Contents

- Brief introduction to Image segmentation
- Types of Image segmentation
- Region growing and Shrinking (split /merge) method
- Applications of Image segmentation
- Results

Introduction

The shape of an object can be described in terms of:

- Its boundary – requires image edge detection
- The region it occupies – requires image segmentation in homogeneous regions, Image regions generally have homogeneous characteristics (e.g. intensity, texture)

Introduction- cont.d

- The goal of Image Segmentation is to find regions that represent objects or meaningful parts of objects. Major problems of image segmentation are result of noise in the image.
- An image domain X must be segmented in N different regions R(1),….,R(N)
- The segmentation rule is a logical predicate of the form P(R)

Introduction- cont.d

- Image segmentation partitions the set X into the subsets R(i), i=1,…,N having the following properties

$X = {}_{i=1,..N} \cup R(i)$

$R(i) \cap R(j) = 0$ for $I \neq j$

$P(R(i)) = \text{TRUE}$ for $i = 1,2,\dots,N$

$P(R(i) \cup R(j)) = \text{FALSE}$ for $i \neq j$

Introduction- cont.d

- The segmentation result is a logical predicate of the form P(R,x,t)
- x is a feature vector associated with an image pixel
- t is a set of parameters (usually thresholds) A simple segmentation rule has the form:

$$P(R) : I(r,c) < T$$

Introduction- cont.d

- In the case of color images the feature vector x can be three RGB image components {IR(r,c),IG(r,c),IB(r,c)
- A simple segmentation rule may have the form:

P(R,x,t) : (IR(r,c) <T(R)) && (IG(r,c)<T(G))&&
(IB(r,c) < T(B))

Introduction- cont.d

- A region is called connected if : …….
- A pixel (x,y) is said to be adjacent to the pixel (a,b) if it belongs to its immediate neighborhood
- The 4-neighbourhood of a pixel (x,y
- The 8-neighbourhood of (x,y)

Types

- By Histogram Thresholding
- By Region Growing and Shrinking
- By Clustering in the color space

Region Growing

- A simple approach to image segmentation is to start from some pixels (seeds) representing distinct image regions and to grow them, until they cover the entire image
- For region growing we need a rule describing a growth mechanism and a rule checking the homogeneity of the regions after each growth step

Region Growing – cont.d

- The growth mechanism – at each stage k and for each region Ri(k), i = 1,…,N, we check if there are unclassified pixels in the 8-neighbourhood of each pixel of the region border
- Before assigning such a pixel x to a region Ri(k),we check if the region homogeneity:

  P(Ri(k) U {x}) = TRUE , is valid

Region Growing – cont.d

- The arithmetic mean m and standard deviation *sd* of a class Ri having n pixels:

$$M = \frac{1}{n} \sum_{(r,c) \in R(i)} I(r,c)$$

$$s.d. = \sqrt{\frac{1}{n} \sum_{(r,c) \in R(i)} \left(I(r,c) - M\right)^2}$$

Can be used to decide if the merging of the two regions R1,R2 is allowed, if

$|M1 – M2| < (k)s.d(i)$, i = 1, 2 , two regions are merged

Region Growing – cont.d

- Homogeneity test: if the pixel intensity is close to the region mean value

$$|I(r,c) - M(i)| <= T(i)$$

- Threshold Ti varies depending on the region Rn and the intensity of the pixel I(r,c).It can be chosen this way:

$$T(i) = \{ 1 - [s.d(i)/M(i)] \} T$$

Split / Merge

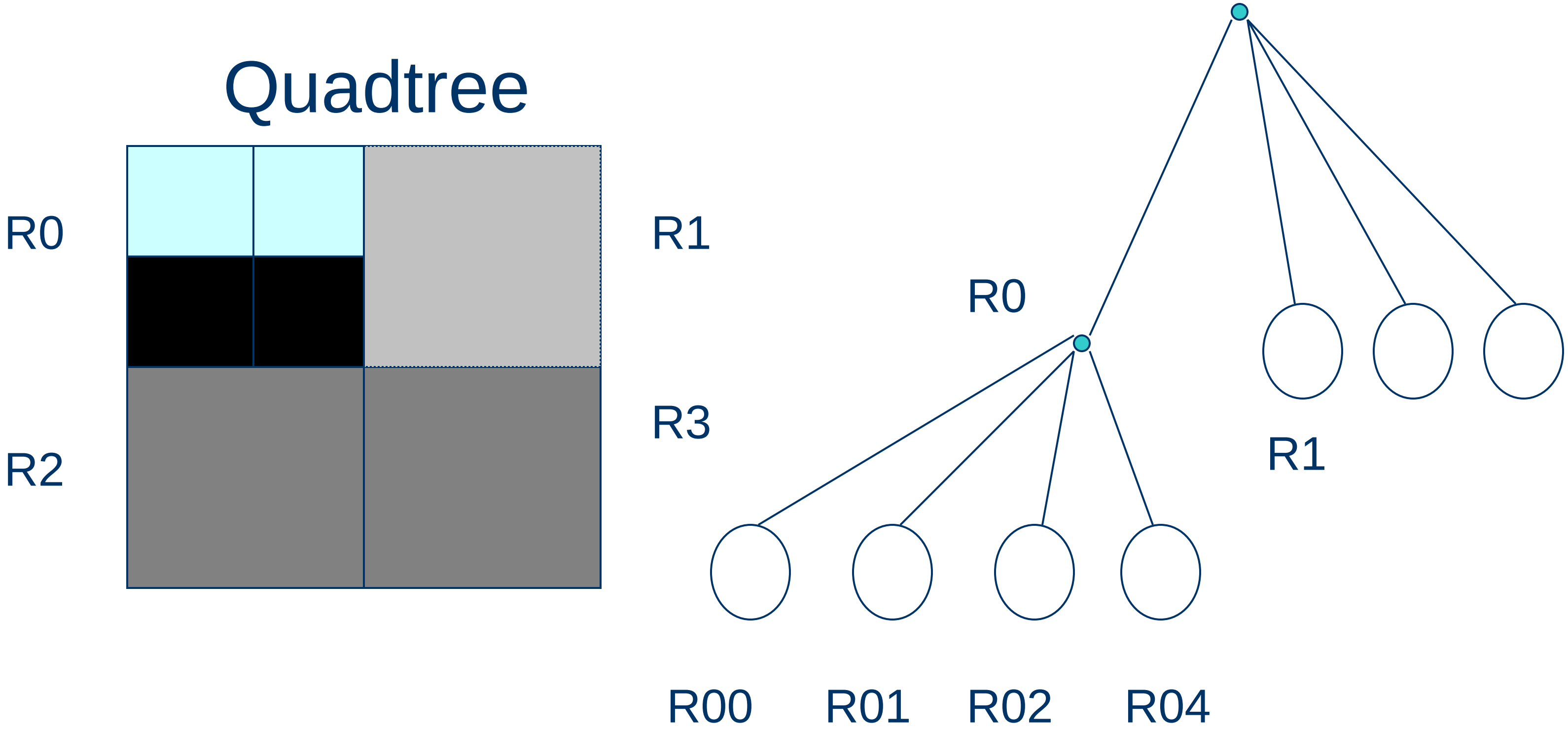
- The opposite approach to region growing is region shrinking (splitting).
- It is a top-down approach and it starts with the assumption that the entire image is homogeneous
- If this is not true , the image is split into four sub images
- This splitting procedure is repeated recursively until we split the image into homogeneous regions

