Volume : 1, Issue : 1
January - June 2011

ISSN : 2229 - 3515

international journal of ADVANCES IN SOFT COMPUTING TECHNOLOGY

Editor-in-Chief
Dr.Vaka Murali Mohan

Published by
BHAVANA RESEARCH CENTER

Central Object Retrieval using Segmentation

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Key Words: *Retrieval, Segmentation, Image, Color, Content Based Image Retrieval (CBIR)*

Abstract: *This paper focuses on image retrieval problems such as an image of a specific object. The object of interest is fairly centrally located in the image; the normalized cut segmentation and region growing segmentation are investigated to segment the object from the background but with limited success. The experimental results shows an improvement for retrieval by local features when compared with retrieval using global features from the whole image. Retrieval comparisons show that the use of salient region background filtering gives an improvement in performance when compared with the unfiltered method. The normalized cut segmentation is used to separate an object and background into different segments. In this experiment, the results on various kinds of images: a synthetic image with one colour background & real image are demonstrated.*

1. Introduction:

The advanced digital technology for capturing and storing media is developing rapidly in the recent years. Image retrieval is becoming more widely developed, following the success of text retrieval technology. The multimedia collection is manually annotated with text and textual queries are used as the basis for multimedia retrieval. However, this method has problems due to the high cost of manual text annotation for large collections and also the limited information that can be captured easily in text. Many researchers are exploring the use of the content of multimedia to facilitate or assist the retrieval process. The difficulty of indexing, matching and retrieving multimedia information has led to the proposal of numerous novel techniques. Image retrieval using image features extracted from the image content is known as Content Based Image Retrieval (CBIR). CBIR plays important roles in many fields such as medical, arts, engineering, science and technology.

Several researchers done lot of work in the similar line and reported several strategies. Sheng-Yang Dai and Yu-Jin Zhang [1] worked on integrating spatial information into content-based image retrieval (CBIR) is aimed at solving the problem caused by global feature based algorithm.

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Chi-Han Chung, Shyi - Chyi Cheng and Chin-Chun Chang [2] proposes region-based object retrieval using the generalized Hough transform (GHT) and adaptive image segmentation. Wan-Ting Su, Ju-Chin Chen and Jenn - Jier James Lien [3] proposed two widely used methods to enhance the performance of content-based image retrieval (CBIR) systems. Sylvie Philipp - Foliguet., Julien Gony and Philippe-Henri Gosselin [4] presented a method of image indexing and retrieval which takes into account the relative positions of the regions within the image. B. G. Prasad., K. K. Biswas and S. K. Gupta [5] presented a technique to retrieve images by region matching using a combined feature index based on color, shape, and location within the framework of MPEG-7. Adel Hafiane and Bertrand Zavidovique [6] described the novel description of coloured textures by LRS (local relational string) so based on relative relations between neighbour pixels and on their distribution Xiangjun Shen., Shiguang Ju, Siu-Yeung Cho and Feng Li [7] described a way to bridge such gap: by learning the similar images given from the user, the system extracts the similar region pairs and classifies those similar region pairs either as object or non-object semantics, and either as object-relation or non-object-relation semantics automatically, which are obtained from comparing the distances and spatial relationships in the similar region pairs by themselves. Jun Wei Han and Lei Guo [8] present a novel five-stage image retrieval method based on salient edges.

The present study aims to deal with the retrieval of images containing the same object of interest as that of the query. The "global" methods capture information not only of the object of interest but also the context. The contextual information may be useful in recognizing some object classes; boat in the water; car in the street; etc. However, the risk is that the context may dominate and the system may fail to distinguish the object from the context. Hence a poor result for object retrieval is obtained. An attempt is made to investigate segmentation based technique for retrieving an image.

