filters

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Image Segmentation

- Group similar components (such as, pixels in an image, image frames in a video) to obtain a compact representation.
- The goal of segmentation :
  - Is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.
- Applications:
  - Finding tumors, veins, etc. in medical images, finding targets in satellite/aerial images, finding people in surveillance images, summarizing video, etc

Segmentation strategy

- Edge-based
  - Assumption: different objects are separated by edges (grey level discontinuities)
  - The segmentation is performed by identifying the grey level gradients
  - The same approach can be extended to color channels

- Region-based
  - Assumption: different objects are separated by other kind of perceptual boundaries –neighborhood features
  - Most often texture-based

    Textures are considered as instantiations of underlying stochastic processes and analyzed under the assumptions that stationarity and ergodicity hold
  - Method

    Region-based features are extracted and used to define “classes”

Region-based methods

- WHAT IS REGION BASED SEGMENTATION?
  - Region-based segmentation is a technique for determining the region directly.
  - Region growing is a simple region-based image segmentation method. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points.
- APPLICATION AND METHOD :
  - Applications-Finding tumors ,veins etc in medical images , finding targets in satellite/aerial images , finding people in surveillance images , summarizing video etc
  - Methods- Thresholding , k-means clustering etc

Region growing filter

- Region growing is a procedure that groups pixels or sub regions into larger regions.
- The simplest of these approaches is pixel aggregation, which starts with a set of “seed” points and from these grows regions by appending to each seed points those neighboring pixels that have similar properties (such as gray level, texture, color, shape).(bottom-up approach)
- Region growing based techniques are better than the edge-based techniques in noisy images where edges are difficult to detect and useful with images which have multi-modal histograms.

THE ADVANTAGES OF REGION GROWING

- Region growing methods can correctly separate the regions that the same properties we define
- Region growing methods can provide the original images which have clear edges with good segmentation results.
- The concept is simple. We only need a small number of seed points to represent the property we want, then grow the region.

THE DISADVANTAGES OF REGION GROWING

- Computationally expensive
- It is a local method with no global view of the problem
- Sensitive to noise.
- Unless the image has had a threshold function applied to it, a continuous path of points related to color may exist which connects any two points in the image.

Watershed segmentation

- The watershed transform is a region based segmentation approach.
- Idea:
  1. Imagine the landscape is being immersed in a lake, with holes pierced in topical minima
  2. The process of filling water is stopped when water reaches the highest peak in the landscape.
  3. This process finally gives a portioned region or basins separated by dams also called watershed lines.
- The watershed transform decomposes an image completely and thus assigns each pixel either to a region or a watershed. With noisy medical image data, a large number of small regions arises. This is known as the “over-segmentation” problem
- Watershed algorithm does not have any parameter.

- The basic steps involved in this algorithm are:
  1. Add neighbors to priority queue, sorted by value.
  2. Choose local minima as region seeds.

  3. Take top priority pixel from queue
     1. If all labeled neighbors have same label, assign to pixel
     2. Add all non-marked neighbors
  4. Repeat step 3 until finished.

Cluster-based segmentation

- Clustering algorithms are used to group closer the data points that are more similar to each other, from other group data points.
- Clustering algorithms are unsupervised algorithms but are similar to Classification algorithms but the basis is different.
- In Clustering, you don't know what you are looking for, and you are trying to identify some segments or clusters in your data. When you use clustering algorithms in your dataset, unexpected things can suddenly pop-up like structures, clusters, and groupings you would have never thought otherwise.

K-means clustering algorithm

- It is an unsupervised algorithm and it is used to segment the interest area from the background.
- It clusters, or partitions the given data into K-clusters or parts based on the K-centroids.
- The algorithm is used when you have unlabeled data(i.e. data without defined categories or groups). The goal is to find certain groups based on some kind of similarity in the data with the number of groups represented by K.
- The objective of K-Means clustering is to minimize the sum of squared distances between all points and the cluster center.
- k-means has only class parameter.