Split / Merge

- If the original image is square N x N, having dimensions that are powers of 2(N = 2n):
- All regions produced but the splitting algorithm are squares having dimensions   M x M , where M is a power of 2 as well (M=2m,M<= n).
- Since the procedure is recursive, it produces an image representation that can be described by a tree whose nodes have four sons each
- Such a tree is called a Quadtree.

Split / Merge

Quadtree



Split / Merge

- Splitting techniques disadvantage, they create regions that may be adjacent and homogeneous, but not merged.
- Split and Merge method – It is an iterative algorithm that includes both splitting and merging at each iteration:

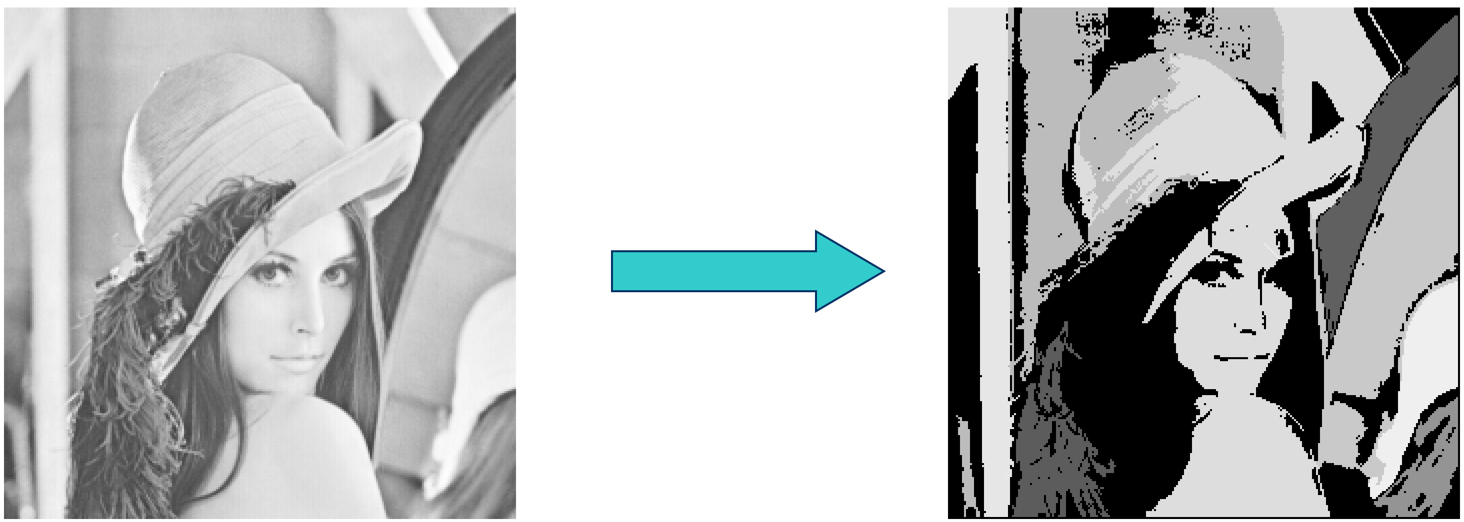
Split / Merge

- If a region R is inhomogeneous (P(R)= False) then is split into four sub regions
- If two adjacent regions Ri,Rj are homogeneous (P(Ri U Rj) = TRUE), they are merged
- The algorithm stops when no further splitting or merging is possible

Split / Merge

- The split and merge algorithm produces more compact regions than the pure splitting algorithm

Results – Region grow



Results – Region growing