An Impact of Complex Hybrid Color Space and Gradient Magnitude Techniques in Image Segmentation

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Abstract

Image segmentation is a crucial stage in image processing and also in pattern recognition. Considering color uniformity as a significant criterion for partioning the image into considerable multiple disjoint regions and the distribution of the pixel intensities are investigated in different color spaces. As image segmentation has become a definite prerequisite in many of the image processing and computer vision applications, an effort towards evaluating such segmentation techniques is indeed found very less in literature. In this paper, comprehensive evaluation of five different gradient magnitude (GM) based image segmentation techniques using CBIR (Content Based Image Retrieval). Firstly, boundary probabilities are detected using the gradient magnitude based techniques such as - Canny edge detection (pbCanny), Second moment matrix (pb2MM), Multi-scale second moment matrix (pb2MM2), Gradient magnitude (pbGM) and Multi-scale gradient magnitude (pbGM2).

Key Words: *Keywords: Image segmentation, gradient magnitude, pbCanny, pb2MM, pb2MM2, pbGM, pbGM2.*

I. INTRODUCTION

In the field of computer vision applications image segmentation is a prerequisite stage in image and video processing. In this stage an image is segmented into different regions corresponding to different real world objects. Image segmentation stage is considered as one of the critical step. Segmentation is to partition an image into regions each of which has a reasonably homogeneous visual appearance or which corresponds to objects or parts of objects (Forsyth and Ponce, 2003). Each pixel in an image is a point in a 3-dimentional space comprising the intensities of the red, blue and green channels, and segmentation algorithm simply treats each pixel in the image as a separate data points.

Berkeley segmentation Dataset, the BSDS300 consists of 200 training and 100 test images, each with multiple ground-truth segmentations. Caltech 101 dataset contains 9,197 images comprising 101 different object categories, including a background category, collected via Google image search by Fei-Fei et.

Gradient Magnitude based segmentation Techniques have five different algorithms to detect boundaries by finding the output images that show us the probability of a boundary's existence. The methods featured are finding the boundary probability through the

following algorithms: Canny edge detection (pbCanny), Second moment matrix (pb2MM), Multi-scale second moment matrix (pb2MM2), Gradient magnitude (pbGM), Multi-scale gradient magnitude (pbGM2).

II. BACKGROUND

Image segmentation using local variation

Felzenszwalb and Huttenlocher describe an efficient graph theoretic algorithm for image segmentation by partitioning image into pair of regions such that the variation across neighboring regions should be larger than the variation within each individual region.

Normalized cuts and image segmentation

Shi and Malik proposed a general image segmentation approach based on normalized cut by solving an eigen system of equations. The normalized cut criterion measures both the total dissimilarity between the different groups as well as the total similarity within the groups. This approach to segmenting static images, as well as motion sequences, and found the results to be very encouraging.

Color image segmentation based on mean shift and normalized cuts.

Mean shift and normalized cut can be applied to segment the color images. The discontinuity property of the images can be maintained by the mean shift algorithm to form the segmented regions. Finally, the normalized cut has been used on the segmented regions to reduce the complexity of the process.

Image segmentation with ratio cut.

Wang and Siskind developed a cost function, named as ratio cut, based on the graph reduction method to segment color images efficiently. The cut ratio is defined as the ratio of the corresponding sums of two different weights of edges along the cut boundary and models the mean affinity between the segments separated by the boundary per unit boundary length.

A fast multilevel thresholding method based on lowpass and highpass filtering.

Chang and Wang used a lowpass/highpass filter repeatedly for adjusting the peaks or valleys to a desired number of classes. The valleys in the filtered histogram are then considered as threshold values. The procedure naturally provides for variable size segmentation with bigger blocks near the extreme pixel values and finer divisions around the mean or other chosen value for better visualization.

A multilevel automatic thresholding method based on a genetic algorithm for a fast image segmentation.

A Genetic Algorithm (GA) was combined with a wavelet transform. The wavelet transform is used for reducing the length of the histogram while the genetic algorithm allows finding the threshold number and the optimal threshold values. Three new soft computing methods for segmentation of both gray level and color images by using a fuzzy entropy based cost function for the genetic algorithm.

Fast multilevel thresholding for image segmentation through a multiphase level set method.

A multilevel threshold method using a multiphase level set technique is used for determining the number & the values of the thresholds for

segmentation The valleys are then highlighted and isolated by deriving the approximated histogram so that the thresholds are easily extracted by searching the minima of these valleys.

A pixel-based color image segmentation using support vector machine and fuzzy C-means.

An implementation of FCM is also analyzed to classify the image into different clusters. Image segmentation is an important tool in image processing and can serve as an efficient front end to sophisticated algorithms and thereby simplify subsequent processing. In this paper, present a pixel-based color image segmentation using Support Vector Machine (SVM) and Fuzzy C-Means (FCM).

III. PROPOSED METHODOLOGY

Gradient Magnitude based segmentation Techniques.

