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Study of Segmentation Process in Images

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Abstract:
Digital image processing allows one to enhance image features of interest while attenuating details irreverent to a given application, and then extract useful information about the scene from the enhanced image. It comprises of two techniques i.e. Image compression and Image Segmentation. Image compression is used to minimize the amount of memory needed to represent an image. Images often require a large number of bits to represent them, and if the image needs to be transmitted or stored, it is impractical to do so without somehow reducing the number of bits. Image segmentation is the process of partitioning a digital image into multiple segments or in sets of pixels. Image segmentation is typically used to locate objects and boundaries like lines, curves, etc. in images. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. This paper proposed a GMM based MRF model using k-mean clustering because GMM is hierarchical clustering, shows the clustering details and smoothness and continuity of color regions are adopted enforced with the adaptation of MRF.
This technique takes more computational time and quite expensive in memory.

Keywords*: Compression, Digital, Fuzzy, Image processing, K-mean clustering, Spectrum, Threshold*

1. Introduction

Image processing is a method to convert an image into digital form and operate some operations on it, to get an enhanced image or to extract some information from it. This type of signal dispensation in which input is image, like photograph or video frame and output may be an image or characteristics associated with that image. Image processing system includes images as two dimensional signals while applying already set signal processing methods to them. Segmenting an image to meaningful parts is a fundamental operation in image processing. A common problem of segmenting a monochrome image occurs when an image has a background of varying gray level such as gradually changing shades. Compared to a monochrome image, a color image provides additional information on the objects in the image. Color information provides complete representation of image and more reliable segmentation can be achieved as compared to gray level image. Earlier, for processing of color images require a very high computation time. But now-a-days we can avoid this problem with increasing speed and decreasing cost of computation [1].

Image segmentation is the process of partitioning a digital image into multiple Segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

2. Application Areas in Digital Image Processing

Today, there is almost no area of technical endeavor which is not impacted by digital image processing. Many application oriented image analyzers are available and are working satisfactorily in real environment. One of the simplest way to develop a basic understanding of image processing application to categorize images according to there resources e.g. Visual, X-ray and so on. The principal energy source for images in use today is the electromagnetic energy spectrum. Other important sources of energy include ultrasonic and electronic in the form of electron beams used in electron microscopy. In this section we discuss how images are generated in these various categories and the area in which they applied. Images based on radiation from the EM spectrum are most familiar, especially images in the X-ray and visual bands of the spectrum.

