An Edge Detection Approach Based on Wavelets

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Abstract

Edge detection is one of the most important steps in image processing, analysis and pattern recognition systems. Early edge detection methods employed local operators to approximately compute the first derivative of gray-level gradient of an image in the spatial domain. Classical edge detection operator is example of the gradient-based edge detector, such as Roberts's operator, Sobel operator, Prewitt operator, LOG operator etc. Because these are very sensitive to noise, classical edge detection operators are not practical in the actual image processing. Recently, a lot of study is done to detect the edge of the image using different methods, such as Wavelet Transform Method, Mathematical Morphological Method, Neural Networks Method, Fuzzy Method. In this paper, explore the wavelet based method for edge detection and performance of wavelet based method is compared with existing traditional techniques by visual results of edge detection techniques. Wavelet based techniques is also good for edge preservation and better noise suppression.

Keywords: *Edge detection, operator.*

1. INTRODUCTION

Edge and feature extraction have been two areas in particular which have involved much research. A grey-scale image is typically processed using an edge detector to extract useful edges. These pixel-based edge descriptions are then transformed into higher, more symbolic features such as regions, lines and vertices. The development of many algorithms for edge detection begs the question of which is the best for a particular application [1]. An edge is usually considered to be a physical one, caused by either the shapes of physical objects in three dimensions or by the material properties inherently. Although the definition depends on the type of application, an edge can generally be defined as a boundary or contour that separates adjacent image regions having relatively distinct characteristics according to some feature of interest.

Edge detection is a terminology in image processing and computer vision, particularly in the areas of feature detection and feature extraction, to refer to algorithms which aim at identifying points in a digital image at image brightness changes sharply or more formally has discontinuities [16].

The main goal of edge detection is to locate and identify sharp discontinuities from an image. These discontinuities are due to abrupt changes in pixel intensity which characterizes boundaries of objects in a scene. Edges give boundaries between different regions in the image [13].

The paper is organized is as follows:

2. THEORETICAL BACKGROUND

There are many methods for edge detection, but most of them can be grouped into two categories.

i) Search-Based

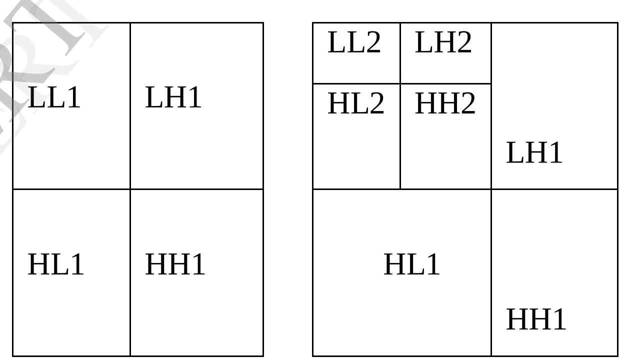
The search-based methods detect edges by looking for maxima and minima in the first derivative of the image, usually local directional maxima of the gradient magnitude. The first order derivatives are used to identify the edge pixels, using some standard operators such as Robert's, Sobel's and Prewitt's operators [13].

ii) Zero Crossing Based

The zero-crossing based methods search for zero crossings in the second derivative of the image in order to find edges, usually the zero-crossings of the Laplacian or the zero-crossings of a non-linear differential expression. The zero in crossingis based on the second order derivatives of image function and it is based on the concept that the second order derivative is positive on which the the one side of the edge and negative on the other side thus assuming a zero value between the positive and negative values [10,11].

3. DISCRETE WAVELET TRANSFORM

The Discrete Wavelet Transform (DWT) is identical to a hierarchical sub band system where the sub bands are logarithmically spaced in frequency and represent octave-band decomposition. By applying DWT, the image is actually divided i.e. decomposed into four sub-bands and critically sub sampled as shown :



(a) One-Level (b) Two-Level

Figure 1: Image Decomposition

3.1 Wavelet Families:

We have used two types of wavelet families in this research:

a) Haar:

In mathematics, the **Haar wavelet** is a sequence of rescaled "square-shaped" functions which together form a wavelet family. Wavelet analysis is similar to Fourier analysis, it allows a target function over an interval to be represented in terms of an orthonormal function basis. The Haar wavelet is also the simplest possible wavelet. The Haar wavelet is not continuous therefore not differentiable. This property can be an advantage for the analysis of signals with sudden transitions, such as monitoring of tool failure in machines [14].

b) DB (daubechies):

Daubechies wavelets named after Ingrid Daubechies, the Daubechies wavelet is more complicated than the Haar wavelet. Daubechies wavelets are continuous. They are more computationally expensive to use than the Haar wavelet, which is discrete. Daubechies wavelet are a family of orthogonal wavelets defining a discrete wavelet transform characterized by a maximal number of vanishing moments for some given support.

3.2 Wavelet Thresholding:

According to wavelet analysis, smearing out the sharp edges features of an ideal image is to threshold only high frequency components while preserving most of the sharp features in the image. The approach is to shrink the detailed coefficients (high frequency components) whose amplitudes are smaller than a certain statistical threshold value to zero while retaining the smoother detailed coefficients to reconstruct the ideal image without much loss in its detail. This process is sometimes called wavelet shrinkage since the detailed coefficients are shrunk towards zero. The schemes to shrink the wavelet coefficients, called the "keep-or-kill" hard thresholding, and "shrink-or-kill" is soft thresholding.

