Region Growing Segmentation

Region growing is a procedure that groups pixels or sub regions in to layer regions based on predefined criteria. The basic approach is to start with a set of seed points and from there grow regions by appending to each seed these neighboring pixels that have properties similar to the seed.

The objective of segmentation is to partition an image into regions. We approached this problem by finding boundaries between regions based on discontinuities in gray levels, whereas segmentation was accomplished via thresholds based on the distribution of pixel properties, such as gray-level values or color.

Basic Formulation:

The growing continues until a ***stopping rule*** takes effect. The region growing has several practical problems:
how to select the seed points growing rule (or uniform criterion) stopping rule.

Let R represent the entire image region. We may view segmentation as a process that partitions R into n subregions, R1, R 2..., Rn, such that The predicate $P(R_i)$ is used to check the condition. In any region, if $P(R_i)$= true, then image is subdivided into various subimages. If $P(R_i)$ = false, then divide the image into quadrants. If $P(R_i)$ = false, then further divide the quadrants into sub quadrants

Region Growing:

As its name implies, region growing is a procedure that groups pixels or subregions into larger regions based on predefined criteria. The basic approach is to start with a set of "seed" points and from these grow regions by appending to each seed those neighboring pixels that have properties similar to the seed (such as specific ranges of gray level or color). When a priori information is not available, the procedure is to compute at every pixel the same set of properties that ultimately will be used to assign pixels to regions during the growing process. If the result of these computations shows clusters of values, the pixels whose properties place them near the centroid of these clusters can be used as seeds.

The selection of similarity criteria depends not only on the problem under consideration, but also on the type of image data available. For example, the analysis of land-use satellite imagerydepends heavily on the use of color. This problem would be significantly more difficult, or even impossible, to handle without the inherent information available in color images. When the images are monochrome, region analysis must be carried out with a set of descriptors based on gray levels and spatial properties (such as moments or texture).

Basically, growing a region should stop when no more pixels satisfy the criteria for inclusion in that region. Criteria such as gray level, texture, and color, are local in nature and do not take into account the "history" of region growth. Additional criteria that increase the power of a region growing algorithm utilize the concept of size, likeness between a candidate pixel and the pixels grown so far (such as a comparison of the gray level of a candidate and the average gray level of the grown region), and the shape of the region being grown. The use of these types of descriptors is based on the assumption that a model of expected results is at least partially available.

SPLITTING AND MERGING

- The quad tree segmentation is a simple but still powerful tool for image decomposition.
- In this technique , an image is divided into various sub images of disjoint regions and then merge the connected regions together. The procedure just discussed grows regions from a set of seed points. An alternative is to subdivide an image initially into a set of arbitrary, disjointed regions and then merge and/or split the regions in an attempt to satisfy the conditions. A split and merge algorithm that iteratively works toward satisfying these constraints is developed.

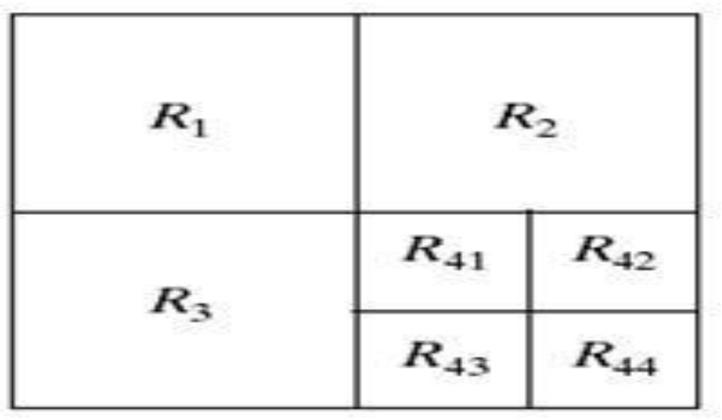
Let R represent the entire image region and select a predicate P. One approach for segmenting R is to subdivide it successively into smaller and smaller quadrant regions so that, for any region Ri, P(Ri) = TRUE. We start with the entire region. If

P(R) = FALSE, we divide the image into quadrants. If P is FALSE for any quadrant, we subdivide that quadrant into sub quadrants, and so on. This particular splitting technique has a convenient representation in the form of a so-called quad tree (that is, a tree in which nodes have exactly four descendants Note that the root of the tree corresponds to the entire image and that each node corresponds to a subdivision. In this case, only R4 was sub divided further.

