A Review : Comparative Study of Various Image Segmentation Alogrithms

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Abstract— **In areas such as computer vision and image segmentation, image processing has been and still is a relevant research area due to its wide spread usage and applications, such as image compression or recognition, we cannot process the whole image directly for the reason that it is inefficient. Therefore, several image segmentation algorithms were proposed to segment an image before recognition or compression . Image segmentation is to classify or cluster an image into several parts according to the feature of image.**
According to their segmentation method, we can approximately categorize them into region-based seg-mentation, data clustering, and edge-base segmentation This paper provides a survey on several popular image segmentation algorithms and their segmentation results .

Keywords : Image, Image segmentation , Clustering, Segmentation algorithms,Lossless ,Lossy
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I . INTRODUCTION

Image : Image is a visual representation of person , place or something .Image has been derived from Latin word "imitari "Image are judged by how realistically they capture the person or thing they show .Image comes in various forms like portraits,photographs,painting and sculptures. Images are set of pixels some images are 1 bit or 8 bit and 24 bits color images.1 bit is called as binary bit it represent either 0 or 1 .0 represent black and 1 represent white image .It is also called monochrome image.8 bit gray image each pixel represent gray value it used for display devices .Increase the numbers of bits it increase the memory size. It have 0 to 256 gray level values.24 bit color image. 24 bit color image used for index values from look up table.It include 8 bit Red, 8 bit Green and 8 bit Blue pixels values.

***A. Image Compression*:** Image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form.

Types of Image Compression

***Lossless Compression* :** A Lossless compression algorithms eliminates only redundant information ,so that one can recover the data exactly upon decompression of the file.Lossless data compression without any loss of data quality. various formats PNG,GIF are Lossless. Eg. medical imaging, technical drawings, clip art, or comics [1]

Numerical Example of Lossless :An Example of seven gray pixels

128,127,126,121,124,123,120

Shorter numbers can be re-written because it requiring less bits like

128,-1,-1,-5,+3,-1,-3

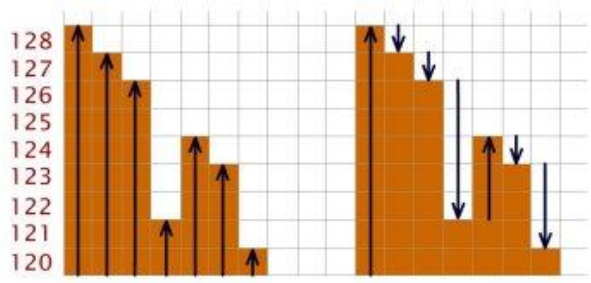


Fig .1 Lossless Method

Lossy Compression: The Lossy Image compression will not preserves the absolute data content of the original image but preserves some specified level of image quality[2]. Lossy Refers to loss of information in mathematics or digital sense and loss of image quality. It used various formats BMP,GIF are lossless and JPEG are lossy used to reduce the original size of the image. Eg. It is suitable for natural images such as photographs

Numerical Example of Lossy :An Example of seven gray pixels

128,127,126,121,124,123,120

Shorter numbers can be re-written because it requiring less bits like

128,-6

After decompression result will be

128,127,126,121,124,122

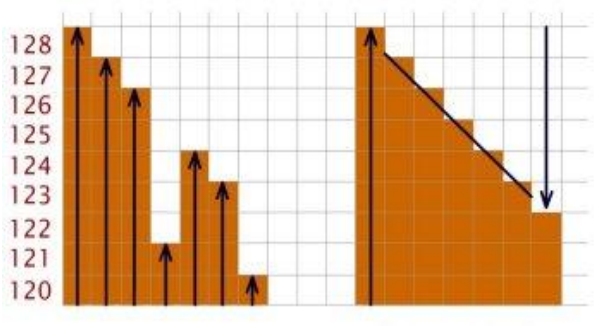


Fig.2 Lossy method

II. IMAGE SEGMENTATION

A. Image Segmentation: Image segmentation is a process in which the given input image is partitiones into object .The key role of segmentation in the mechanical component classification is to extract the boundary of the object from background . The output of the segmentation stage usually consist of either boundary of the region or all the parts in the region itself.The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application [2] . Each Segments have numbers of clusters.

Image segmentation properties:Data should be consistent. Unauthorised users does not access segmented data over the image. Segmentation is better and more secure way for hiding data.

