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IMAGE ENHANCEMENT USING AUTOMATIC SEGMENTATION TECHNIQUES

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ABSTRACT

This paper provides automatic image segmentation using dynamic region merging algorithm. Image segmentation is to partition the image into meaningful regions with respect to particular application. Image segmentation is basically to partition image into certain number of pieces that have coherent features, and again group the meaningful pieces for the convenience of perceiving. Image segmentation usually serves as the pre-processing before image pattern recognition. Initially the image is clustered and oversegmented using K-means and Watershed Algorithm. With an initially oversegmented image in which many regions with homogeneous color are detected, image segmentation is performed by iteratively merging the regions according to novel predicate. Novel predicate is defined by sequential probability ratio test. Also an faster algorithm is developed to accelerate region merging process which maintains nearest neighbour graph in each iteration of merging to produce segmentation which satisfies global properties.

KEYWORDS: DRM, SPRT, DP, Nearest Neighbour graph.

INTRODUCTION

The purpose of image enhancement is to improve the quality of images so that they will be better to use as input to image analysis and processing. 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 and its iterative merging.[1] Starting from an over segmented image, neighbouring regions are progressively merged if there is an possibility for merging according to the 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 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[3],[7]. Usually image segmentation is an initial and vital step in a series of processes aimed at overall image understanding. The goal of segmentation is to simplify the representation of an image into something that is more meaningful and easier to analyze. [12] Image segmentation is typically used to locate objects and boundaries in images. Segmentation refers to another step in image processing methods where input are images and outputs are attributes extracted from image.[19]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, MPEG-4 video object (VO) segmentation, satellite images (roads, forests, etc.) such target tracking, content-based image retrieval ,and medical image processing.[6]

The applications of image segmentation lie in different aspects of segmentation techniques,which are used in disease diagnosis, including localization of tumors and other medical problems, measuring tissue measurement

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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 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), of some cost functions.

LITERATURE SURVEY

Numbers of different segmentation techniques are viewed in the literature, but there is not even a one single method to be considered as a best method for different kind of images, only suitable for one specific type of images. So here the objective is to combine different algorithms to increase the accuracy of system.[21] 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,[9] in this method our interest mainly focus on identification of isolated points, lines and edges.[10] In similarity based group those pixels which are similar in some sense, it includes approaches like thresholding, 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 three distinct methods of segmentation :graph cuts, normalized cuts, and mean shift, and reviews some of the common matting techniques.[13] The graph cut algorithm is quite versatile and aside from image segmentation, it can be easily adapted to solve other problems in computer vision, and related problems in other areas of computer science. Graph cut method provides a probabilistic explanation of the optimal segmentation definition[14] It uses edge information.Normalized cuts also uses a graph model, but it is quite different in nature than the graph cuts technique. The first difference lies in the way this technique defines an optimal segmentation. In normalized cuts we just consider the boundaries, whereas in graph cuts we take into account a regional term and a boundary term.[17] The main matting techniques 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 approach to minimize an energy function, and in doing so obtain a segmentation of an image.[18] “Grab-Cut” uses a graph to represent an image, and then segments this graph by using a Min-Cut/Max-Flow algorithm. “Grab-Cut” also makes use of a matting technique for regions that do not have clear boundaries ,in order to obtain a good grounding.

1. Image Segmentation and in particular “Grab-Cut”, as well as some of the energy minimization techniques 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.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 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 found in the image. This might be pixel gray level information that is used to create graphs, or information about the pixels that indicate edges or boundaries or texture information.

There are two types of algorithms: the edge detection algorithms 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.[21] 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

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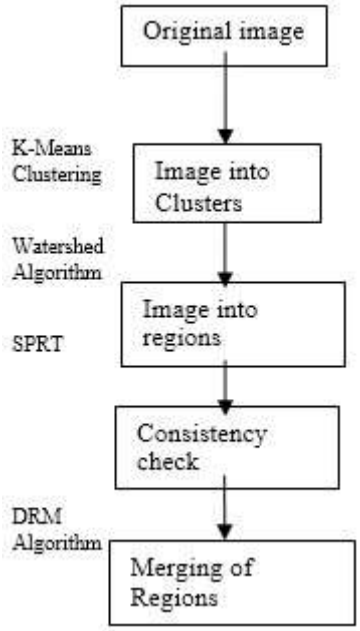
predicate can be therefore interpreted as a combination of the consistency measure and the similarity measure and this consistency tells whether the tested data belong to the same group or not.

It is measured by two hypotheses according to the sequential probability ratio test (SPRT): 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.

FLOW GRAPH OF SYSTEM



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. The speed of this process can also be accelerated using nearest neighbour graph.

K-means Clustering

k-means is one of the simplest learning algorithms that can solve the well-known clustering problem[23].The procedure follows a simple and easy way to classify a given data set through a certain number of clusters.[8] . The main idea is to define k centers, one for each cluster, These centers should be placed in a cunning way because different location causes different result. So, the better choice is to place them as much as possible far away from each other.[40] The next step is to take each point belonging to a given data set and associate it to the nearest center.

