International Journal of Advances in Image Processing Techniques– IJIPT
Volume 1 : Issue 3 *[ISSN 2372 – 3998]*
Publication Date : 30 September, 2014

Performance Evaluation of Texture based Image Segmentation using GLCM

Inderpal Singh

***Abstract*— This paper presents image segmentation and texture analysis algorithms on synthetic and real images. This research work demonstrates the considerable variability in an image understanding system performance based on different choices of image segmentation and texture analysis algorithms used. This research work includes results of a segmentation method to extract the object based on color and texture features of color images. Image segmentation denotes a process of partitioning an image into distinct regions. Based on the color segmentation result, and the texture variances between the background image and the object, we extract the object by the gray level co-occurrence matrix for texture segmentation. The GLCMs broadly represent the joint possibility of occurrence of grey-levels for pixels with a given spatial relationship in a defined region. Finally, the segmentation result is improved by mathematical morphology methods.**

Keyword: **Image segmentation, Texture analysis and GLCM**

I. Introduction

Image segmentation [1] is an important technique of image processing. It has an broad application in many domains, such as Computer Vision, Image Analysis. The key of image segmentation is to find an appropriate threshold to distinguish the object and background efficiently. In computer vision, image processing is any form of signal processing for which the input is an image, such as photo's or frames of videos. The output of image processing can be either an image or a set of appearances or parameters related to image. Also, segmentation refers to the process of splitting a digital image into several segments. Image segmentation is usually used to locate objects and boundaries (lines, curves, etc.) in images. The goal of segmentation is to simplify and difference the representation of an image into something that is more meaningful and easier to evaluate. Image segmentation is typically used to locate objects and boundaries in images [2].

II. Gray level co-occurrence matrix (GLCM)

Gray level co-occurrence matrix(GLCM) was suggested by Haralick[15].Texture can be measured as repeating patterns [2] of local variation of pixel intensities. Unlike colour, texture occurs in a region than at a point.

Inderpal Singh
DAV Institute of Engineering & Technology Jalandhar
INDIA

A number of techniques have been used for calculating the texture features such as Gabor filter, fractals, wavelets, co-occurrence matrix etc [8]. Using these texture features like contrast [10], coarseness [10], directionality and regularity can be measured. The Gray Level Co- occurrence Matrix (GLCM) is a statistical method of examining texture that considers the spatial relationship of pixels [8]. It is a matrix showing how often a pixel with the intensity (gray-level) value i occurs in a specific spatial relationship to a pixel with the value j. It is defined by P(i, j| d,Θ), which expresses the probability of the couple of pixels at Θ direction and d interval. Once the GLCM is created various features can be computed from it. The most commonly used features are contrast, energy, entropy, correlation and homogeneity (Table 1) [9]. We have taken d=1 and Θ = 00, 450, 900 and 1350 for computing the texture features. Contrast, energy, correlation and homogeneity [3] are taken in all the four directions and entropy of the whole block is separately calculated as it gave better retrieving results.

Table 1. Texture Feature

Sl. No	Texture Features	
	Feature	*Formula*
1	Contrast	$\sum_{i,j} \|i-j\|^2 p(i,j)$
2	Correlation	$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j}$
3	Energy	$\sum_{i,j} p(i,j)^2$
4	Entropy	$-\sum_{i,j}(p(i,j).*\log(p(i,j))$
5	Homogeneity	$\sum_{i,j} \frac{p(i,j)}{1+\|i-j\|}$

III. Background

Jian et al.[1] He presented a novel texture image segmentation method based on Gaussian mixture models and gray level co-occurrence matrix (GLCM). The feature space was formed by eight statics generated by gray level co-occurrence matrix (GLCM) including mean, variance, angular second moment, entropy, inverse difference moment, contrast, homogeneity and correlation. The parameters of Gaussian mixture models were estimated by maximization algorithm.

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Hengqiang et al.[2] They have studied Image recognition technology is a new plant disease diagnosis. The accuracy of its identification has important implications. They propose a new image segmentation algorithm, which is based on super-green characters and OSTU methods. This segmentation algorithm is good, easy to implement and suitable for the pretreatment of corn disease identification work. It can provide a good pre-treatment of disease identification results, to improve recognition accuracy.

Prakash et al.[3] They have proposed a new segmentation method for noise removal, image enhancement and segmentation. The algorithm offers the good quality segmentation. This method extracts all the dark objects from the background of the image. In order to segment the image, laplacian of Gaussian operator is applied, the importance of this operator is it removes the noise if present and then identifies the segments in the image. The algorithm does segmentation along with enhancement.

