Analysis of Image Segmentation Techniques and Searching for Future Scope of Research

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Abstract

Research in (CBIR) content-based image retrieval has proved extremely difficult because of the inherent problems in proper automated analysis and feature extraction of the image to facilitate efficient retrieval. An image may contain more than one object and to segment the image in line with object features to extract meaningful objects has become a challenge to the researchers in the field. Until we win over this challenge, the efficient retrieval of images from the database based on given input image will be difficult to achieve. In this paper we take stock of the current situation and suggest some future scope in the resolution of this problem.

Keywords

Overview Content-based image retrieval, Image segmentation, multimedia, Future scope

1. Introduction

Research on multimedia systems and content-based image retrieval has gained momentum during the last decade Content-based image retrieval (CBIR) is a very difficult area in the access of multimedia databases simply because there still exists vast differences in the perception capacity between a human and a computer. There are two basic problems that still remain unresolved in the area although some progresses have been made The first one is the problem of efficient and meaningful image segmentation where we break-up a particular image into meaningful parts based on low-level features like color, texture, shape and spatial locations. Developing a segmentation algorithm which will meaningfully segment all images is yet an open problem in image analysis [8]. The second one is the vast gap existing for an image between low-level features mentioned earlier and high-level or semantic expressions contained in the image like the image of a car, a house, a table and so on. To develop efficient indexing techniques for the retrieval of enormous volumes of images being generated these days, we need to achieve reasonable solutions to these above mentioned two problems. But only in very limited and selected cases, some kinds of solutions have been achieved with apparently promising experimental results Section one gives an introduction of the area. Section two provides an analysis of the works done in the field. Section three suggests future directions of research. We put our concluding remarks in section 4

2. Overview of Works Done

As we mentioned low-level features like color, texture, shape and spatial locations are applied to segment images in image database and then find symmetry based on database and then find symmetry based on these segmentations, with the input image In the past images are segmented manually beforehand and text generated based on these manual segmentations and retrievals are carried out accordingly. But since the volume of images generated could be enormous in fields like satellite picturing, this method of manual part

processing proved time-consuming and expensive Also the automated retrieval techniques developed without human intervention are far from perfect. Segmentation has been done in some packages based on color where the segmented parts taken individually do not contribute to any meaningful identification [1]. NETRA is a prototype image retrieval system that was developed in the UCSB Alexandria Digital Library (ADL) project. NETRA uses color, texture, shape and spatial location information in segmented image regions to search and retrieve similar regions from the database. It has developed a robust automated image segmentation algorithm that allows object or region based search [1]. To overcome the problem of segmenting an image in an automated way, segmentation based on user assistance has been proposed by providing assistance in splitting an image into meaningful piece [2].

A content-based image retrieval approach using a Wavelet transform and sub-band using a Wavelet transform and sub-band image segmentation has been proposed where the image is first decomposed using a Wavelet transform and adopt vector a quantization(VQ) algorithm to perform automatic segmentation based on image features such as color and texture. The wavelet transform decomposes the image into 4 sub-bands (LL,LH,HL,HH) out of which LL component is further decomposed until the desired depth is reached. The image segmentation is performed using the HIS color and texture features of the low pass sub-band component image [3].

A content-based image retrieval system based on object extraction through image segmentation has been proposed where a multi-scale segmentation algorithm automates the segmentation process into homogenous classes of color and texture Normalized color and texture features are mapped to a multidimensional feature space. Spatial information is incorporated into the process by including spatial features into feature space [4]. Human assisted boundary segmentation technique using Active Contour Segmentation (ACS) has been developed for medical images where ACS tool allows user to place an initial template on the vertebra and apply the ACS algorithm [5]. For segmentation a spatial partitioning has been used for generic database and for a domain specific case, domain information for feature extraction has been used [8].

A fuzzy segmentation method is discussed where color uniformity is achieved by defining membership functions to regions based on a set of thresholds [6]. A complex algorithm of region growing limited by edges has been proposed [7]. Another work is to automatically partition an image into disjoint region coherently different in color and texture (image segmentation) using Multi scale Region- Boundary Refinement for Color-Texture Segmentation. The segmented objects seem to be quite clear and specific [2]. An image representation based on segmentation using the Expectation- Maximization algorithm on combined color and texture features which provides a transformation from the raw pixel data to a small set of image regions which are coherent in color and texture space, has been presented [8].

An image segmentation approach based on binary thresh-holding has been developed. In this case segmented regions have been used in injecting spatial information into the histogram description although they do not correspond to high-level objects in the scene. Specifically, the two image classes (black and white) defined two masks Histograms are computed separately from each area and standard histogram based CBIR has been applied [1].

In another unsupervised image segmentation method named Simultaneous Partition and Class Parameter Estimation (SPCPE), the module is applied for the identification of perceptually salient regions in images. The algorithm obtains an optimal class partition of image pixels by minimizing a probability function derived from Bayes' theorem. The algorithm starts with a semi-random initial partition and refines the partition recursively based on computed class parameters obtained in the previous iteration [4].

