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Edge Detection based on K-means and Gabor Wavelet Technique

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***Abstract**: A combination of K-means clustering, and Gabor wavelet method are used to accomplish image segmentation and edge detection tasks. We attained an initial segmentation created on K-means clustering technique and wavelet technique with Gabor filter used to detect their boundaries. Gabor wavelets are used at this point to detect edges, corners and blobs. A routine of such an interest point detector is related to detectors employing a Haar wavelet and a derivative of a Gaussian function. In this paper: We have solved the problem of undesirable over segmentation results produced by the wavelet algorithm, when use straightly with raw data images. Also, the edge we obtained has no broken lines on complete image and the final edge detection outcome is one closed borderline per actual region in the image. The planned approach may be useful when a fast implementation of edge detection is available.*

Keywords: Gabor function, wavelet, K-means, edge detection, image segmentation.

I. INTRODUCTION

Image segmentation is the process of dividing an image into non-overlapping regions based on perceptual information. Image segmentation continues to be an important and active research area in image analysis. In order to analyze complicated image signals, engineers and mathematicians have been searching for a simple, yet well-understood representation. K-means clustering is a method of vector quantization, initially from signal processing, that is well-liked for cluster analysis in datamining. K-means clustering tries to partition *n* observations into *k* clusters in which each remark belongs to the cluster with the nearest mean as a prototype of the cluster.

The problem is computationally difficult; also there are efficient heuristic algorithms that are commonly active and converge quickly to a local optimum. These are similar to the expectation-maximization algorithm for mixtures of Gaussian distributions via an iterative fine-tuning approach employed by both algorithms. Also, they both use cluster centers to classical the data. K-means clustering tends to find clusters of comparable spatial extent and the expectation-maximization mechanism permits clusters to have dissimilar shapes.

In Image processing, Dennis Gabor is the founder of Gabor filter. Gabor filter is a linear filter use for edge detection. Frequency representations and coordination representations of Gabor filters are alike to those of the human visual system, and they have originate to be particularly suitable for texture representation and discrimination. In the spatial domain, Gabor filter is a Gaussian kernel function controlled by a sinusoidal plane wave. To perform image segmentation and edge detection tasks, there are many methods that

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incorporate region growing and edge detection techniques. In this paper a combination of K-means clustering and Wavelet techniques then region merging and edge detection procedures are used. The clustering method are applied to obtain an image of different intensity regions based on minimum distance to examine each pixel in the image and then to assign it to one of the image clusters.

In the proposed work an algorithm based on K-means and Gabor wavelet rules are developed for detecting edges from an image. K-means algorithm consists of two main steps one is assignment and another one is update. Using this first performs clustering and then we go to next method called Gabor wavelet, in this we follow four steps to achieve out result.

II. K-MEANS AND WAVELET TECHNIQUE

A. K-means Clustering

K-means clustering have used to cluster the image depending upon its pixel values while clustering global optimum value is taken in to consideration. Given an initial set of k means $m_1^{(1)},\ldots,m_k^{(1)}$, the algorithm proceeds by two steps:

Assignment step: Assign each observation to the cluster whose mean yields the least within cluster sum of squares (WCSS). The sum of squares is the squared Euclidean distance, this is intuitively the "nearest" mean.

$$S_i^{(t)} = \{x_p : \|x_p - m_i^{(t)}\|^2 \leq \|x_p - m_j^{(t)}\|^2 \ \forall j, 1 \leq j \leq k\},$$

where each x_p is allocated to exactly one $S^{(t)}$, even if it could be is assigned to two or more of them.

Update step: Compute the new means to be the centroids of the observations in the new clusters.

$$m_i^{(t+1)} = \frac{1}{|S_i^{(t)}|} \sum_{x_j \in S_i^{(t)}} x_j$$

Since the arithmetic mean is a least-squares estimator, which also minimizes the within cluster sum of squares objective. The algorithm has converged when the assignments no longer change. In both steps optimize the WCSS objective, and there exists only a finite number of such partitioning, the algorithm must converge to a optimum. There is no guarantee that the global optimum is found using this algorithm.

Original image

Clustered image

B. Gabor Wavelet

Gabor Wavelet have used for edge detection purpose, the clustered image is given as input for this. In the one-dimensional case, the Gabor function consists of a complex exponential localized around x = 0 by the envelope with a Gaussian window shape

$$g_{\alpha,\xi}(x) = \sqrt{\alpha/\pi}\, e^{-\alpha x^2} e^{-i\xi x},$$

for $\alpha \in \mathbb{R}^+$ and $\xi, x \in \mathbb{R}$, where $\alpha = (2\sigma^2)^{-1}$, σ^2 is a variance and ξ is a frequency.