Vimina et al.[4] They proposed a region based image retrieval system using the local colour and texture features of image sub regions. The Regions Of Interest are roughly identified by segmenting the image into fixed partitions. The colour and texture features of the ROIs are computed from the histograms of the quantized HSV colour space and Gray Level Co-occurrence Matrix (GLCM) respectively.

Saroja et al.[5] They have studied the texture analysis finds central role in medical image analysis, document processing and remote sensing. The result illuminant direction affects the texture appearance. The images present in the universe are not uniform because of changes in scale, orientation and lighting conditions. The feature extraction of the non uniform images was done using gray level co-occurrence matrix(GLCM) for the different datasets for the non ideal images

IV. Proposed methodology

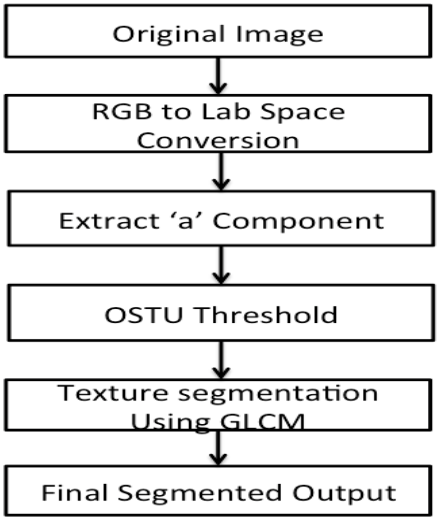

Figure 1. Research methodology

First the color image of RGB space is changed into Lab space. Next, due to the negative end of a-channel reflects the color feature of image, the L, a, and b channels are split.

(a) Original image (b) Image of L-channel

(c) Image of a-channel (d) Image of b-channel

Figure 2. Results of channel separation

So segmentation by two-dimension OTSU of automatic threshold in a-channel.

Figure 3. Two-dimensional OTSU segmentation result

Based on the color segmentation result, and the texture differences between the background image and the object, we extract the object by the gray level co-occurrence matrix for texture segmentation.

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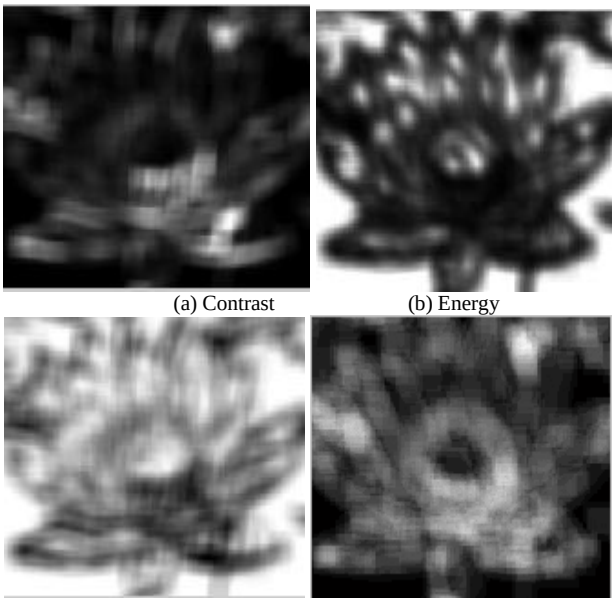

(a) Contrast (b) Energy

(c) Homogeneity (d) Entropy

Figure 4. Results of GLCM

Finally, the segmentation result is corrected by mathematical morphology methods.

Figure 5. Morphological Filling

V. Experimental Set-Up

The GLCM segmentation algorithm is implemented in Matlab with the help of image processing toolbox. This algorithm is tested of different images with different kind of textures. The result shows that the GLCM based texture segmentation will segment the given object having higher texture than other object in more efficient way.

VI. Results & Discussion

The proposed algorithm is tested on flower texture images. In this paper step wise results of flower images are shown in Figure 2. The results in Figure.2 clearly show the extraction of flower from the background. The results clearly indicate that the green and yellow backgrounds in the images are converted to black in the "a" component of the image. Otsu threshold is applied for enhancing the "a" component output. The Figure 4 shows that the object is smoothened after texture segmentation. The Figure5. Clearly shows that morphological filling step is applied to fill small gaps in the object.

VII. Conclusion and Future Scope

This paper has proposed the GLCM based texture segmentation will segment the given object having higher texture than other object in more efficient way. The taken results are more reliable than available segmentation technique as existing segmentation techniques may introduce some artifacts. In future we will extend this work by taking an optimize binarization algorithm to improve the texture area in an image.

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