The methods featured are finding the boundary probability through the following algorithms:

3.1 pbGM

The gradient is a vector consisting _ of certain magnitude and direction. To increase the speed of computation, the magnitude of gradient can also be approximated using magn(rf) = |Mx|+|My|. The strength of the edge is given by the magnitude of gradient and the direction of edge is always perpendicular to the direction of gradient.

3.2 pbGM2

In pbGM2, different scales are used to analyze and classify image features. Gradient magnitudes can be defined using the properties of multi-scale gradient watershed regions. Probabilities of these boundaries corresponding to the definite edges of objects are easily identified. Hence, multi-scale analysis imposes scale-based hierarchy on watersheds associated to identify the boundaries. These hierarchies are further used to label boundaries obtained due to watershed giving valuable and in-depth properties of multi-scale edges.

3.3 pbCanny

Pb canny [12], introduced by John Canny outperforms many of newer algorithms due to its inherent property of removing noise and preserving edge features before finding edges. Few important steps are mentioned below:

1. Convolve given image f(r, c) with a Gaussian function to get smooth image f_(r, c). i.e. f_(r, c) = f(r, c) _ G(r, c).
2. Apply first order gradient to find edge strength, magnitude and its direction.
3. Apply non maximal threshold and find edges with local maxima of gradient magnitude.
4. Find local maxima to find the edges.
5. Apply thinning to broad ridges and retain the points w.r.t the largest local change.

3.4 pb2MM

As pbCanny fails to detect boundaries/edges in textured regions due to the presence of subtle intensity variations, one can think of analyzing gradients at multiple orientations that helps in exploiting multiple incident edges within the textured regions. pb2MM (Second moment matrix) is one of the best approach in finding solutions for such cases and are derived from the gradient of an image. It identifies the predominant directions in the gradient of neighboring pixel and also

identifies the angles to its coherent directions. Boundaries are detected by observing the spectrum of eigen values from the derived spatially averaged second moment matrix.

3.5 pb2MM2

The Multi-scale second moment matrix of a function Iie in contrast to other one-parameter scale-space features an image descriptor that is defined over two scale parameters. One scale parameter, referred to as local scale t, is needed for determining the amount of pre-smoothening when computing the image gradient. Another scale parameter, referred to as integration scale s, is needed for specifying the spatial extent of the window function that determines the weights for the region in space over which the components of the outer product of the gradient by itself T are accumulated.

DATASETS

A multi-stage algorithm canny edge detection operator is applied on to the resultant segmented images of the proposed system to evaluate the performance with human segmented edges of Berkeley dataset. In this, the proposed segmented edges are compared with the human segmented edges of Berkeley dataset to obtain the performance measures such as correlation Hausdorff distance, Jaccard & Dice coefficients , root mean square error (RMSE) analysis on Berkeley dataset of 110 images is listed as follows

• Correlation refers to the statistical dependency between two images lies in the
range [0, 1] and higher value of 0.1851 of proposed method shows better segmentation
result than 0.1652 & 0.1635 of methods [12] & [13].

• Hausdorff distance of value 8.0623 measures the extent to which each point of
proposed segmented image lies minimally near some point of ground-truth segmentations.

• Jaccard and dice should be in the range of [0, 1], shows 0.1232 greater than the
related values revealed extremely close results compared to other two existing methods.

• Finally, RMSE takes segmented and ground truth images as input and produces
real valued output in the range [0, 1], the obtained value 0.2599 signifies lesser
error with improved result of 0.2808 & 0.2738 of Edison's mean shift and fuzzy
c-means respectively.

IV. SEGMENTED RESULT

Fig 4.1: Original image

Fig 4.2: pbCanny

Fig 4.3: pb2MM

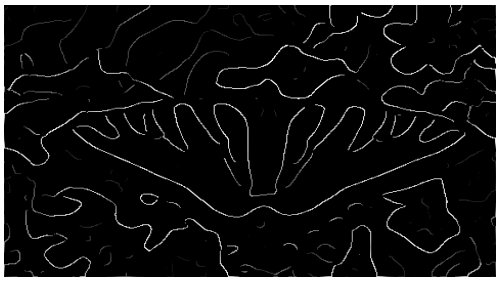

Fig 4.4: pb2MM2

Fig 4.5: pbGM

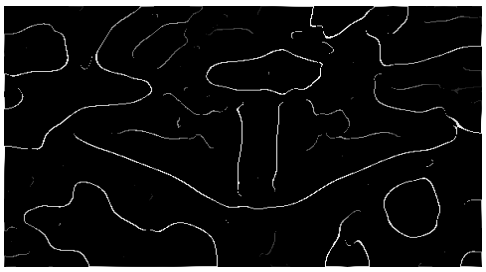

Fig 4.6: pbGM2

V. CONCLUSION

In the present work, image analysis describing the relationship between the color image segmentation and its impact on Gradient magnitude techniques considering different ground truth images and derived an efficient image segmentation. Experimental results based on the standard segmentation metrics shows that the image is efficiently segmented into sub regions with clearly defined edges based on human color visual perception and retaining low frequency components which efficiently describes the shape, color and texture of the object.

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