A Review on Evaluative Measures in Image Segmentation

S. Bharathi
Asst. Professor,
SCSVMV University

Abstract

Segmentation techniques are broadly classified in to supervised and un supervised method of segmentation. Human intervention is needed in case of supervised segmentation .clustering techniques such as kmeans ,Fuzzy c means do not require human intervention ,therefore they lie in the category of unsupervised segmentation. Performance analysis is done with the help of evaluative measures. This paper deals with the various evaluative measures of image segmentation.

Introduction:

Image segmentation has to be done on images to obtain interested region from an image. various segmentation techniques are available in the literature to achieve segmentation.otsu's segmentation technique is employed to segment an image based on threshold value. Fuzzy c means clustering techniques are used to achieve segmentation based on membership value of a pixel to its cluster.Intuionistic concepts are blended to FCM to perform segmentation, In Intuionistic FCM hesitation degree is found in addition to membership values of a pixel to a cluster. Morphological segmentation techniques works based on dilation and erosion of an image.Region splitting and merging techniques first splits the image in to very small regions and then joins them if they are of homogeneous nature. Atlas based segmentation technique perform image registration and it has a large database of images.Medical images are obtained through various scans such as PET,MRI,ultrasound etc. Atlas based segmentation has been widely used now a days.the image is contaminated with noise during acquisition of image.noise and Illumination artifacts affects the performance of segmentation methods.In [4] texture image segmentation is carried out using gabor filters.In [8] edge detecting techniques are employed to perform segmentation of image.

Evaluative measures of segmentation:

Segmentation accuracy

It is defined as the ratio of number of correctly classified pixels to the total number of pixels.if segmentation accuracy is high then it can be said that the partitioning of image is rightly done.

$$SA = \frac{Number\ of\ correctly\ classified\ pixels}{Total\ number\ of\ pixels}$$

Jaccard measure (JM):

It is otherwise called as jaccard similarity(JS). Two sets are considered here,pixels of segmentation output is considered as the first set S1 and the pixels of gold stardard image is considered as the second set S2. Jaccard similarity is defined as the ratio of common elements in S1 and S2 to the union of sets S1 and S2.If the value of JS is one then it can be said that the partitioning of image is better and the bias correction is also better.

$$JM = \frac{A_j \cap A_{ref\,j}}{A_j \cup A_{ref\,j}}\ X\ 100\ \%$$

Where A_j indicates the set of pixels lying in the j[th] class and A_{refj} indicates the set of pixels lying in the j[th] class of the reference segmented image.

Dice coefficient:

Two sets are considered here ,pixels of segmentation output is considered as the first set S1 and the pixels of gold stardard image is considered as the second set S2. It is defined as the ratio between intersection of sets S1 and S2 to the addition of sets S1 and S2.

$$k(s_1, s_2) = \frac{2|s_1 \cap s_2|}{|s_1| + |s_2|}$$

Silhouette width:

The average distance between the ith data and other data in the cluster is indicated by the symbol a(i).

The smallest average distance between the ith data and all other data of other clusters is indicated by the symbol b(i).silhouette width of the object i is defined as

$$s(i) = \frac{b(i) - a(i)}{\max \quad b(i)\,, a(i)}$$

Peak signal to noise ratio:

$$psnr = 10 \lg \frac{x_{max}^2}{\left(1/_{(MXN)}\right) \sum_{i=1}^{M} \sum_{j=1}^{N} \left[x(i,j) - y(i,j)\right]^2}$$

Where M and N are the number of rows and number of columns of the image respectively.

Partition coefficient :

If there are c number of clusters and the membership degree of pixels to c different clusters is indicated by the matrix $[U_{ik}]_{CXN}$ then the partition coefficient is defined as follows

$$V_{PC} = \frac{1}{n} \sum_{i=1}^{c} \sum_{k=1}^{n} u_{ik}^2$$

Where n is the number of pixels in an image.

Partition entropy:

If there are c number of clusters and the membership degree of pixels to c different clusters is indicated by the matrix $[U_{ik}]_{CXN}$ then the partition entropy is defined as follows

$$V_{Pe} = -\frac{1}{n} \sum_{i=1}^{c} \sum_{k=1}^{n} (u_{ik} \log u_{ik})$$

Where n is the number of pixels in an image.

Similarity index:

Similarity index for a class takes in to account the matching pixels in gold standard image and in segmentation output.if the matching between gold standard image and segmentation output is more then this index value will be more. This index is defined as follows

$$\rho = \frac{2|X_i + Y_i|}{|X_i| + |Y_i|}$$

Where X_i denotes class i in the gold standard image and Y_i denotes the class i in the segmentation result.

False positive ratio:

This ratio takes into account the presence of undesired pixels of a class.if the segmented part as more desired number of pixels then this index will be less otherwise it will be more. This ratio is defined as follows

$$r_{fp} = \frac{|Y_i| - |X_i \cap Y_i|}{|X_i|}$$

False negative ratio:

This ratio takes into account the absence of desired pixels of a class. if the number of pixels of a class available in the ground truth is unavailable in the segmented part of a class is more than this index will be more. This ratio is defined as follows

$$r_{fn} = \frac{|X_i| - |X_i \cap Y_i|}{|X_i|}$$

Global consistency error:

This error is found by considering that segmentation results are obtained due to the refinement of the other one.In this error all the local refinements are in the same direction as that of the earlier segmentation result. This error is defined as follows

$$GCE(s_1, s_2) = \frac{1}{n} min\left(\sum_i E(s_1, s_2, p_i), \sum_i E(s_2, s_1, p_i)\right)$$

Local consistency error:

In this error all the local refinements are allowed to occur in either direction at different locations during segmentation. This error is defined as follows

$$LCE(s_1, s_2) = \frac{1}{n} \sum_i min\big(E(s_1, s_2, p_i), E(s_2, s_1, p_i)\big)$$

Bidirectional consistency error:

$$BCE(s_1, s_2) = \frac{1}{n} \sum_i max\big(E(s_1, s_2, p_i), E(s_2, s_1, p_i)\big)$$

Conclusion:

This paper specifies the evaluative measures of image segmentation . The segmentation performance is judged by comparing the segmentation results with the gold standard image.These evaluative measure can also be used in data clustering .Images employed for segmentation can be an natural image,synthetic image or medical image.the medical images are obtained through PET ,ultrasound ,CT scan etc.,.MRI images are obtained from brain. Data sets includes Iris dataset,Wine dataset,Zoo data set,cancer dataset,synthetic image dataset.features are obtained from different things and the features are then employed for data clustering.

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