Algorithmic steps for k-means clustering

Let $X = \{x_1,x_2,x_3,\ldots\ldots\ldots,x_n\}$ be the set of data points and $V = \{v_1,v_2,\ldots\ldots\ldots,v_c\}$ be the set of centers.

1) Randomly select *'c'* cluster centers.
2) Calculate the distance between each data point and cluster centers.
3) Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers..
4) Recalculate the new cluster center.
5) Recalculate the distance between each data point and new obtained cluster centers.
6) If no data point was reassigned then stop, otherwise repeat from step 3).

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Watershed algorithm

The Watershed algorithm 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.[23],[25] An alternative approach is to imagine the landscape being immersed in a lake, with holes pierced in local minima.

Watershed techniques considered the gradient of an image (GMI) as a topographic surface. Pixels having the highest GMI correspond to watershed lines, which represents region boundaries 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. [38]The boundaries are continuous and there are no gaps.

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.[37] 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 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

Dynamic region merging algorithm:

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

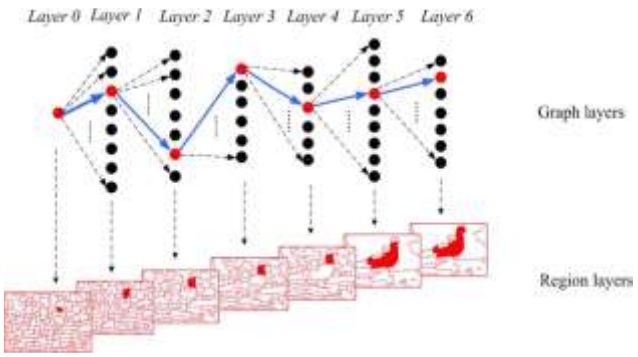

Fig.1 DRM Process

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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.[5][28] The shortest path is shown as the group of (in blue) the directed edges .shortest path algorithm is processed by two algorithms:

1. Region Adjacency Graph
2. Nearest Neighbour Graph

Region Adjacency Graph:

Region Adjacency Graphs are used to represent segmentation data. Each node represents a region.[36] 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.[39] 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.

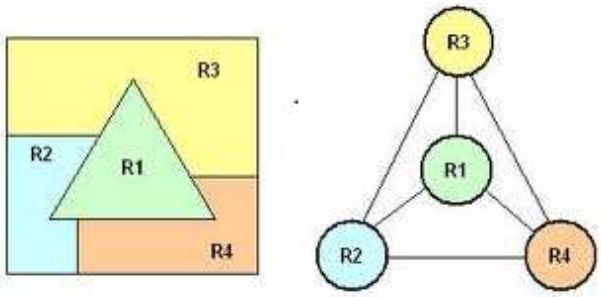

Fig.2 Example of RAG

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.

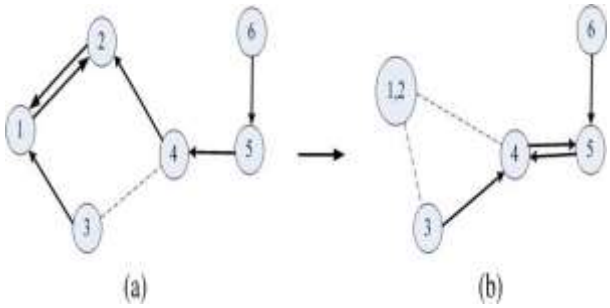

Fig.3RAG and its NNG

The figure demonstrates the stopping criteria for the proposed DRM Algorithm i.e if there is no cycle in NNG,the region merging will stop. So we can keep NNG cycles during the region merging process instead of scaning the

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whole RAG[22]. The original RAG is constructed from oversegmented image and NNG is formed by searching for most similar neighbors of each graph node.The fig.4 shows a comparison between RAG and NNG cycles in different colours at different merging stages.

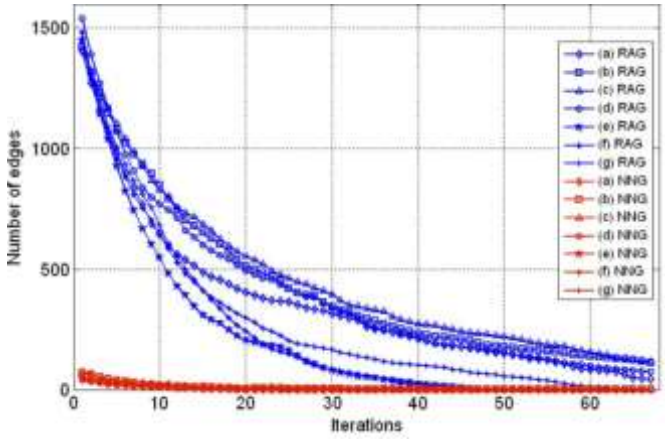

Fig.4 RAG & NNG Cycles at different Merging Stages

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

FUTURE SCOPE

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

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[2] 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].

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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