Diyala Journal of Engineering Sciences

Journal homepage: https://en.enginmag.uodiyala.edu.iq/

ISSN: 1999-8716 (Print); 2616-6909 (Online)

Image Segmentation Using Discrete Wavelets Transform

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ARTICLE INFO

Article history:
Received 23 May 2019
Accepted 31 May 2020

Keywords:

Color and gray image; DWT; Canny; R.G and Matlab

ABSTRACT

Segmentation of Image plays an important role in image processing and application technology. Image segmentation has importantly contributed to many aspects of life like agriculture, medical image, and computer vision. Because of has the ability to decompose image that is making extract feature like object and edge of image easy. The algorithms of segmentation depend on two essential properties similarity and discontinuity. This paper proposed the segmentation of image based on discrete wavelet transform (DWT were used "Daubechies") which its concerns with the exploitation of pixels in an image. In this paper, discrete wavelets are used with another type of technique like canny, R.G and thresholding to reduce the number of the segment and maintain the edge of an image, also in this paper presented description the interesting of discrete wavelets transform, canny& region growing.

1. Introduction

With the rapid advancement of digitization image processing was found in many application. Image processing and digitized color image were used to analyze and store the image information. Digital images are the images which are expressed with numbers[1]. Wavelets Transform an important approach to work with signal processing and analysis has called a multi-resolution theory. Multiresolution theory has been focused on combining and unifying the techniques from a range of disciplines, including pyramid image processing, optical speech recognition quadrature mirror filtering and sub-band coding from signal processing. The procedure of image segmentation is parting the image into meaningful structures. Segmentation of image very important step in image analysis, object representation and, many other image processing tasks. The segmentation is the decision of which points pixels in an image indicate to information of an object that is important (such a person) or date of the less interesting background (like sky or buildings). The main objective of segmentation is trying to represent the content of an image in a way that is more meaningful and easier to analyze. The algorithms of segmentation are categorized into data clustering, edge-based segmentation, region-based segmentation. Region-based segmentation includes growing algorithms for the seeded and unseeded regions. It is very necessary for many usual techniques, such agriculture image which cannot be highly interpreted and thus the segmentation becomes very interesting. The rest of the paper is organized as follows. In section 2 of this paper overview of related work. In section 3 explain the segmentation. In section4 description of technique has used with segmentation. In section 5description of the motivation of using image segmentation. In

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DOI: 10.24237/djes.2020.13301

section6 introduction[give a description of WT, DWT and explain of canny &R.G]. Result and discussion in section 7and in section 8is given a conclusion.

2. Relatedwork

Proposed the rotation and scale the invariant feature descriptors that are SIFT(Scale-invariant feature transform) is used transformation techniques DWT, Haar wavelet one of interesting wavelet transform is used with review and these are the forms that are used in many techniques or method of the discrete wavelet transform and processing[1]. This paper proposed a frame work for image processing used discrete wave late transform system. The method lets users create high-level images using DWT without understanding the low-level design styles [2]. This paper, introduced segmentation of color image by extracting best features for disntiguishing between regions. Using two dimensions wavelet transforms decompose the image into sub-bands channels and generates a smooth image and convert the image into NTSC color space also, known as YIQ color space allow us to quantify image differences, image information consists of three components luminance (Y), hue (I), and saturation (Q)[3]. In this paper, Automatic Image Segmentation Wavelets (AISWT) had been presented using AISWT, which simplifies and allows segmentation fast. The Discrete Wavelet Transform approximation band is considered for segmentation which contains the most important data of the input image. The algorithm based on histogram used to obtain the number of regions and the initial parameters such as mixing factor, mean and variance. The final parameters are obtained by using the Expectation and Maximization algorithms[4]. The paper focuses on the study of extraction from color images and texture analysis after image segmentation. The basic concept behind segmentation is region growing and to consider one or more criteria which are characteristic of a request region,[5].

