Image Enhancement Using Dynamic Region Merging

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Abstract: ***This paper addresses image enhancement using image segmentation using dynamic region merging algorithm. Image segmentation is typically used to locate objects and boundaries in images. For correct interpretation, image must be partitioned into regions that correspond to objects or parts of an object. We may need image segmentation to separate objects and analyze each object individually to check what it is. Image segmentation usually serves as the pre-processing before image pattern recognition, The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application The segmentation is based on measurements taken from the image like grey level, colour, texture, depth. Image segmentation is performed by iteratively merging the regions according to a statistical test using dynamic region merging algorithm. Starting from a segmented image, neighboring regions are progressively merged if there is an evidence for merging according to this predicate. The consistency of predicate is decided by sequential probability ratio test. Merging of the region follow this consistency and dynamic region merging algorithm. An accelerated algorithm is developed to accelerate the region-merging process, which maintains a nearest neighbor graph in each iteration.***

Keywords: DRM, SPRT, DP, Nearest Neighbour graph

1. Introduction

The purpose of image enhancement is to modify images so that so they will be better to use as input to image analysis. We can modify the images by smoothing, sharpening, segmentation etc. Here we will discuss image segmentation as enhancing technique. Image segmentation is to partition an image into meaningful regions [5] and its iterative merging. Starting from an over segmented image [24], neighbouring regions are progressively merged [5] if there is an evidence for merging according to this predicate. Regions are group of connected pixels with similar properties. Regions are used to interpret images. A region may correspond to a particular object, or different parts of an object. These regions are then merge iteratively using dynamic region merging algorithm. We show that the merging order [2] follows the principle of dynamic programming. The segmentation is based on measurements taken from the image that might be grey level, colour, texture, depth or motion [19]. Usually image segmentation is an initial and vital step in a series of processes aimed at overall image understanding. Segmentation refers to another step in image processing methods where input are images and outputs are attributes extracted from image .It subdivides an image into its constituent regions or objects. Segmentation accuracy determines the eventual success or failure of computerized analysis procedures.

Segmentation algorithms are based on basic properties of intensity values: discontinuity & similarity.

Discontinuity: Approach is to partition image based on abrupt changes in intensities (edges).

Similarity: Approach is to partition the image based on similar regions according to predefined criteria. Application of image segmentation consists of airport security system, object recognition, criminal investigation, computer graphics, medical imaging[20], MPEG-4 video object (VO) segmentation, satellite images (roads, forests, etc.) such target tracking, content-based image retrieval[3] ,and medical image processing.

The applications of image segmentation lie in different aspects of segmentation techniques [6],[7]which are used in disease diagnosis, including localization of tumors and other medical problems, measuring tissue measurement and computer-guided surgery, etc. In remote sensing interpretation image segmentation is being used to locate objects in satellite images (roads, forests, etc.). In order to maintain security, face recognition fingerprint recognition technique can be helpful. On the other hand, traffic control systems, such as brake light detection, is another application of automatic image segmentation in practice. Most recently proposed method for image segmentation is dynamic region merging. In order to cluster the collection of pixels of an image into meaningful groups of regions or objects, the region homogeneity [36] is used as an important segmentation criterion. Many cut criteria in graph theory have been studied for this purpose. The most widely used cut criteria include normalized cut, ratio cut, minimum cut, and so on. The aim of these algorithms is to produce a desirable segmentation by achieving global optimization (Optimal partition)[15],[16] of some cost functions.

2. Literature Survey

Many methods have been developed to segment the color images, many of them are based on the basic two properties. Discontinuity partition and Similarity parameters, In discontinuity based partition sub-division is carried out based on abrupt changes in intensity levels or grey levels of an image, in this method our interest mainly focus on identification of isolated points, lines and edges. In similarity based group those pixels which are similar in some sense, it includes approaches like thresholding [22], region growing, and region splitting and merging. This literature review

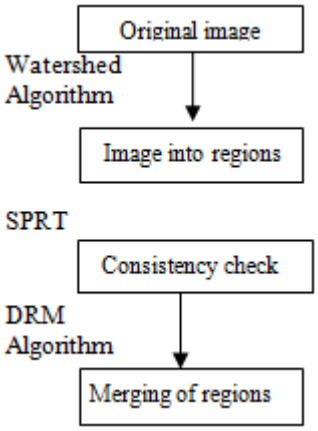
attempts to provide a brief overview of some of the most common segmentation techniques and a comparison between them. It discusses the "Grab-Cut" technique[12], and reviews some of the common matting techniques. The graph cut approaches to segmentation can be extended to 3-D data and can be used for segmenting 3-D volumes. Other segmentation techniques use either contour or edge segmentation to perform segmentation. The graph cut[29] techniques use edge information. The main matting techniques [34] are Poisson matting and probabilistic alpha matting using colour statistics. Poisson matting works on the alpha matte of the image, and is interactive. The statistical approach uses Gaussians to model colour statistics in the image and is not interactive .It is a new innovative segmentation technique that uses a graph-cut[33] approach to minimize an energy function[28],, and in doing so obtain a segmentation of an image. "Grab-Cut" uses a graph to represent an image, and then segments this graph by using a Min-Cut/Max-Flow algorithm. "Grab-Cut"[30] also makes use of a matting technique [34]for regions that do not have clear boundaries. In order to obtain a good grounding in the workings of "Grab-Cut".