A CBIR system for Medical Images has been developed where to pose a query to the database, the physician circles one or more pathology bearing regions (PBR) in the query image. The system then retrieves the n most visually similar images from the database using an index comprised of a combination of localized features of the PBRs and of the global image. Since state- of-the-art techniques are not capable of accurate image segmentation, relevance feedback supplied by the user is used [2]. To address the imperfection of image segmentation algorithms, a test-bed for the comparison of different segmentation algorithms have been presented. The four segmentation algorithms mentioned are Pseudo Flat Zone Loop Algorithm, Modified Recursive Shortest Spanning Tree Algorithm, K-Means-with- Connectivity-Constraint algorithm, Expectation-Maximization algorithm [2]. In Simplicity, an image retrieval system for picture libraries and biomedical image databases, the system uses among other things a

wavelet-based approach for feature extraction, and real-time region segmentation [4]. An image segmentation technique has been applied for medical images where the output is usually in the form of image components such as sub-images, edges, boundary contour, color/intensity measurements, and texture measurements and so on. Segmentation techniques include variants of active contour segmentation [5] and active shape modeling [6] [7].

The issue of image segmentation has posed challenges for decades and no clear- cut solution has been proposed. It would be difficult to find a proper solution since cortex in the brain plays a vital role in image processing, denoting a concentration of resources upon this task. One commonly used approach in image retrieval systems is the use of Expectation-Maximization to determine the segmentation of image based on color. First the growing of a coherent image region from a single point in an image is developed. Then a related algorithm is presented which provide full image segmentation. Both of these algorithms rely solely upon color information for segmentation. The base assumption made in all of these algorithms is that an image can be segmented in coherent regions based on the similarity of color which makes up these regions [8].

In IRMA (Image Retrieval in Medical Applications), the registration and evaluation of geometric content information is developed. Multi-scale image segmentation methods are developed and integrated for further evaluation [1]. A justification has been provided whereby partitioning an image into different homogeneous regions are likely to be homogeneous regions are likely to be biased and incorporating knowledge, perceptual organization can overcome the bias and generate better segmentations [2].

Image segmentation has proceeded a long way by grouping neighboring pixels based on color. A segmentation method based on texture has been proposed by taking advantage of the similarities between the neighboring pixels. The experimental results have been reported to have immensely increased the extraction speed while keeping the distortion within a reasonable range [3]. For displaying garments, a segmentation method of variation of k-means segmentation [2] in the RGB color space has been applied. The standard k-means iteration is supplemented by an additional relaxation step which makes use of simple Markov random field (MRF) model. The first order MTF model penalizes the nearest neighboring pixels that belongs to different clusters. In effect spatially contiguous regions of pixels belonging to same clusters are encouraged [5].In an ideal case of image segmentations, the segments would directly correspond to the real-world objects present in the image. In practice it is impossible to achieve such a complete segmentation in an unsupervised manner as the processes of segmentation and complete understanding of image contents are intrinsically intertwined. In practice one has to settle for partial segmentations, where the images are partitioned into regions that are homogeneous in terms of some visual property such as color or texture or a combination thereof. Despite not being able to solve the automatic image segmentation problem in full, it is still hoped that we can produce partial segmentations that are good enough to be helpful for CBIR purposes. In the PicSOM system the use of segmentation results is made possible by the general ability of the system to deal with hierarchical objects [7]. One example of an image where the automatic segmentation has been successful enough for utilization in CBIR has been demonstrated [6].For intensity images (ie, those represented by point-wise intensity levels) four popular approaches are: threshold techniques, edge-based methods, region- based techniques, and connectivity- preserving relaxation methods [8].

3. Suggested Future Directions Of Research

We have presented quite a bit of efforts so far made in achieving meaningful image segmentation. Image segmentation has come a long way from manual segmentation to reasonable automated segmentation through the application of various techniques and methodologies. Using just a few simple grouping cues, one can now produce rather impressive segmentation on a large set of images [3]. In some cases from an image, meaningful objects have been identified based on variations of color depth beyond a threshold value. In some case boundary between two regions are measured by comparing intensity differences across the boundary and intensity differences between neighboring pixels within each region [2]. Some attempts have also been based on texture and pattern recognition. But the works done so far will not be able to get meaningful image segmentation in all cases, particularly when the threshold values change drastically within the same object or the object is a combination of various different parts with different features and colors [3]. Although it is safe to draw the conclusion that a very thorough, accurate and meaningful image segmentation would be extremely difficult to achieve in foreseeable future, the past and present directions and efforts of research on this problem seem to be appropriate and as such should be

continued to achieve more accuracy as far as possible in future. But for the moment since the segmentation may not always be very accurate, we suggest to keep the provision of threshold values to be put by the users on the segmentation based on color, texture shape or spatial locations so as to enable them to control the accuracy of segmentation they desire in the output generated.

4. Conclusion

In this paper we studied the area of image segmentation in content-based image retrieval. We referred to various segmentation techniques developed and presented them so that a full-fledged picture of the problem of segmentation can be obtained. Since this is a very important area of research with major implications in all spheres of life beginning with medical images, the necessity of this study cannot be overestimated.

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