This paper proposed visual quality control in ceramic tile. The approach was tested using the artificial defects on the contrast and size of image and sensitivity testing is performed on the failure. The algorithm is experimentally tested using images from real tile images[6]. The paper presented approach edge detection of image using 2-D Discrete Wavelet Transform (DWT) and results compared to one of the classical edge detectors, Canny edge detectors[7]. This paper proposed the segmentation of the document image based on the wavelet transform and Gabor filter technique[8]. In this paper presented Discrete Wavelet Transform for tumor brain segmentation, Support Vector Machine, which involves the Learning Vector Quantization (LVQ) and supervised learning algorithm with high rate of complexity such as tumor appearance and its contour deformation[9]. Presented in this paper comparative, the important place of images segmentation in drawing up decision making information. And present the most relative and general methods grouped into three categories, the first category represents pixels based, the edges based and the third represent regions based methods[10].The paper explain and described various image segmentation techniques are reviewed and discussed [11]. The main idea was improved video coding by a using texture synthesizer[12]. Presented in this paper method of segmentation and compact multiscale representation of images depend on progressive backward clustering[13].

3. Segmentation

Image segmentation processes of broken the image to many segments. The main idea of the segmentation image is a processing of parting the image into several segments that have properties homogenous concerning to the main information. The homogenous segment came by a result of information, and indwell pixels that having similarities in each segment according to particular criteria enable us to recognize the main differences in the image. based on, attribute of the image. Image segmentation can be divided into two main kinds: Local segmentation (work on the specific part of an image concerned with specific of information from image) and Global segmentation (work on all regions of an image). Each region process concerned with specific information from the image each region possesses has diverse features

contain texture, intensity, color or other statistical properties. Regions of segmentation images are containing pixels and these have similar properties to be useful and meaningful for image analysis. There are a lot of various methods to extract a specific part from the image. The segmentation process considers the first step from low-level image processing to convert a color or greyscale image into one or more images with high-level objects and features image information etc. The successfully of image interruption depends on accurate segmentation, but until now an accurate partitioning of an image is a challenging issue[1]. Result of image segmentation is either a group of regions that together coverage all image or a set of contours which have been come from the image.

4. Image segmentation techniques

There are various technique methods that work on image segmentation. Every technique can be applied to different kinds of images to perform the required segmentation. These methods have an advantage and drawbacks in this section introduce several methods. Like thresholding it considers the simplest method and has the ability to recognize the background image from foreground objects images, these objects have lighter more than its background. Unfortunately, there is no guarantee of object coherency may have outer pixels or holes[11]. The idea of thresholding supposes the clusters in the histogram are either objects or background that can be extracted by dividing these clusters in histogram. There are three styles of thresholding method (Global Thresholding, Variable Thresholding, Multiple Thresholding) and all these have special properties to work with an image. The second method has regions based segmentation depend on divided an image according to on similarity properties of the pixels and it can classify in two categories region growing method and split merging methods[11].

The third segmentation method is clustering depends on segmentation which separates the image into clusters that having pixels with similar properties. The four segmentation method is watershed methods which use the concept of topological analysis [11]. Where the representation of the intensity has based on the basins having a hole in its minima from where the water spills and this method it is gradient method of an image as topographic surface. The pixels are having a huge gradient that is represented as boundaries that are continuous. The five methods[11] and the fast segmentation methods are partial differential equation-based methods. In fact, several image segmentation algorithm depends on two interesting attributes of the pixels: similarity and discontinuity. The name of methods have based on pixel similarity are called region-based methods whereas methods based on pixel discontinuity are called boundary based or edge extraction methods. In general, there are no single or standard segmentation methods which work well with all kinds of an images. In this paper, improve the work of the DWT technique by using canny and R.G to extracts features, edge detection from the image and remove the noise by reducing the number of the segment. Chose the appropriate technique of segmentation image depends on the kind of images and applications that have been wanted and need it.

5. Motivation of image segmentation

Segmentation is a very essential step in many advance techniques of color image processing and its applications. The segmentation usually provides an easy method to extract the main feature from an image. The segmentation of image is to analyze and transforms an image's information into something that is more useful in application. The goal image segmentation is to a simpler analysis of data and cluster pixels into salient image regions. If the image contains objects with different intensity background segmented become necessary. Segmentation can be used to estimate the occlusion boundary within motion or image editing, stereo systems, object recognition, or image database look-up. The medical images, example DWT used with a medical image for providing different data on the tumor of the brain scene as it shows various parts of the tumor region with a set of visuals[9].