Fig. 3 Segmentation on Image

III. CLUSTERING

***A. CLUSTER*:** Clusters are the groups of similar pixels.The pixels are such that they are similar to each other in a cluster and dissimilar with pixels of other clusters. The process of creating clusters is known as clustering. Clusters can be created according to color, size etc[3]

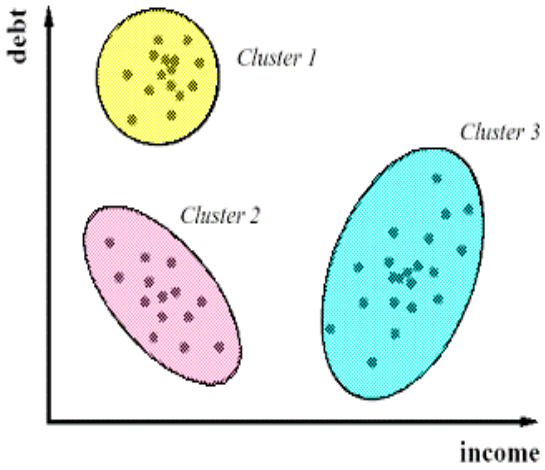


Fig.4 Clustering

IV. COMPARISON OF SEED REGION GROWING AND UNSEED REGION GROWING ALGORITHMS

A. Seed Region Growing Alogrithm[SRG]: . Region growing methods can correctly separate the regions that have the same properties or intensity values we define. Region growing can provide the original images which have clear edges the good segmentation.

Region Growing Algorithms have following *Adventages and Disadventages*

1.Seed point is generated Explicit.
2. The concept is simple. We only need a small numbers of seed point to represent the property we want then grow the region.
4. We can determine the seed point and the criteria we want to make.
5. We can choose the multiple criteria at the same time.
6. It performs well with respect to noise.

Disadvantages:

1. Time consuming.
2. Initial seed point problem.

B.UnSeed Region Growing Method [URG]: Anisotropic filtering with unseeded region growing results in a powerful image segmentation process. Effectively applicable for 3D images**.** Explicit seed selection is not needed. Seed generated Automatically.[4]

Parameters	SRG	URG
Seed Selection	Explicit seed selection	Seeds can be generated by segmentation procedure automatically
Noise	Noise in the image can cause the seed to be poorly placed	Unseed algorithm removing noise and smoothing of pixels. Algorithms fast and reliable.
Performance	SRG has high color similarity and no fragmentary problem	Adaptive and anisotropic filter can be used to improve the performance of unseed algorithms
Segmentation result	When input image are noisly the seed may falls on pixels that are not representative of region .its leads erroneous segmentation result	Segmentation result of Unseed region growing is little over segmentation.
Computational time	Time consuming lot of computation time	Less computational time
Application	It is application specific and will require domain specific Knowledge and training sets.	URG efficiently workable approach for 3D images

Table No.1

V. COMPARISON OF FAST SCANNING AND REGION SPLITTING AND MERGING ALGORITHMS IN IMAGE SEGMENTATION

***A. Region Splitting and Merging Algorithm*:** Distinguish the homogeneity of the image. It is a recursive approach. Its concept is based on quadtrees. We choose the criteria to splitt the image based on quard tree. If the adjacent regions satisfy the similarity properties, we will merge them.

***B. Fast Scanning Algorithms* :**It has good shape connectivity. The computation time is faster than both region growing algorithm and region splitting and merging algorithm. It has good shape matching.

Parameters	Region splitting and merging	Fast Scanning
Main goal	Distinguish the homogeneity of the image. Its concept is based on quadtrees,	Fast scanning algorithm we do not used seed point .It scan from upper left to lower right corner of the whole image.
Splitting	We choose the criteria to splitt the image based on quard tree.	No splitting is done
Merging	If the adjacent regions satisfy the similarity properties, we will merge them.	It determine if we can merge the pixel into existed cluster.
Computation time	Extensive computation	Computation time faster then region growing and region splitting and merging algorithms
Algorithm speed	Low	Fast speed
Good shape connectivity	Average	High
Good shape matching	Average	High
Performance	The blocky segment problem could be reduced by splitting in higher level,computation time arise.	It scan one pixel at a time .adjustable region mean and adaptive threshold are improve the performance
Over segmentation	Not	Avoid
Blocky segmentation	Present	Not present
Time Complexity	O(nlogn)	O(n)

Table No.2

VI. REGION GROWING ALGORITHM WITH DIAGRAM: Region Growing is simplest in region-base image segmentation methods [5]. The concept of region growing algorithm is to check the neighboring pixels of the initial seed points, then determine whether those neighboring pixels are added to the seed point or

not.

