IMAGE SEGMENTATION

- Image segmentation is dividing an image into its component regions or objects.
- We should stop segmenting an image when objects of interest in an application has been isolated.

- Segmentation algorithms are based on one of the two basic properties of intensity values:-

  Discontinuity:- to partition an image based on abrupt changes in intensity (such as edges).

- Similarity:- to partition an image into regions that are similar according to set of predefined criteria such as thresholding, region growing, region splitting and merging.

THRESHOLDING

- We use a threshold to partition an image into two parts, namely foreground and background. • It is used

to convert gray scale image into binary image and this is done by selecting a single threshold value (T).

- Then all gray level values below T will be classified as black (0) i.e. Background and those above T will be white (1) i.e. objects.

- Thresholding is gray value remapping operation g defined by:-

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

where (x,y)-> gray value

T-> Threshold

g(x,y)-> Threshold image

f(x,y)-> Input image

SEMI-THRESHOLDING

- In this foreground is unchanged and background is set to black.

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

BAND-THRESHOLDING

- A threshold interval D defined by two thresholding values is used instead of a single value T.

$$g(x,y) = \begin{cases} 1, & for\ f(x,y) \in D \\ 0, & otherwise \end{cases}$$

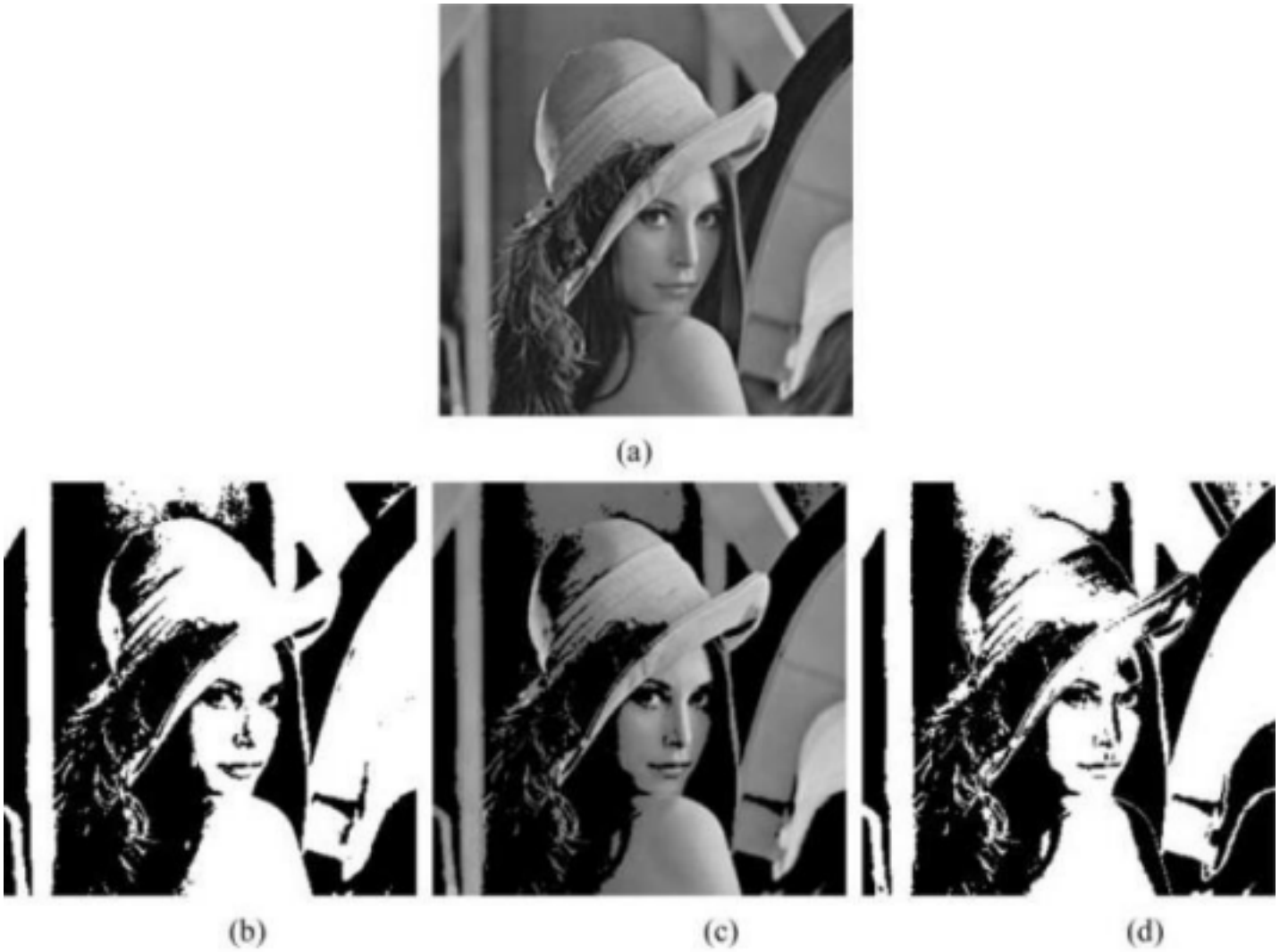

FIGURE 4.1 Basic thresholding segmentation: (a) original image, (b) basic thresholding, (c) semi-thresholding, and (d) band-thresholding.

HISTOGRAM BASED THRESHOLDING

1. The Mode Method

- If an image contains similar grey-level objects that vary from the grey levels of the background, its grey-level histogram consists of two peaks :-

    i. belonging to the objects

    ii. belonging to the background

