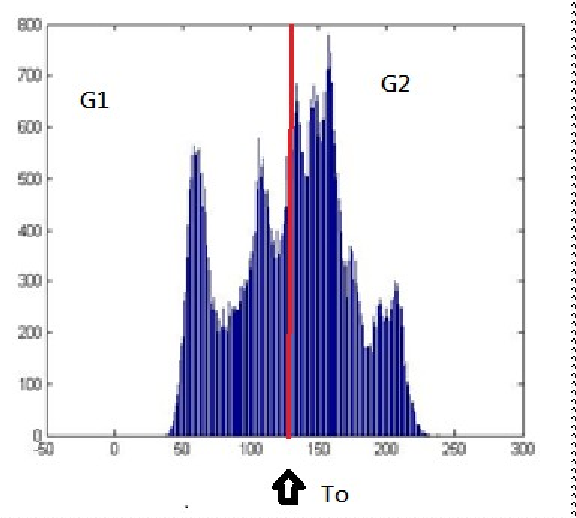
1) Select an initial To
2) Segment image use:

$$g(x,y)=\begin{cases} 1 & \text{if } f(x,y)\geq T \\ 0 & \text{if } f(x,y)\leq T \end{cases}$$

3) Compute the average intensity m_1 and m_2 for the pixels in and .

7) Compute a new threshold: $T=\frac{1}{2}(m_1+m_2)$

8) Until the difference between values of T is smaller than a predefined parameter.



Otsu's Method

- {0,1,2,…,*L*-1} , *L* means gray level intensity
- $MN = n_0 + n_1 + n_2 + \ldots + n_{L-1}$

  *M*N* is the total number of pixel.

  n_i denote the number of pixels with intensity i
- we select a threshold $T(k) = k, 0 < k < L-1$ and use it to classify C_1: intensity in the range $[0, k]$ and C_2: $[k+1, L-1]$
- $P_1(k) = \sum_{i=0}^{k} p_i$ $\quad P_2(k) = \sum_{i=k+1}^{L-1} p_i = 1 - P_1(k)$
- $P_1 m_1 + P_2 m_2 = m_G$ $\quad P_1 + P_2 = 1$
- $\sigma_G^2 = \sum_{i=0}^{L-1} (i - m_G)^2 p_i$ is *global variance.*

- $\sigma_B^2(k) = P_1 P_2 (m_1 - m_2)^2 = \dfrac{(m_G P_1(k) - m(k))^2}{P_1(k)(1 - P_1(k))}$

  it is between-class variance

- $\eta = \dfrac{\sigma_B^2(k)}{\sigma_G^2}$, $0 \le \eta(k^*) \le 1$

  it is a measure of separability between class.

- $\sigma_B^2(k^*) = \max\limits_{o \le k \le L-1} \sigma_B^2(k)$

- $g(x,y) = \begin{cases} 1 & \text{if } f(x,y) \ge k^* \\ 0 & \text{if } f(x,y) \le k^* \end{cases}$

- For x = 0,1,2,...,*M*-1 and y = 0,1,2...,*N*-1.

- U … obal Thre s …

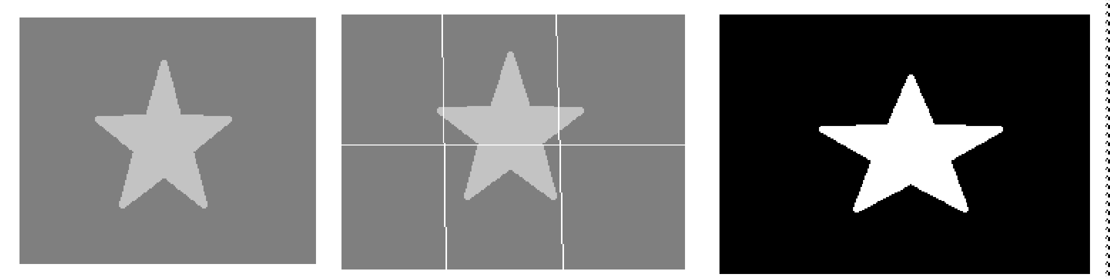
	Smoothing	Edge detection
What situation is more suitable for the method	Large object we are interested.	Small object we are interested

Multiple Threshold

- As Otsu's method, it takes more area and k*
- $\sigma_{\mathrm{B}}^2 = P_1(m_1 - m_G)^2 + P_2(m_2 - m_G)^2 + P_3(m_3 - m_G)^2$
- $P_1 m_1 + P_2 m_2 + P_3 m_3 = m_{\mathrm{G}}$
- $P_1 + P_2 + \mathrm{P}_3 = 1$
- $\sigma_{\mathrm{B}}^2(k_1^*, k_2^*) = \max\limits_{o < k_1 < k_2 < L-1} \sigma_{\mathrm{B}}^2(k_1, k_2)$
- $\eta(k_1^*, k_2^*) = \dfrac{\sigma_{\mathrm{B}}^2(k_1^*, k_2^*)}{\sigma_{\mathrm{G}}^2}$
- Disadvantage: it becomes too complicate when number of ar ea more than three.