- Steps in K-Means algorithm:
  1. Choose the number of clusters K.
  2. Select at random K points, the centroids(not necessarily from your dataset).
  3. Assign each data point to the closest centroid → that forms K clusters, By calculating the distance between them (Squared Euclidean distance)
  4. Compute and place the new centroid of each cluster.
  5. Reassign each data point to the new closest centroid. If any reassignment . took place, go to step 4, otherwise, the model is ready.
- K-Means Advantages :
  1. If variables are huge, then K-Means most of the times computationally faster than hierarchical clustering, if we keep k smalls.
  2. K-Means produce tighter clusters than hierarchical clustering, especially if the clusters are globular.
- K-Means Disadvantages :
  1. Difficult to predict K-Value.
  2. With global cluster, it didn't work well.
  3. Different initial partitions can result in different final clusters.
  4. It does not work well with clusters (in the original data) of Different size and Different density

Mean shift algorithm

- The Mean Shift segmentation is a local homogenization technique that is very useful for damping shading or tonality differences in localized objects.
- It is a versatile, non-parametric density gradient estimation for mode finding or clustering procedure
- Idea :
  1. For each data point, mean shift defines a window around it and computes the mean of the data point.
  2. Then it shifts the center of the window to the mean and repeats the algorithm till it converges.
  3. After each iteration, we can consider that the window shifts to a more denser region of the dataset.
- Mean-shift algorithm has only one bandwidth parameter

- Advantages:
  - Mean Shift is quite better at clustering as compared to K Means, mainly due to the fact that we don't need to specify the value of 'K', i.e. the number of clusters.
  - Output of mean shift is not dependent on initialization
  - The algorithm only takes one input, the bandwidth of the window
- Disadvantages
  - Mean Shift performs a lot of steps, so it can be computationally expensive, with a time complexity of O(n(squared))
  - The selection of the bandwidth itself can be non-trivial.
  - If the bandwidth is too small, enough data points may be missed, and convergence might never be reached.
  - If the bandwidth is too large, a few clusters may be missed completely.

Connected component labeling

- Connected Component Labeling is used in computer vision using binary images to detect connected regions.
- Connected Component Labeling solves the problem of finding out parts of the image that are connected physically, irrespective of color.
- How It Works?
  - The algorithm makes two passes over the image
    - The first pass to record equivalences and assign temporary labels.
    - The second pass to replace each temporary label by the label of its equivalence class.

- **The First Pass:**
- Each pixel is checked from the top left corner to the bottom right corner moving linearly. If we are considering the pixel p, we will check only the pixel above it and the pixel to the right.
- **Step 1:**
  - The first step involves checking, if we are interested in a pixel or not.
  - We are interested in foreground pixels, which in binary images are represented by a pixel value of 255 (White).
  - If the image is not of interest we simply ignore it and move onto the next step.
- **Step 2:**
  - In this step if we are interested in pixel p. We fetch the labels of the pixels above and to the left of p and store then A and B.
  - The following cases can arise:
    - The pixels above or to the left or both are foreground pixels: Proceed as normal
    - Both are background pixels: In this case, we create a new label and store it in A and B.
- **Step 3:**
  - In this step we figure out which one out of A and B is smaller and assign that value to p.
- **Step 4:**
  - If we have a situation where pixel above p has a label A and the pixel to the left of p has a label B.
  - We know that these pixels are connected as pixel p connects them.
  - Hence we need to store in information that the labels A and B are actually the same.
  - We do this by using the Union-Find Data Structure. We set the larger label as the child of smaller label.
- **Step 5:**
  - Go to the next pixel.
- **The Second Pass:**
- In the second pass the algorithm goes through each pixel again and checks the label of the current pixel.
  - If the label is a 'root' in the Union-Find Data Structure, it goes to the next pixel.
  - If not it follows the links to the parent till it reaches the root after which it assigns that label to the current pixels.