Such a histogram is called a bi-model.

- The valley between the two peaks- a minimum histogram value that corresponds to the minimal number of pixels

in grey level is selected as a threshold.

2. The Adaptive (Local) Method

• For some images, brightness or the distribution of grey levels of the background may be non uniform. • In this case, mode method does not work and it leads to grey-level histograms with more than two peaks.

- So, we partition the image into several sub images and obtain a threshold for each sub image using the mode method.

OPTIMAL(ITERATIVE) THRESHOLDING

- Initial threshold is set to roughly partition the image into foreground and background.
- The mean value of the average intensity of the foreground and the average intensity of the background is calculated and used as a better approximate threshold.
- It is an iterative process and it continues until no new values of the threshold can be obtained.

FIGURE 4.3 optimal thresholding: (a) original image, and (b) optimal thresholding segmentation (optimal threshold = 115).

Algorithm 4.1: Optimal thresholding segmentation

For the given image $f(i, j)$: $0 \le i \le m-1, 0 \le j \le n-1$

Set an initial threshold $\tau^{(0)}$, e.g., $\tau^{(0)} = \frac{1}{n \times m} \sum_{i,j} f(i,j)$;

Set $k = 0$; $\delta = 0.0001$;

Do

{

Partition the pixels of f into two sets:

$$\Omega_1 = \{(i,j): f(i,j) \ge \tau^{(k)}\};$$

$$\Omega_2 = \{(i,j): f(i,j) < \tau^{(k)}\}$$

Compute the average intensities of two sets:

$$\mu_1 = \frac{1}{|\Omega_1|} \sum_{(i,j) \in \Omega_1} f(i,j)$$

$$\mu_2 = \frac{1}{|\Omega_2|} \sum_{(i,j) \in \Omega_2} f(i,j)$$

where $|\Omega_1|$ and $|\Omega_2|$ denote the number of pixels in Ω_1 and Ω_2, respectively.

Compute the new threshold:

$$\tau^{(k+1)} = \frac{1}{2}(\mu_1 + \mu_2);$$

$$k := k + 1;$$

} until { $\left|\tau^{(k)} - \tau^{(k-1)}\right| < \delta$ }

End-Algorithm