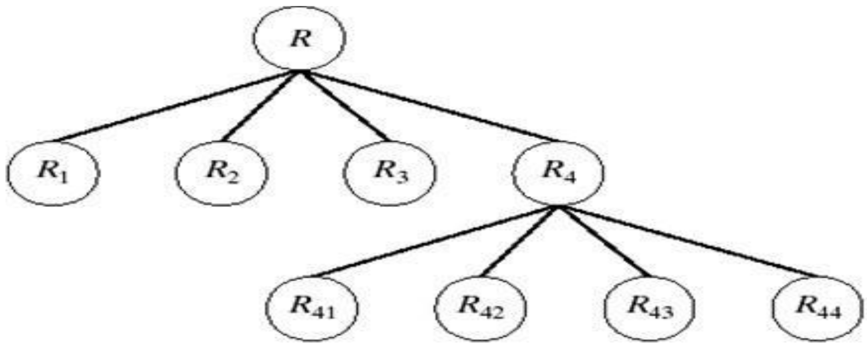
Steps involved in splitting and merging

- Split into 4 disjoint quadrants any region Ri for which P(Ri)=FALSE.
- Merge any adjacent regions R_j and R_k for which $P(R_j U R_k)$=TRUE.
- Stop when no further merging or splitting is possible.

The following shows the partitioned image



(A)



(B)

Fig:4.3.1 (a) Partitioned image. (b) Corresponding quadtree. Represents the entire image region.

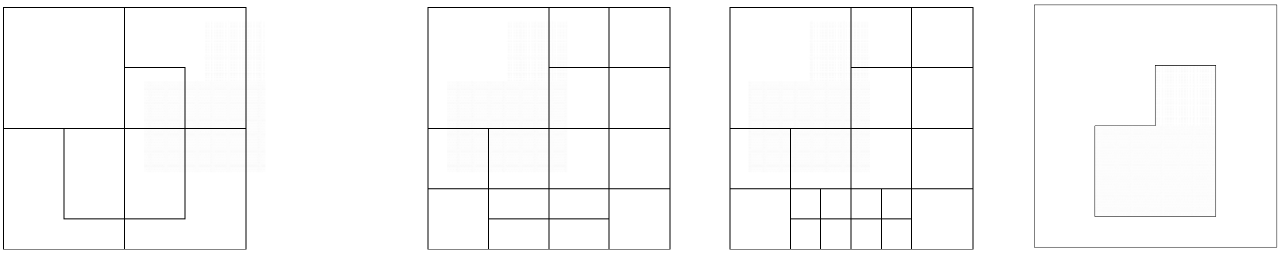
(Source: Rafael C. Gonzalez, Richard E. Woods, ‗Digital Image Processing‘, Pearson, Third Edition, 2010-Page- 767)

An **example of quad tree-based** split and merge is shown below

In the first phase the image is decomposed into four sub blocks (a), which are then further divided, except the top leftmost block (b).

- At the third phase the splitting phase is completed(c).
- At the merging phase the neighboring blocks that are uniform and have the same color are merged together.

The segmentation results to only two regions (d), which is ideal in this favorable example.



(a) (b) (c) (d)

Figure :4.3.2 Example of quad tree based splitting and merging.

(Source: Rafael C. Gonzalez, Richard E. Woods, ‗Digital Image Processing‘, Pearson, Third Edition, 2010.-Page-367)

If only splitting were used, the final partition likely would contain adjacent regions with identical properties. This drawback may be remedied by allowing merging, as well as splitting. Satisfying the constraints, requires merging only adjacent regions whose Several variations of the preceding basic theme are possible. For example, one possibility is to split the image initially into a set of blocks. Further splitting is carried out as described previously, but merging is initially limited to groups of four blocks that are descendants in the quadtree representation and that satisfy the predicate P. When no further mergings of this type are possible, the procedure is terminated by one final merging of regions satisfying step 2. At this point, the merged regions may be of different sizes. The principal advantage of this approach is that it uses the same quadtree for splitting and merging, until the final merging step.