6. Image processing

6.1.WT for image processing

Wavelets transform is one technique that has used with signal processing and analysis. Wavelets are a more general way to represent and analyze information of images, and very useful for image segmentation and image compression. Wavelet transform has similar properties to Fourier transform the difference between both wavelets are localized in both frequency and time domain, whereas the standard Fourier transform is just localized the frequency domain[8]. The wavelet transform provides a compact description of color images and it is very useful for the description of edges and lines that are highly localized. The wavelets have been getting it from a signal prototype wavelet for example y(t) called mother wavelet by dilations and shifting. Wavelet transform analyzed the signal into a set of basis functions. These basis functions called by wavelets. Wavelet transform has interestingly affected in a wide area of signal processing especially image compression and image analysis [11]. The idea of Wavelet Transform comes by repeating filtering of the image coefficients on a column by column and a row by row basis[4]. A two-dimensional DWT decomposition of an image have different band frequency such as low-lowfrequency approximation band, high-low frequency vertical detail band, low-high frequency horizontal detail band, and high-high frequency diagonal detail band. The coefficients of the frequency approximation band are a random variable. The approximation band is used for the segmentation purpose, and which has interesting data of the original image [1].DWT with image has been decomposed on wavelet decomposition techniques using transform with diverse levels of decomposition. Wavelet transform comes with different style wavelet transform the discrete wavelet transform (DWT). The work of (DWT) depend on time-scale representation, gives very well multi-resolution subband decomposition of signals. And continuous wavelet transforms(CWT) the normal expansion of the discrete wavelet transform in the continuous wavelet transform, which transforms a continuous function into a highly redundant function of two continuous variables translation and scale [1]. With wavelet found many kinds like Daubechies, Haar, Morlet, etc. Wavelet is filtering play an important role in achieving an effective coding performance.

6.2.DWT for image segmentation

DWT is any wavelet transform for which the wavelets are discretely sampled. In 1976, DWT was used for decomposition of discrete-time signals. The same work is performed with coding of speech signal which has been called sub-band coding, and another methode similar to sub-band coding was used in 1983,and became known as pyramidal coding[5]. Today DWT become one of the most promising techniques. It has other important properties such as progressive reconstruction that make wavelet transform a powerful tool for data compression. In this paper, we concern with discrete wavelet transform. We use Discrete wavelet transform with gray and color images because wavelets can provide information of frequency as well as time space localization. Besides, their multi-resolution enables color of image to be visualized at different scales. The DWT is a signal processing tool which is especially suitable for the analysis of non-stationary signals[Stationary signals are signals whose spectral characteristics do not change with time] these signals have been found in a countless number of everyday applications and processes. Through the work, we will note that the wavelet transform has several properties like a high-energy compaction property that makes DWT a very interesting tool for image analysis. The DWT sequence is composed of two expansions in series, one corresponding to approximation information and another one to corresponding detail coefficients[14]. So standard formal which used with DWT as follow:

$$w_{\emptyset(j_0,k)} = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x[n] \emptyset_{j0,k}[n] \qquad (1)$$

$$w_{\Psi}(j,k) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x[n] \Psi_{j,k}[n] \geq j_0 \qquad (2)$$

$$x[n] = \frac{1}{\sqrt{N}}\sum_{k}^{\infty} W_{\varphi}(j_0,k)\varphi_{j_0,k}[n] + \frac{1}{\sqrt{N}}\sum_{j=0}^{\infty} \sum_{k} W(j,k)\Psi_{j,k}[n] \quad (3)$$

The parameter of scale at equation (3), has an infinite number of terms, however, in practice the upper limit for the parameter of scale is generally fixed at certain value for example, J. Typically the starting scale value j_0 set to zero, which corresponds to the original signal. Thus, the coefficients DWT for x[n], 0≤n≤N-1 are therfor deterimend for, j=0,1,…,J-1 and k=0,1,..,2^j-1. So, N is usually a power of 2, of the term N=2^(J).