However, for more challenging image collection which consists of more complex and cluttered images, automatic image segmentation is more difficult and normally becomes computationally more expensive. Therefore, we continue the investigation on Content Based Image Retrieval using only the salient region approach. Processes of Content Based Image Retrieval system are shown as work flow diagram in figure 1. A process of image retrieval begins with a query which is an input of Image Retrieval system is extracted features. Content-based visual features such as color, texture, shape, contour or intensity become the important information called feature vectors in a vector space. They are used to decide similarity or difference between a query and images in the database.

The similarity is ordered by the distance between features in a vector space. Images with lower feature distance will be ranked in a higher order. The main problem in Content-Based Image Retrieval called semantic gap corresponds to the mismatch between users' requests and the way a retrieval system try to satisfy these requests. The semantic gap between the low-level similarity and the high-level user's query leads classical search algorithms to erroneous results.

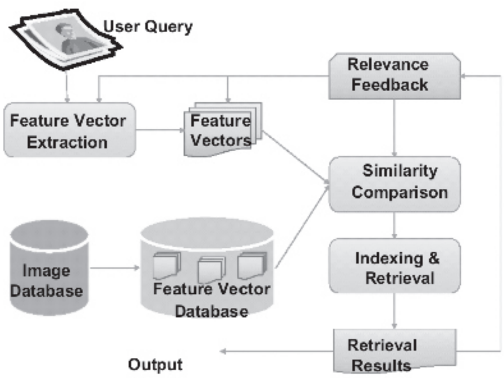

Figure 1. work flow diagram of CBIR system

Content Based Image Retrieval have been studied by several researchers and proposed several methods to narrow the semantic gap. Relevance feedback (RF) is one of methods in order to bridge this gap by allowing systems to interactively improve their discriminatory capabilities. Although there are a large number of content-based retrieval techniques, the retrieval results have still not reached a satisfactory level of performance for widespread general application and bridging the semantic gap. Focusing on the class of retrieval problems where the query is formed by an image of an object of interest, users often expect to retrieve images that contain the specified object or region in the top rank. Finding a similar object in the image database is often challenging especially when the object images have possibly been captured from different views or within different scenes or backgrounds. A motivating scenario for the work in this paper is where a museum may have images of art effects set against a variety of backgrounds. A searcher may then wish to use one image to retrieve images of other art effects in the same class. Even in this particular class of retrieval problems, retrieval results have still not reached a satisfactory and stable level of performance. The images that contain the required object are sometimes ordered at lower rank in the retrieval than some irrelevant images. One of the reasons is that features which are representing the image do not come from the object but from background which typically is not involved with the particular object in the image.

The image segmentation in an attempt to get rid of background and extract a single salient object in the image which is assumed to be located near the central area of the image. The normalized cut segmentation is introduced in an attempt to extract the central object. The region growing segmentation is one of the choices to produce a better segmentation result on a neat background or pattern background. The retrieval performance using image segmentation on a simple collection is investigated.

2. Normalized Cut Segmentation

The step of segmentation is required to attempt to segregate the object in an image and in the database images. A graph cut segmentation called the normalized cut segmentation is investigated because it has been widely used in much image retrieval; the normalized cut algorithm was compared with other image segmentation algorithms. The result showed that the normalized cut segmentation gave higher accuracy and recall in their application. It suggested that the normalized cut was possibly a good choice to extract an object from an image.

Normalized Cut

Normalized cut is the best option to find the segmentation, Graph-Theoretic clustering is an idea to model data into a graph and segment it by partitioning the graph in segmentation process for retrieving an image. Each data point is represented by a vertex in a weighted graph $G = (V, E)$, where V is a set of nodes in an image and E is a set of edges connecting the nodes. Each edge (u, v) has a weight $w(u, v)$ that represents the similarity between node u and v. A graph can be partitioned into two disjoint set, A and B by removing edges connecting the two parts. The normalized cut is the degree of divergence between two pieces which can be computed as the total weight of the edges. The normalized cut can be defined by equation (1) and it is shown in figure2.