Dilation of the complex exponential function and shift of the Gaussian window when the dilation is fixed form kernel of a Gabor transform. The Gabor transform hires such kernel for time-frequency signal analysis. The Gaussian window is the finest time frequency localization window in a sense of the Heisenberg indecision principle. In a two-dimensional case, the absolute square of the correlation

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between an image and a two-dimensional Gabor function provides the spectral energy density concentrated around a given position and frequency in a certain direction. The two-dimensional obscurity with a circular Gabor function is separable to series of one-dimensional ones

$$g_{\alpha,\boldsymbol{\xi}}(\boldsymbol{x}) = g_{\alpha,\xi_0}(x_0)\, g_{\alpha,\xi_1}(x_1),$$
$$\text{for } \boldsymbol{\xi} = (\xi_0, \xi_1) \text{ and } \boldsymbol{x} = (x_0, x_1).$$

Elements of a family of mutually similar Gabor functions are called wavelets when they are created by dilation and shift from one elementary Gabor function, i.e.

$$g_{\alpha,\xi,a,b}(x) = |a|^{-1/2}\, g_{\alpha,\xi}\left(\frac{x-b}{a}\right)$$

for 2 $\in$ R^+ (scale) and b $\in$ R(shift). By convention, the mother wavelet has the energy confined around x = 0 as well as all of the wavelets are normalize ||g|| = 1. Although the Gabor wavelet does not form orthonormal base which is the discrete set of them form.

This method includes four main steps:

1. Parameter Setting are width = 45, height = 45, kmax = pi / 2, f = 1.41, delta = pi/3 ;
2. Create the Gabor wavelets using Gabor Kernel
3. Use default superposition method
4. Finally normalize the output

Without Clustering

With Clustering

III. EXPERIMENT AND RESULTS

The proposed system was developed using MATLAB R2012b and it have tested with different images, its performance have compared the existing edge detection algorithms and it have observed that the outputs of this algorithm provide much more distinct marked edges and thus have better visual appearance than the standard existing.

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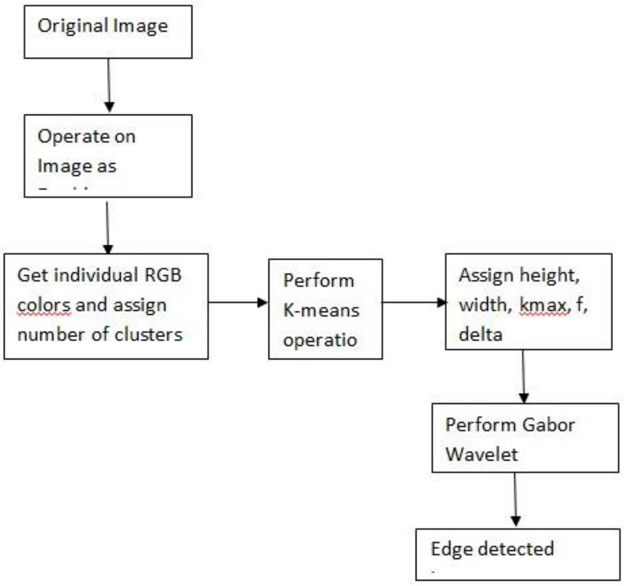

Block Diagram of proposed algorithm

Figure 1: (296059.jpg)

(a) *(b)* *(c)* *(d)*

Figure 2: (147091.jpg)

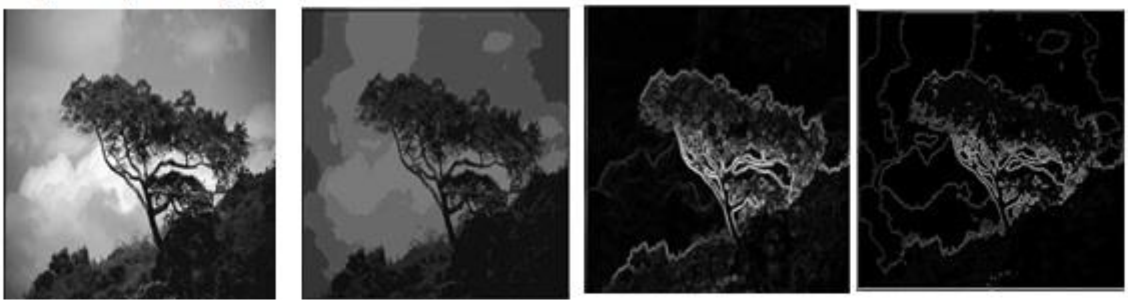

Figure 3: (189080.jpg)

(a) *(b)* *(c)* *(d)*

Edge detection: (a) input image, (b) K-means clustered image, (c) Gabor Wavelet image, (d) Both K-means clustering and Gabor Wavelet

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The experimental results of various pictures in Berkley dataset are shown below and other images to test our segmentation and edge detection methods. We obtained output images that comprise of all edge information and regions about the input image.

IV. CONCLUSION

In this paper, we have proposed a very simple and small but a very efficient, K-means and Gabor wavelet based edge detection algorithm which infuse the concepts of artificial intelligence and digital image processing. Displayed results have shown the accuracy of the edge detection using the K-means and Gabor wavelet based algorithm over the other method.

Finally, the disadvantages of these techniques depend mainly on k-means results, where if the clustering procedure is not implemented correctly, the results are incorrect by the other techniques we used. However, in this paper we have solved the problem of undesirable over segmentation results produced by the Gabor wavelet algorithm.

The future plans include additional improvement of the robustness of the method and development of the realtime facial expression system.

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