3. Components of An Image Processing System

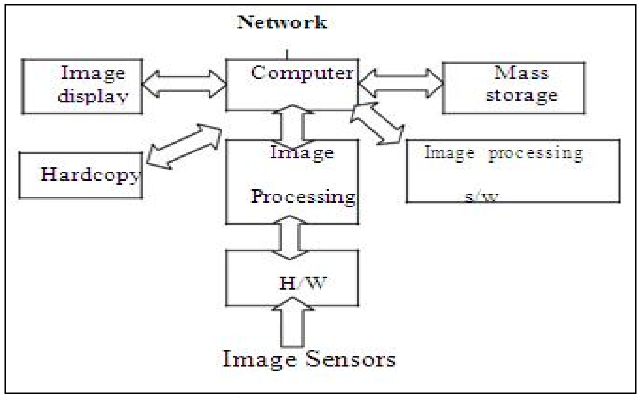

Figure 1: ©Components of a general purpose image processing system

In the 1980 and early in 1990s, the market shifted to image processing hardware in the form of single boards designed to be compatible with industry standard buses and to fit into engineering workstations cabinets and personal computers. In addition to lowering costs, this market shift also served as a catalyst for a significant number of new companies whose specialty is the development of software written specifically for image processing. Although large scale image processing system still being sold for massive imaging application, such as processing of satellite images, the trend continues toward miniaturizing and blending of general purpose small computers with specialized image processing system. Fig © shows a typical general purpose system used for digital image processing. With reference to sensing, two elements are required to acquire digital images. The first physical device that is sensitive to the energy radiated by the object we wish to image. The second is the digitizer is a device for converting the output of physical sensing device into digital form. Specialized image processing hardware usually consist of the digitizer just mentioned, plus hardware that performs other primitive operations, such as an arithmetic logical unit, which performs arithmetic and logical operations in parallel on entire images. The computer in an image processing system is a general-purpose computer and can range from a PC to a supercomputer. In these systems, almost any well equipped PC type machine is suitable for offline image processing tasks. Software for image processing consists of specialized modules that perform specific tasks. A well designed package also includes the capability for the user to write code that, as a minimum, utilizes the specialized modules. Mass storage capability is a must in image processing applications. An image of size 1024 * 1024 pixels, in which the intensity of each pixel is an 8 bit quantity, required one megabytes of storage space if the image is not compressed. Digital storage for image processing application falls into three principal categories: (1) short term storage for use during processing, (2) on-line storage for relatively fast recall and, (3) archival storage, characterized by infrequent access. Storage is measured in bytes, Kbytes, Mbytes, Gbytes, and Tbytes. Image display in use today is mainly color TV monitors. Monitor is driven by the output of images and graphics display cards that are an integral part of computer system. Image display application that cannot be met by display cards available commercially as part of computer system Hardcopy devices for recording images include laser printer, film camera, heat-sensitive device, inkjet units and digital units. Networking is almost a default function in many computer systems today. Because of large amount of data inherent in image processing application, the key consideration in image transmission is bandwidth. In dedicated networks, this typically is not problem, but communication with remote sites via internet is not always as efficient. [Gonzalez, 2005]

4. Characteristics of Good Color Image Segmentation

The desirable characteristics that good image segmentation should exhibit with reference to gray-level images

- Regions of image segmentation should be uniform and homogeneous with respect to some characteristics such as gray tone or texture.
- Region interiors should be simple and without many small holes.
- Boundaries of each segment should be simple, not ragged, and must be spatially accurate.
- Adjacent regions of segmentation should have significantly different values with respect to the characteristic on which they are uniform.

5. Image Segmentation Techniques

Image segmentation techniques are of following types:

5.1. Edge detection

It usually involves two stages. The first stage is edge enhancement process in which the evaluation of derivatives of the image is done and use of Laplacian operators. In second stage, selection and combination of edge map pixels using edge linking, boundary detection and grouping of local edges. This stage can be viewed as a search for optimal con-figuration of pixels that better approximate edges. In possible edge configuration R is encoded as chromosome.

Each chromosome has B2 bits string, where B represents the dimension of any image I. Each bit shows the presence of an edge pixel in the image I. Algorithm evaluates each chromosome by using a cost function. This form of the point cost function is a linear combination of five weighted point factors [3]. These factors are evaluated for each pixel in its local neighborhood of MxM window. Fragmentation describes local edge discontinuities.

5.2. Thresholding method

The simplest method of image segmentation is called the thresholding method. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and k-means clustering.

5.3. Clustering methods

It is defined as a non-supervised classification of objects in which one has to generate classes or partitions without any a priori knowledge. The problem of clustering is defined as, once we given a certain number of patterns and determining the set of regions such that every pattern belongs to one of these regions and never to two adjacent regions at the same time.

5.4. Compression-Based Methods

Compression based methods postulate that the optimal segmentation is the one that minimizes, over all possible segmentations, the coding length of the data [2]. The method describes each segment by its texture and boundary shape. Each of these components is modeled by a probability distribution function and its coding length is computed as follows:

- The boundary encoding leverages the fact that regions in natural images tend to have a smooth contour.
- Texture is encoded by lossy compression in a way similar to minimum description length (MDL) principle, but here the length of the data given the model is approximated by the number of samples times the entropy of the model. The texture in each region is modeled by a multivariate normal distribution whose entropy has closed form expression. An interesting property of this model is that the estimated entropy bounds the true entropy of the data from above.

5.5. Histogram-Based Methods

Histogram-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image. Color or intensity can be used as the measure.

One disadvantage of the histogram-seeking method is that it may be difficult to identify significant peaks and valleys in the image.

5.6. Split-and-merge methods

It is sometimes called quadtree segmentation as it is based on a quadtree partition of an image. This method starts at the root of the tree that represents the whole image. If it is found nonuniform then it is split into four son-squares and so on so forth. Conversely, if four son-squares are homogeneous, they can be merged as several connected components . The node in the tree is a segmented node. This process continues recursively until no further splits or merges are possible.