1. Image Segmentation and in particular "Grab-Cut", as well as some of the energy minimization techniques [31] that make use of graph-cut. Snakes are also energy minimizing splines that are guided by external constraints and internal constraints, Snakes are so called due to the wriggling motion they undergo while minimizing their energy functions.and are influenced by image forces that pull them towards features like lines and edges[32].They are active in that they lock onto nearby edges.
2. Matting - The different techniques that can be used to pull an alpha matte from an image I segmentation is the process of separating or grouping an image into different parts. These parts are made of something that humans can easily separate and view as individual objects. Computers cannot recognize difference between objects, and so many different methods have been developed in order to segment images. The segmentation process is based on various features [27] found in the image. This might be pixel gray level information that is used to create graphs [39], or information about the pixels that indicate edges or boundaries or texture information.

There are two types of algorithms: the edge detection algorithms [8]-[11] are based on the abrupt changes in image intensity or colour; thus, salient edges can be detected. However, because the resulting edges are often discontinuous or over detected, they can only provide candidates for the object boundaries. Another classical category of segmentation algorithms is based on the similarities among the pixels within a region, namely region-based algorithms. In order to cluster the Collection of pixels of an image into meaningful groups of regions or objects, the region homogeneity is used as an important segmentation criterion. Many cut criteria in graph theory have been studied for this purpose. The most widely used cut criteria include normalized cut [12] , ratio cut[13] , minimum cut [14]homogeneity criteria(cues) are essential to the region-merging process. The proposed predicate can be therefore interpreted as a combination of the consistency measure and the similarity measure. More specifically the extent of consistency tells whether the tested data belong to the same group.

It is measured by two hypotheses according to the sequential probability ratio test (SPRT) [37]: null hypothesis, i.e. "the tested data are consistent," and alternative hypothesis, i.e. "the tested data are inconsistent". We can also make use of probabilistic alpha estimation using colour statistics [30].

3. Flow of system



4. Overview of System

1. Partition the image into regions using watershed algorithm.
2. This partition depends on predicate.
3. We will check consistency of regions.
4. Most consistent regions are merged first and so on.
5. Merging follows dynamic region merging.
6. This process can also be accelerated using nearest neighbour graph.

4.1 Watershed algorithm

The Watershed algorithm [38] is used to separate plane image into regions. The watershed transform can be classified as a region-based segmentation approach. The intuitive idea underlying this method comes from geography: it is that of a landscape or topographic relief which is flooded by water, watersheds being the divide lines of the domains of attraction of rain falling over the region. An alternative approach is to imagine the landscape being immersed in a lake, with holes pierced in local minima. Watershed techniques [38] considered the gradient of an image (GMI) as a topographic surface. Pixels having the highest GMI correspond to watershed lines, which represents region boundaries[23] some positive points of watersheds are by this method segmentation results are unchanged, they do not depend on any limit and secondly the region boundaries are formed naturally out of the process. The boundaries are continuous and there are no gaps. Other method to segment the data is Ostu's method. [21]

4.2 Consistency Property

This property checks if the regions are homogenous. The merging predicate on regions and could be thus "merge and if and only if they are the most similar neighbors in each other's neighborhood, and follow the principle of consistency. Region information is usually presented by the features extracted from the observed data. The choice of features can be gray level, color, texture, and so on. Here we will consider two hypothesis [37] according to sequential probability ratio test.

1. X=X1 if neighboring regions are same, then we merge the regions. It is also called as null hypothesis.
2. X=X2 if neighboring regions are dissimilar. This hypothesis is known as alternative hypotheses.