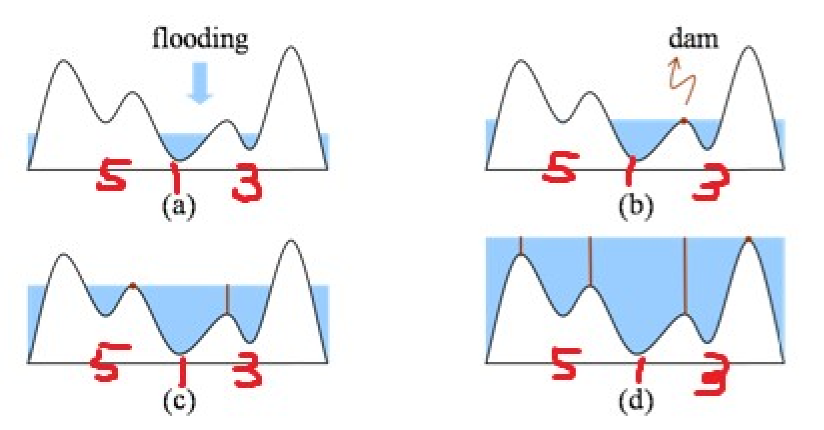
Variable Thresholding

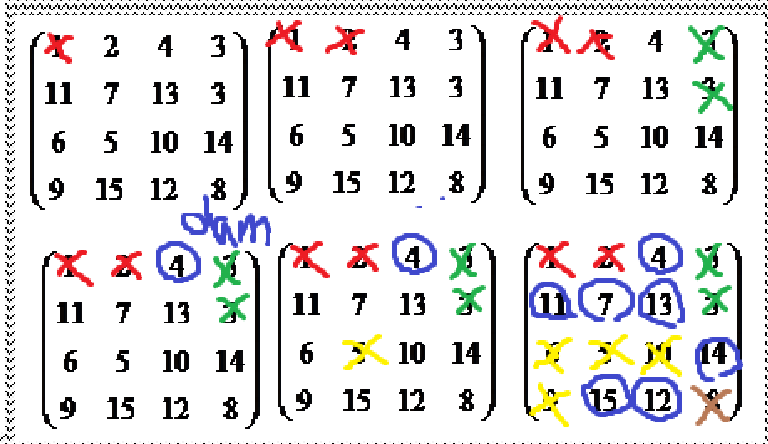
1) **Image partitioning**



- It works when the objects of interest and the background occupy regions of reasonably comparable size. If not , it will fail.

Watersheds

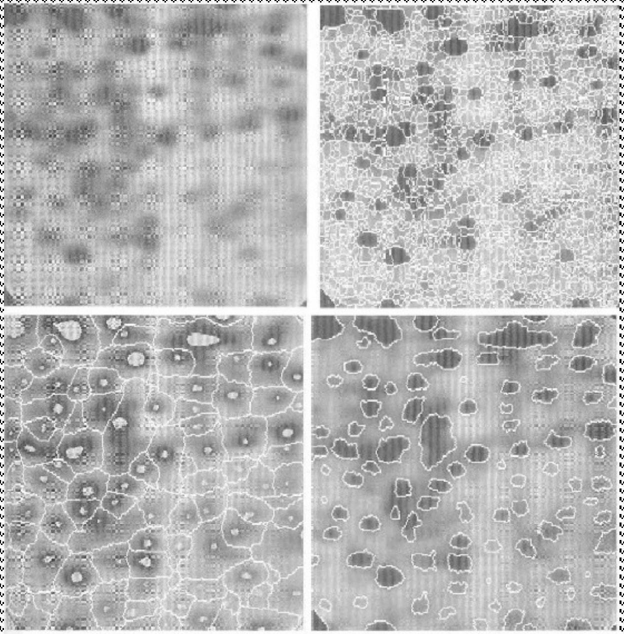




- Algorithm:
- $T[n]=\{(s,t) \mid g(s,t)<n\}$, g(s,*t*) is intensity.

  n= min+1 to n = max +1. And let T[n]=0, others 1.
- $C[n]=\bigcup_{i=1}^{R} C_n(M_i)$, $C_n(M_i)$ is minimum point beneath n.

Markers



- External markers:
- Points along the watershed line along highest points.

- Internal markers:

(1) That is surrounded higher points .

(2) Points in region form a connected component

(3) All points in connected component have the same intensity.

Region-based segmentation
Region Growing

A basic region-growing algorithm based on 8-connectivity may be stated as follows.

1. Find all connected components in $S(x, y)$ and erode each connected component to one pixel; label all such pixels found as 1. All other pixels in S are labeled 0.
2. Form an image f_Q such that, at a pair of coordinates (x, y), let $f_Q(x, y) = 1$ if the input image satisfies the given predicate, Q, at those coordinates; otherwise, let $f_Q(x, y) = 0$.
3. Let g be an image formed by appending to each seed point in S all the 1-valued points in f_Q that are 8-connected to that seed point.
4. Label each connected component in g with a different region label (e.g., $1, 2, 3, \ldots$). This is the segmented image obtained by region growing.

Region-based segmentation
Region Growing

- Algorithm:

a. Choose a random pixels
b. Use 8-connected and threshold to determine
c. Rep lassified.