Fig.5 Seed Region Growing

1.If the neighboring pixels of the initial seed points are satisfy the criteria such as threshold, they will be grown. 2.The threshold can be intensity, gray level texture, and color…etc.We use the criteria of the same pixel value in Fig.6. If their pixel values are identical with seed points, they can be added to the seed points. We use 4-connected neighborhood to grow the neighboring pixels of the initial seed points here.

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(a)original image

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(b) step1

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(c)Step 3

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(d)Step 4

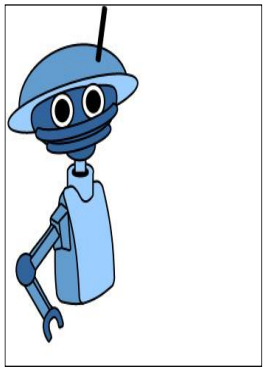
1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(e)Step5

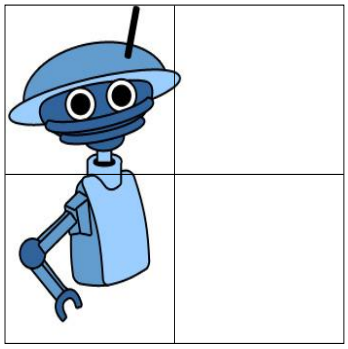
Fig 6. An Example of Region growing

VII. REGION MERGING AND SPLITTING ALGORITHM

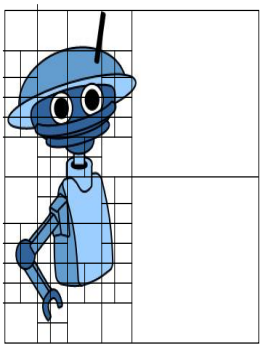
Region merging and splitting is a developing algorithm in segmenting the Images [6]. Region merging and splitting is recursive approach. It is used to differentiate the homogeneity of the image. Region merging and splitting algorithm:1)Splitting step: We choose the criteria to split the image based on quad tree. At the same time, we can determine the numbers of splitting levels gradually.2)Merging step :If the adjacent regions satisfy the similarity properties, we will merge them.Repeat step 2 until it is not changed .In Fig. 7, it is an example of region merging and splitting algorithm.. We split the image until get the resolution we need. Fig.7(a), (b), (c) and (d) show the splitting part and Fig. 7 (e) and (f) show the merging part.



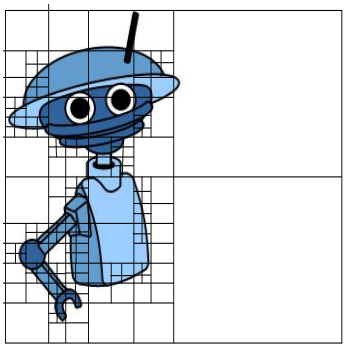
(a) Original Image



(b) Splitting: stage 1



(c) Splitting: stage 4



(d) Splitting: stage 5

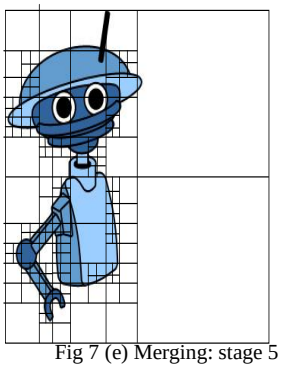
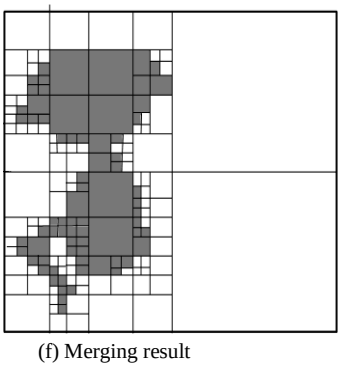


Fig 7 (e) Merging: stage 5



(f) Merging result

VIII. FAST SCANNING ALGORITHM

Unlike region growing, fast scanning algorithm do not need seed point. The concept of fast scanning algorithm [7] is to scan from the upper-left corner to lower-right corner of the whole image and determine if we can merge the pixel into an existed clustering.

The merged criterion is based on our assigned threshold. If the difference between the pixel value and the average pixel value of the adjacent cluster is smaller than the threshold, and this pixel can be merged into the cluster.