$$Cut(A,B) = \sum_{u \in A, v \in B} w(u,v) \qquad (1)$$

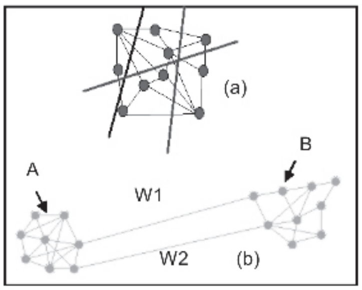

Figure 2. (a) Graph model and cuts
(b) Disjoint set A and B which associate with w1 & w2

The optimization of the graph partitioning is to minimize the cut value. This method is called the minimum cut, the minimum cut that can bipartition the segments will be calculated recursively. However, sometimes the minimum cut can split small sets in the graph. Figure 3 shows that the cuts partition out only two nodes because these cuts have smaller values than the ideal cut.

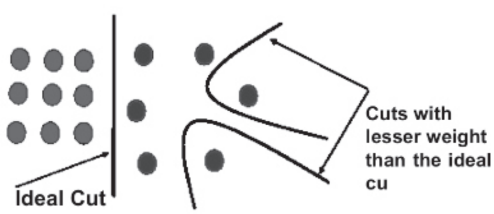

Figure 3 Case of a bad partitioning by minimum cut

The normalized cut (Ncut) was proposed by Shi, J and Malik, J [9] to measure computes the cut cost as a fraction of the total edge connections to all the nodes instead of finding the total edge weight values connecting the two partitions and is shown in equation (2).

$$N_{cut}(A,B) = assoc(A,V) + assoc(B,V) \qquad (2)$$

where $assoc(A,V) = \sum_{u} \varepsilon\, At\varepsilon_{v}\, w(u,t)$ is the connection from nodes in A to all nodes and similarly is defined for assoc (B, V), The partition algorithm tries to minimize the disassociation between groups and maximize the association within the groups. Unfortunately, the minimizing of the normalized cut is an NP-complete problem. Let x be an N ≠ V dimensional vector, xi = 1 if node i is in A and -1, otherwise. Let W be an N x N symmetrical matrix with W(i,j) = wij. Let D be an N x N diagonal matrix with D(i,i) = j W(i,j). Shi, J and Malik, J [9] showed that minimizing Ncut from equation [2] can be reduced to minimizing a Rayleigh quotient:

$$\min_x N_{cut(x)} = \min_y y\,Dy \qquad (3)$$

with the condition y(i) {1,b}and yT D1 = 0 . By relaxing y to take on real values, the solution to equation [3] can be minimized by solving a generalized eigen value system in the form of [4].

$$(D-W)\,y = \lambda\, Dy \qquad (4)$$

From the calculation, the optimal solution corresponds to the second smallest eigenvector. Therefore, an image can be subdivided by finding the second smallest eigenvector of equation [4] and can subdivide the existing graphs, each time using the eigenvector with the next smallest eigen value.

Normalized Cut Segmentation

The normalized cut segmentation is used to separate an object and background into different segments. The results on various kinds of images: (a) a synthetic image with one contour background; (b) a real image are demonstrated. The steps of segmentation are as follows

1. Set up a weighted graph G = (V, E) and set the weight on the edge.
2. Solve (D W)x = Dx for eigenvectors with the smallest eigen values.
3. To bipartition the graph, use the eigenvector with the second smallest value.
4. Decide if the current partition should be subdivided and recursively repartition if necessary.

   To investigate segmentation results, segmentation which is based on three features; colour, intensity and intervening colour are compared. Image segmentation by the intensity is weighted from the intensity value (0-255) of each pixel while the image segmentation by colour is calculated from values of H (Hue), S (Saturation), and V (Value). To obtain the H, S, and V values, an input RGB image is changed to an HSV image before segmentation. The colour feature vector from each pixel can be calculated by using equation (5)

$$F(i) = [v, v.s.\sin(h), v.s.\cos(h)](i) \qquad (5)$$

For intervening contour features, the weight is calculated from the maximum energy of edge information. Edge information is derived from an edge detector. Information about the strength of a contour can be obtained through orientation energy (OE) from elongated quadrature filter pairs. The orientation energy is normally high at a sharp contour was used as an edge detector by Canny, J [10]. If the orientation energy between nodes is strong, it means that those nodes belong to two different partitions. The maximum of edge response is a peak in contour orientation energy.