6.3.Canny and R.G

Canny edge detection refers to a multi-step algorithm which can use to detect edges in an image, widely used in image processing and has developed in 1986 by John F. The work of canny edge depends on many steps first one is Gaussian filters to smooth image, compute the gradient magnitude, non maximum suppression to remove the pixels that do not use of an edge and the last one is using thresholding and in this paper we have used different value of thersholding to extract the edge of image. The advantage of canny have a low error rate, at the same time preserve the necessary information and enhance the image with respect to noise ratio. R.G(region growing) indicate to exploit the essential fact that pixel which closes together have similar gray values. The first step of R.G Start by a single pixel (seed) and add a new pixel slowly. The second step of R.G select the seed pixel. Diagnosis neighboring pixels and added them to the region slowly if they have similarity to the seed. Repeat step 2 for each of the newly added pixels. The proposed method which has used in this paper, the first step start by reading the image by using canny and R.G checked the number of a segment and the edge detection of an image. the Second step read the image and we are using DWT, canny and R.G and compare the no of a segment in both cases, as shown in Fig 2.

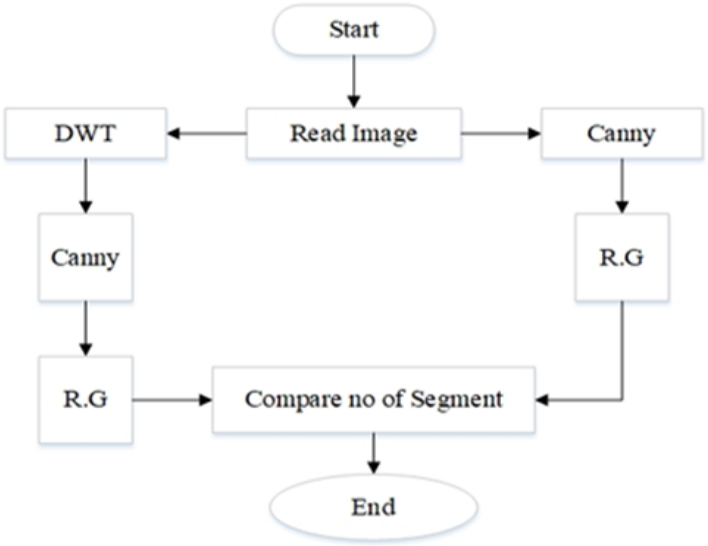

Fig. 1. Flowchart of an Image segmentation procedure

7. Result and Discussion

The approach have been applied to a different kind of images, with varying sizes and objects. The first step was read input image in Matlab (version 2015). The method is applied Discrete Wavelet Transform(Daubechies wavelet db2) on the image, the process has done with image by dividing the information of image into approximation and details sub-signal of filters, the approximation has maximum information and indicated to general trend of pixel values and rest of three details sub-signal referred to horizontal, vertical and diagonal details. In this experiment the DWT approximation band is taken for segmentation, where are used DWT with canny and R.G with a different value of thresholding in this paper, have been compare the result when are

used DWT and when are used discrete wavelet transform, canny and R.G with thresholding., In figure.2 as illustrated girl image 2(a) refer to original image, 2(b)using DWT(discrete wavelet transform) where are using approximation component, 2(c) are used canny where the image content more information, 2(d) has applied canny and R.G to find number of segment where reduce redundancy data, 2(e) when are using DWT with canny to find no of segments and 2(f) where are using DWT with, canny, R.G and were used thresholding [T=3] where keep the edge of hair, face and reduce the redundancy data that make extract feature possible then have been compare the result among them. Figure.3 the ball image, where 3(a) show original image, 3(b)applied DWT where using approximation component, 3(c) using canny with image, 3(d) using canny and R.G with image to find number of segment, 3(e) DWT and canny and3(f) DWT, canny and R.G with [T=100] to find number of segment then compare the result among them as noted keep the bounders of ball and reduce the no of segment. See figure.4 boy image, 4(a) original image, 4(b) using DWT, 4(c)using canny, 4(d)using canny and R.G to find number of segment, 4(e) using DWT and canny and 4(f) using DWT, canny, R.G and thresholding[T=2] then have been compare the result among them in this case provide better result by keeping the edge of face, eyes, nose, hair and necessary information of image. The main idea when are using a different values of thresholding with R.G to reduce the number of segments and redundancy data as possible. The table 1gives the comparison of number of segment when we are using canny with R.G, when applied DWT and when applied DWT, canny & R.G(with thresholding). Its observed the number of segment decrees when are using DWT, canny &R.G with T. The main purpose of using discrete wavelet transform with canny and R.G to analyze, segment the image and keep the facial feature and boundaries of image. The interesting point in this paper it used different techniques to improve the segmentation image and remove the noise.