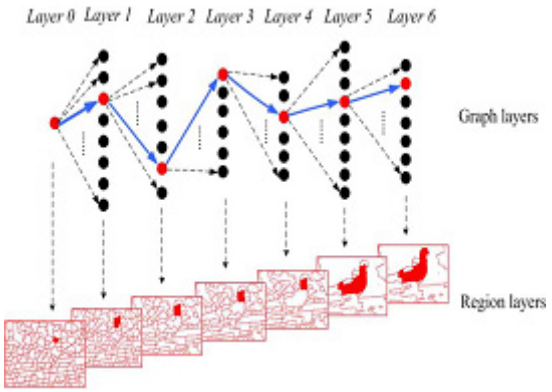
After checking the consistency we follow the dynamic region merging algorithm

4.3 Dynamic Region Merging Algorithm

DRM algorithm is started from a set of segmented regions. This is because a small region can provide more stable statistical information than a single pixel, and using regions for merging can improve a lot the computational efficiency. The algorithm is as follows:

1. Input = initially over segmented image So.
2. Output = region merging result
3. Steps:
4. For given over segmented image assign each region as label.
5. Consider n regions.
6. Assign initial label as L0, likewise final label as Ln.
7. The label of each region is sequentially transited from initial to final.
8. To find optimal sequence of merges which produces optimal merging of all regions we require minimization of objective function Fmin.
9. For this original problem is broken down into sub-problems using dynamic programming [35].
10. For each sub problem calculate the minimum edge weight
11. Obtain the merging result by shortest path algorithm

In the DRM algorithm, there is at least one pair of regions to be merged in each iteration before the stopping criteria is satisfied.



DRM Process

Dynamic region merging process as a shortest path in a layered graph (Upper row) the label transitions of a graph node. (Lower row) The corresponding image regions of each label layer. Starting from layer 0, (in red) the highlighted region obtains a new label from (in red) its closest neighbor. If the region is merged with its neighbor, they will be assigned to the same name of label. The shortest path is shown as the group of (in blue) the directed edges .shortest path algorithm is processed by two algorithms:

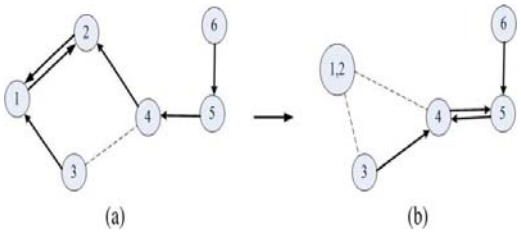
1. Region Adjency Graph
2. Nearest Neighbour Graph

4.4 Region Adjency Graph:

Region Adjacency Graphs are used to represent segmentation data. Each node represents a region. One edge exists between two nodes if the corresponding regions are adjacent.

(1) Form initial regions in the image using thresholding (or a similar approach) followed by component labeling.
(2) Prepare a region adjacency graph (RAG) for the image.
(3) For each region in an image, perform the following steps:
(a) Consider its adjacent region and test to see if they are similar.
(b) For regions that are similar, merge them.
(4) Repeat step 3 until no regions are merged.

DRM performs a scan of the whole graph by which the relations between neighboring regions are identified. If the number of regions to be merged is very large, then time requirement will be very high and the total computational cost in the proposed DRM algorithm will be very high, so we increase the speed of dynamic region merging algorithm by using nearest neighbor graph.



RAG and its NNG

4.5 Nearest Neighbour Graph:

Instead of scanning whole graph only a small portion of RAG edges counts for the merging process, this process is explain below:

(1) Along any directed edge in NNG, the weights are non-increasing.
2) The maximum length of a cycle is two.
3) The NNG contains at least one cycle.
4) The maximum number of cycles is half of number of edges.

5. Advantages of Image Segmentation

- Automatic car assembly in robotic vision
- Airport security systems
- Object recognition
- Criminal investigation

- Computer graphics
- Medical Imaging
- MPEG-4 video object segmentation

6. Future scope

1. The current image segmentation technique can be fully automated in which over-segmentation of the data is done in automated fashion.
2. The speed of combining the regions can be increased by using nearest neighbour graph.
3. We can increase the system efficiency.

7. Alternative to DRM

1. Fuzzy logic: Among the clustering formulations based on minimizing formal objective functions, the most widely used and studied is the K-means(KM)[25],[26] clustering. KM is an exclusive clustering algorithm i.e data which belongs to a definite cluster could not be included in another cluster. This Fuzzy logic is it evolves according to partial differential equation [1] which sometimes can be derived from an energy function[4].
2. Relay Level set method*:* The level set function is defined as the closest distance between the pixels and a given closed curve in an image domain, and the distances of points inside the curve are assigned positive and are negative outside[7],[8].

8. Conclusion

Thus in this paper we studied the image enhancement technique with the help of different algorithms at different stages. We are first separating the plane image into different regions with the help of "Watershed algorithm" and then we check the consistency of regions according to predicate. At last the regions are merged using dynamic region merging algorithm.

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