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Classification Based Image Segmentation Approach

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Abstract

Image segmentation is the critical step in the process of object recognition in digital image processing. It segments the overall image into different regions so that their description can be used to identify different objects in an image. The quality of object recognition depends upon the quality of segmentation. This paper proposes a novel approach to segment an image. Unlike traditional approaches which does classification after segmentation, our method repeatedly takes output of classification as the basis for image segmentation.

Keywords

Classification, Segmentation, Digital Image Processing

I. Introduction

In computer vision, segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). 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 [1]. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image .Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).

The traditional processing flow for image-based pattern recognition consists of image segmentation followed by classification. This approach assumes that the segmentation is able to accurately extract the object of interest from the background image autonomously. Note that rather than merely providing a labeling of all regions in the image, the segmentation process must extract the object of interest from the background to support the subsequent feature extraction and object classification processing. The performance of this subsequent processing is strongly dependent on the quality of this initial segmentation. This expectation of ideal segmentation is rather unrealistic in the absence of any contextual information on what object is being extracted from the scene. There are three limitations of existing image segmentation algorithms.

A. Existing segmentation algorithms are built upon the following two common underlying assumptions:

1. The object of interest,"Should be uniform and homogeneous with respect to some characteristic".

2. "Adjacent regions should be differing significantly". These assumptions, however, are rarely met in real-world applications. As Pal and Pal note, "any mathematical algorithm [for segmentation] usually should be supplemented by heuristics which involve semantic information about the class of images under consideration"

B. There are few metrics available for evaluating segmentation algorithms, as noted by Pal and Pal, "the literature is very rich on the methods of segmentation, but not many attempts have been made for the objective evaluation of segmented outputs" Some of the proposed measures of segmentation quality include:

1. Edge-border coincidence
2. Boundary consistency
3. Pixel classification
4. Object overlap
5. Object contrast however, none of these metrics have been widely accepted as ideal, and many require ground truth information. Some recent methods have used multiple hand-segmentations from a number of human experts to define a segmentation quality metric that is really measuring the segmentation consistency This metric would clearly not be appropriate for any real-time application, and also requires a considerable offline effort.

C. The final limitation of existing segmentation algorithms is their "inability to adapt to real-world changes" These changes in the image can be caused by variations in the object itself (i.e., different color or texture), or by variations in the environmental factors, such as the sensor, lighting conditions, and most importantly shadow and highlight bands which cause non uniform changes in the appearance of the objects. Again since the existing methods require homogeneity of the object of interest, any non uniform changes will lead to a violation of the homogeneity assumption. To address these three issues, we introduce a method that depends upon classification for segmenting the image.

II. The Method

Our novel approach to image segmentation is shown below in fig. 1.

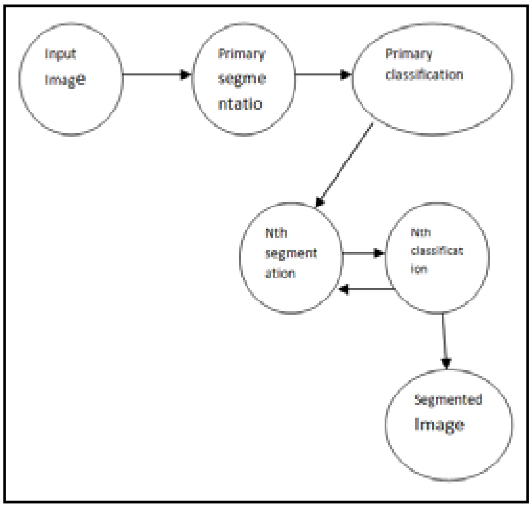

Fig. 1: Novel Segmentation Approach

To explain the process, consider a set 'U' of images that are to be classified. Let 'S' be a set containing a sample of images taken from the set 'U'. For each image in the set 'S', repeat the following steps.

Step1: First the input image is segmented using any of the traditional filters. Now this segmented image is classified. This completes the primary stage of our segmentation process.

Step2: Now the accuracy of the classification is tested with any of the available measures. Let's say that the accuracy of the classification is measured on the scale [0,1]. Let 'a' denotes the accuracy of the classification. We define a threshold 'T' such that

->if a>=T, GO TO step4.(as the classification accuracy fits our intended accuracy)

->Else

->Apply a segmentation method other than the one used before. Suppose a method, say, method-1 is used to segment the image in one of the iterations, it is not used again. A new method "method-I" can be used.

Step3: Iterate step2 with the segmented image.

Step4: Take a note of the method that yielded better classification accuracy with the sample image.

Let 'L' denotes a set containing a list of methods that yielded better classification accuracy for each sample image in the set 'S'. If

S={s1,s2,s3…si} is the set of sample images, then

L={l1,l2,l3,…li} is the set of segmentation methods used to segment the corresponding images in 'S'.

Since the number of segmentation methods in the literature is finite, it is more likely that the set 'L' contains at least one element repeated more than once. We find 'L-average' that contains the segmentation methodthat is common to many of the sample images. This segmentation method can be now used to segment the entire image set 'U'.

The entire method described above can be summarized as follows. A set of images to be segmented are sampled to form a subset of the original set 'U'. Now each image in this subset is segmented with each of the segmentation methods available. The accuracy of the segmentation is tested to see if the method gives best results for the image. In this the best segmentation method that better yields classification accuracy is found for each image in the sample set. Now an average method 'L-average' is taken from this set containing listed segmentation methods for each sample image. This method, when applied to the original set 'U' is likely to yield better results when compared to all other methods. Thus the segmentation method 'L-average' is considered as the method to segment the entire set of images.

III. Analysis

The method just described when applied to a set of images comes out with one segmentation method that can be used to segment the entire set of images. However the following points has to be considered before we apply this method

1. This method is vulnerable to the value of threshold 'T' that we take. 'T' has to be taken optimally so that the algorithm gives best result.
2. The segmentation method generated by this algorithm is likely to give 80%-90% accuracy. This is because, even though the method is proven to be the best among existing, it doesn't imply that it gives good results with every image it is applied to.
3. Sampling is another critical issue. Sampling has to be done in such a way that the generated samples are as diverse as possible in terms of underlying features. Otherwise the resulting segmentation method would only do well with one or two kinds of images. The more diverse the image samples are, the more precise the output would be.

IV. Conclusion

Unlike traditional approach of segmentation followed by classification, this paper introduces a naïve approach in which segmentation depends on the results of classification. This approach tries to find an optimal method to segment the entire set of input images so that the classification accuracy is enhanced. However, the functionality of this proposal depends upon several factors (mentioned above). Future research could be envisaged to improve the process and make it less vulnerable to the factors mentioned.

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