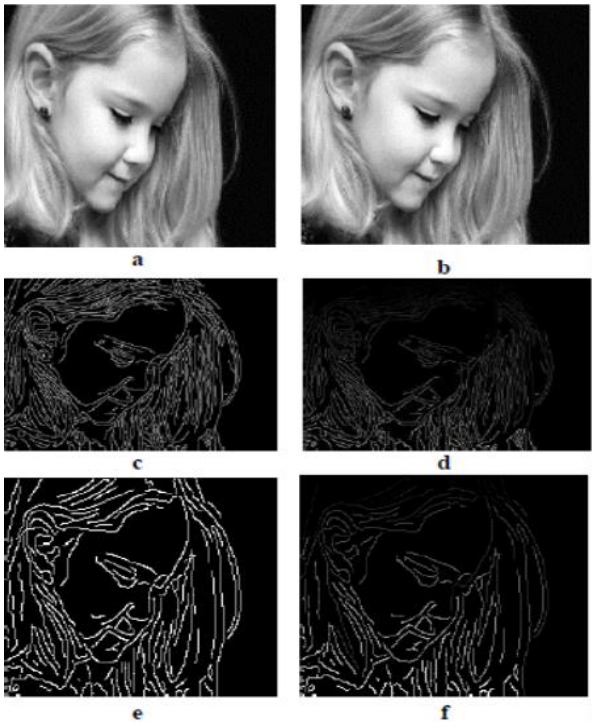

Fig. 2. a) Original girl image b) Approximation of DWT c) Canny d) canny&R.G e) DWT&canny and f) DWT,canny,R.G&T=3.

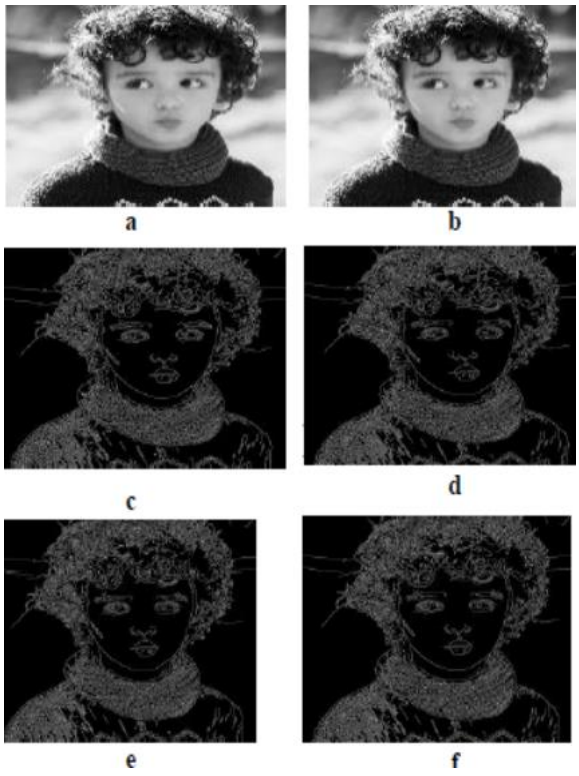

Fig. 3. a) Original ball image b) Approximation of DWT c) Canny d) Canny&R.G e) DWT&canny and f) DWT,canny,R.G&T=3