A.The Improvement of Fast Scanning with Adaptive Threshold

In our primitive method, the threshold of the whole image is all the same. However, the different parts of image have the different color distribution or the different variance and frequency. So the concept of adaptive threshold better then Fast scanning algorithm decision dependent on local variance and local frequency. The Improvement of Fast scanning algorithm with adaptive threshold decision:

1. Separate the origin image to 4*4, 16 sections.
2. Compute the local frequency and local variance of the 16 sections.
3. According to the local variance and local frequency, compute the suitable threshold. The method is below.[8]

Fig .8 Lena image separated into 16 sections

To summarize, we classify four situations for the improvement

High frequency, high variance

Fig.9 Figure of high frequency and high variance

High frequency, low variance

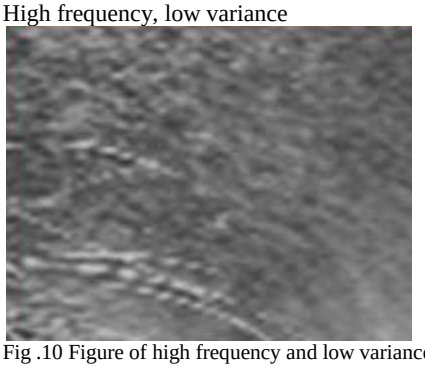


Fig .10 Figure of high frequency and low variance

Low frequency, high variance

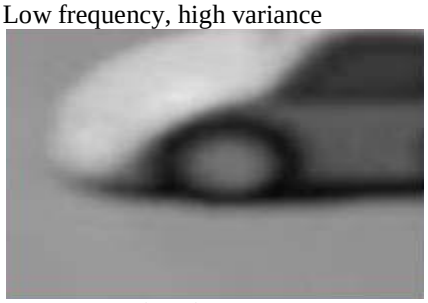


Fig. 11 Figure of low frequency and high variance

Low frequency, low variance

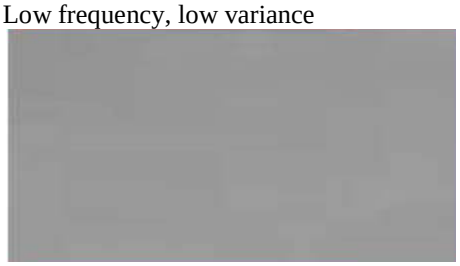


Fig. 12 Figure of low frequency and low variance

From the four situations, we assign the largest value of threshold to the figure with high frequency and high variance. Although the larger value of threshold will cause a rougher segmentation, the clear edge and the variety between different objects will make the segmentation successfully. So the larger value of threshold will avoid some over-segmentation cause by high frequency and high variance. The smallest value of threshold may cause over-segment result generally. But the low frequency and low variance region's character is monotonous, so case 4 can endure the smallest threshold and not make the over-segment work.

For example, defined a formula for threshold:

$$\text{Threshold} = 16 + F + V$$

The formula of F: $F = A \times$ (local average frequency) + B

The formula of F $V = C \times$ (local variance) + D

IX. ADVANTAGE AND DISADVENTAGES OF

REGION GROWING, UNSEED REGION GROWING, REGION SPLITTING AND MERGING , FAST SCANNING ALGORITHMS

Algorithm	Adventage	Disadventage
Seed Growing Region	Reliable	Time consuming
	Good segmentation results which means clear edges	Over-segmentation
		Speed slow
		initial seed point Problem
	Separate the regions that have the same properties.	Noise may result in holes
Useed Region Growing	Automatically seed selection	Little over seg-mentation
	Robustness	
	Fast and reliable	
	Removing noise	
	Less computation	
Splitting and merging	Image could be split progressively according to our demand	It may produce the blocky segments.
	The splitting criteria and the merging criteria can use different criteria	Computation is extensive
Fast Scanning	it has good speed,shape connectivity	Blocky segmentation not present

Table No.3

X. CONCLUSIONS

We want to make a better environment to compress after we segment it, There are three advantages in image segmentation. The first is the speed. The second is good shape connectivity its segmenting result. The third is good shape matching. Moreover, Unseed region growing, region growing, and region merging and splitting do not have these three characteristics at the same time, but in fast scanning algorithm all three characteristics at the same time. So the author creates fast scanning algorithm better than above all three algorithms of image segmentation and also to improve those disadvantages. adaptive threshold decision by local variance and frequency to improve his algorithm [9].It also used in steganography to hide data and provide more security.

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