Sampling Points

In principle each pixel is compared with all others. That means if the image size is 100 by 100, space for a big matrix 10,000 x 10,000 must be reserved to keep the weighted matrix from the comparison of all pixels. To reduce the calculation time, a sample radius (r) and a sample rate are used to sample the points that was compare around each pixel. The sample radius shows how far the area extends from the pixel. The sample rate sets the fraction of selected points within the sample radius. In experiments, the sample radius is set to 10 and sample rate is set to 0.3. Figure 4 illustrates numbers of points varied by sample radius (r).

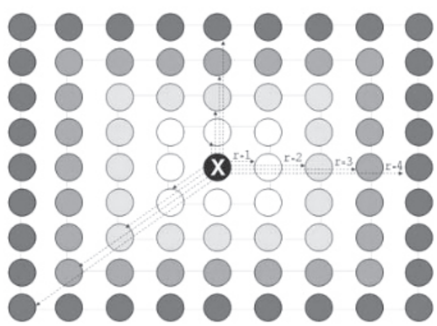

Fig.4. The number of points from different values of sample redius (r)

3. Results

In this experiment, the normalized cut algorithm is applied to a simple 100 x 100 black and white image with I = 0.01, X = 4, r = 10 . In Figure 5, the red line shows the boundary of an object in the image. It can be noticed that the extraction using different features on an uncomplicated image seems similar.

4. Conclusions

Segmentation into essential regions can be successful if objects can be separated from the background and have distinctive physical structure. For general images, more reliable segmentation is required because the segmentation process affects directly the retrieval results. The object of interest is fairly centrally located in the image; the normalized cut segmentation and region growing segmentation are investigated to segment the object from the background but with limited success. The experimental results shows an improvement for retrieval by local features when compared with retrieval using global features from the whole image. Retrieval comparisons show that the use of salient region background filtering gives an improvement in performance when compared with the unfiltered method. The normalized cut segmentation is used to separate an object and background into different segments. In this experiment, the results on various kinds of images: a synthetic image with one colour background & real image are demonstrated.

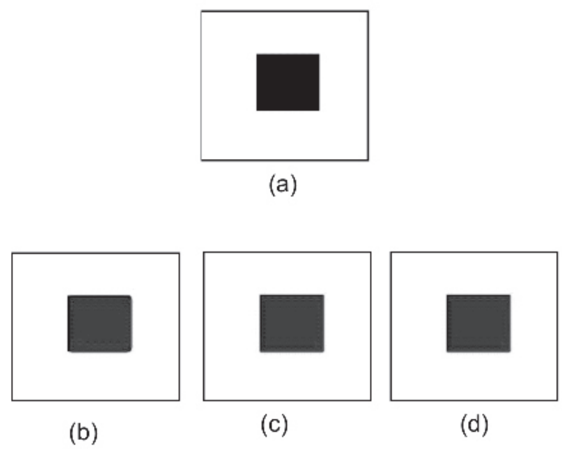

Figure 5 The result of segmentation.
(a) an original image, (b) using intervening contours, (c) using colour and (d) using intensity

5. Nomenclature

G = Vertex in a weighted graph
V = Set of nodes in an image
E = Set of edges connecting the nodes.
Ncut = Normalized cut
u, v = Nodes
w = Weight (u, v)
A, B = Edges
i = Dimensional vector
i = Node
wij = Weight Matrix
D(i,i) = Diagonal matrix
H = Hue
S = Saturation
r = sample radius

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