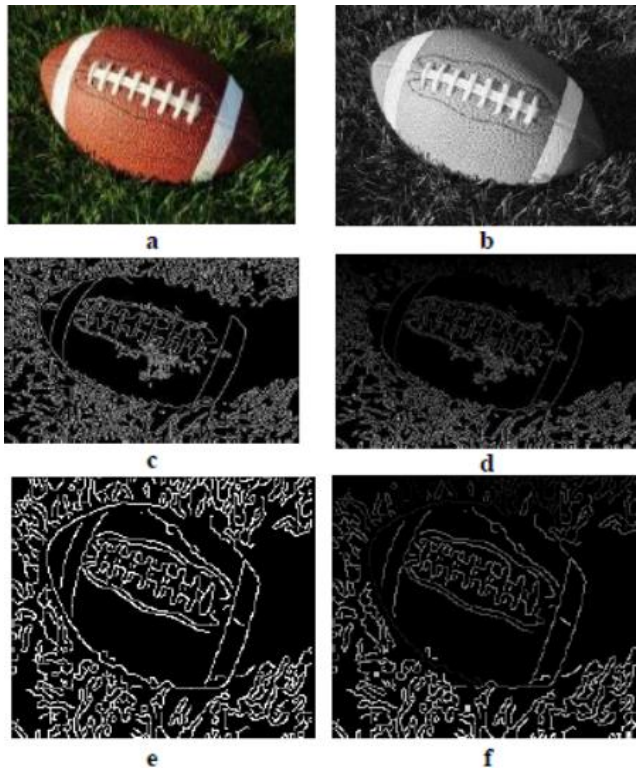

Fig. 4. a) Original boy image b) Approximation of DWT c) Canny d) Canny& R.G e) DWT& canny and f) DWT, canny, R.G&T=3.

Table1 Gives the comparison the number of segments for canny with R.G, DWT and DWT with canny &R. G.

Image	No.of segment		
	Cany with R.g	DWT	DWT with canny and R.G
Girl	393	40822	113
Ball	588	38420	14
Boy	2062	867	467

8. Conclusion

The Basics concept of discrete wavelet transform has presented in this paper. The technique of DWT with canny and R.G produce novel algorithms for edge detection and useful in application. The wavelet transform gives an interesting description of details images and it is very helpful in the description of edges and lines that are highly localized. The Practical experiment shows the flexibility of discrete wavelet transform with canny filter and R.G with a different value of T, we can decrease the number of segmentations according to the value of T but not with all kind of image. The DWT has good spatial localization is achieved by this method for the higher frequency components where still keep the edge of the image but the drawback with this experiment we cannot apply this method on all kind of image. In other words, we can consider DWT is stochastic techniques.

References

[1] A. Kumari and M. Thakur, "Feature Based Object Detection Using DWT Technique : A Review," vol. 5, no. 9, pp. 337–340, 2015.

[2] P. Kour, "Image Processing Using Discrete," IPASJ - Int. J. Electron. Commun., vol. 3, no. 1, pp. 53–59, 2015.

[3] S. kaisJameel and R. R. Manza, "Color image segmentation using wavelet," Int. J. Appl. Inf. Syst., vol. 1, no. 6, pp. 1–4, 2012.

[4] H. Kumar, K. Raja, K. R. Venuopal, and L. M. Patnaik, "Automatic image segmentation using wavelets," Int. J. Comp. Sci, vol. 9, no. 2, pp. 305–313, 2009.

[5] A. Singh and M. Joshi, "Image Segmentation using Haar DWT & Texture Analysis in MATLAB," Int. J. Comput. Sci. Technol., vol. 5, no. 3, pp. 22–25, 2014.

[6] Ž. Hocenski, S. Rimac-Drlje, and T. Keser, "Visual Diagnostics Based on Image Wavelet Transform," 9th Eur. Conf. Power …, pp. 1–8, 2001.

[7] R. Monika, "Image Edge Detection using Discrete Wavelet Transform," Int. J. Innov. Res. Comput. Commun. Eng., vol. 4, no. 4, pp. 169–175, 2016.

[8] M. T. Wanjari and M. P. Dhore, "Document Image Segmentation Using Wavelet Transform and Gabor Filter Technique," pp. 25–29, 2016.

[9] M. R. Krishna, F. G. Daizy, and F. K. Sravani, "Brain Tumor Image Segmentation Based On Discrete Wavelet Transform and Support Vector Machine," vol. 3, no. 02, 2017.

[10] B. B., "a Comparative Study on Classification of Image Segmentation Methods With a Focus on Graph Based Techniques," Int. J. Res. Eng. Technol., vol. 03, no. 15, pp. 310–315, 2014.

[11] E. Anjna, "Correction: (The Journal of Pediatrics (2016) 174 (247–253-e3) (S0022347616300075