5.7. Partial differential equation-based methods

Using a partial differential equation (PDE)-based method and solving the PDE equation by a numerical scheme, one can segment the image. Curve propagation is a popular technique in this category, with numerous applications to object extraction, object tracking, stereo reconstruction, etc. The central idea is to evolve an initial curve towards the lowest potential of a cost function, where its definition reflects the task to be addressed.

5.8. Graph partitioning methods

Graph partitioning methods can effectively be used for image segmentation. In these methods, the image is modeled as a weighted, undirected graph. Usually a pixel or a group of pixels are associated with nodes and edge weights define the (dis)similarity between the neighborhood pixels. The graph (image) is then partitioned according to a criterion designed to model "good" clusters. Each partition of the nodes (pixels) output from these algorithms are considered an object segment in the image.

5.9. Watershed transformation

The watershed transformation considers the gradient magnitude of an image as a topographic surface. Pixels having the highest gradient magnitude intensities (GMIs)

correspond to watershed lines, which represent the region boundaries. Water placed on any pixel enclosed by a common watershed line flows downhill to a common local intensity minimum (LIM). Pixels draining to a common minimum form a catch basin, which represents a segment.

5.10. Model based segmentation

The central assumption of such an approach is that structures of interest/organs have a repetitive form of geometry. Therefore, one can seek for a probabilistic model towards explaining the variation of the shape of the organ and then when segmenting an image impose constraints using this model as prior. Such a task involves (i) registration of the training examples to a common pose, (ii) probabilistic representation of the variation of the registered samples, and (iii) statistical inference between the model and the image. State of the art methods in the literature for knowledge-based segmentation involve active shape and appearance models, active contours and deformable templates and level-set based methods.

5.11. Semi-automatic segmentation

In this kind of segmentation, the user outlines the region of interest with the mouse clicks and algorithms are applied so that the path that best fits the edge of the image is shown. Techniques like SIOX, Livewire, Intelligent Scissors or IT-SNAPS are used in this kind of segmentation.

6. Applications of Image Segmentation

Some of the practical applications of image segmentation are:

- Content-based image retrieval
- Machine vision
- Medical imaging
- Object detection
- Recognition Tasks
- Traffic control system

7. Our Approach

In this paper a new technique is proposed by combination of GMM and MRF methods using k-mean clustering to improve the performance From the segmentation results, it is possible to identify the regions and objects in the scene, which is very beneficial to the subsequent image analysis.

Results are improved from the proposed technique as compared to the existing technique.

8.Methodology and Results

The simulation results of image segmentation are obtained by using MATLAB .MATLAB stands for matrix laboratory.

MATLAB is a multi-paradigm numerical computing environment and fourth-generation programming language. Results are obtained by using combination of GMM and MRF methods using k-mean clustering.

Figure 2: Original image

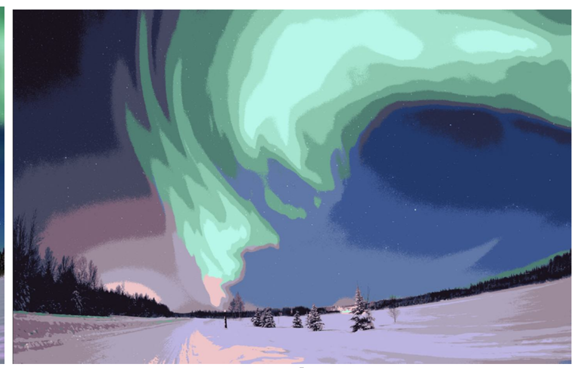

Figure 3: Segmented image

9. Conclusion

All of the existing approaches are by nature to some extent. Most gray level image segmentation techniques could be extended to color image, such as histogram thresholding, region growing, edge detection and fuzzy based approaches. These can be directly applied to each component of a color space, and then the results can be combined in some way to obtain final segmentation result. So a new technique is proposed by combination of GMM and MRF methods using k-mean clustering. Results are improved from the proposed technique as compared to the existing technique. This technique takes more computational time and quite expensive in memory.

10. References

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