4. PROPOSED ALGORITHM FOR EDGE DETECTION BASED ON WAVELETS

1. Load the input image of size [m n] where m=n=128,256,512,1024.

2. Apply Discrete Wavelet Transform (DWT) on an input image to decomposed the image into detail part and approximation part.

3. Threshold the each Horizontal, Vertical and Diagonal sub band .

4. To detect the edges from an image, apply step (6) on detailed parts of an image (H,V,D) of an image i.e. HL,LH,HH.

5. We should set a certain threshold to display the edges.

6. Apply soft thresholding on H,V,D.

7. After apply soft thresholding technique, take inverse discrete wavelet transform (IDWT) to the modified wavelet coefficient.

5. RESULTS AND DISCUSSION

Various edge detection techniques like gradient methods (e.g. Sobel Operator, Prewitt Operator), second order derivative operators (e.g. Laplacian of Gaussian) and Canny Operators are widely used. The traditional techniques do not give satisfactory results. The purpose of this following results is to investigate the effectiveness of wavelet for edge detection.

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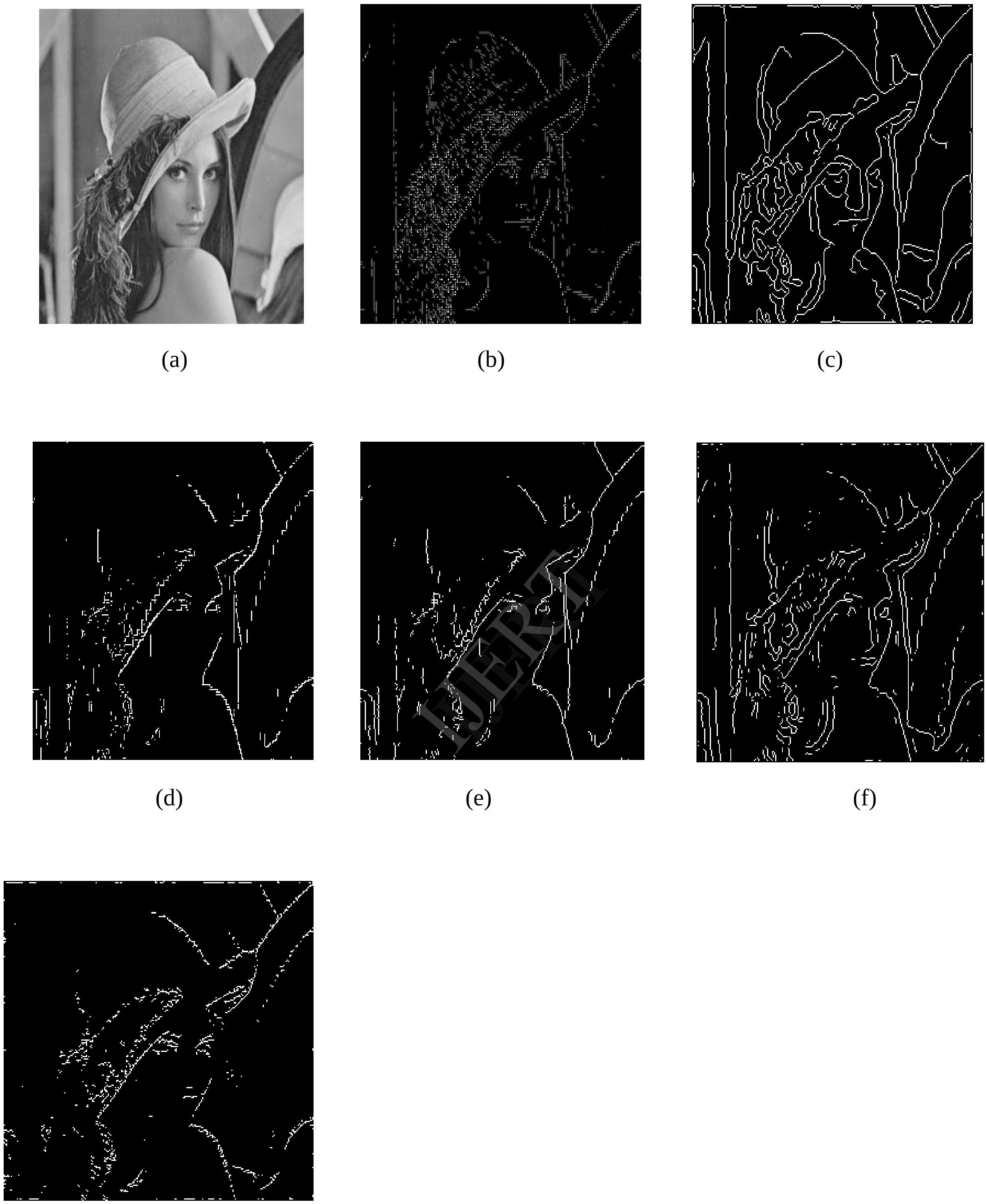

(a) (b) (c) (d) (e) (f) (g)

Figure 2: Results of Edge detetion of "Leena" image using various operators.

a) Input "Leena" image b) DWT c) Canny opartor d) Robert operator e) Prewitt operator f) LoG g) Sobel operator.

6. CONCLUSIONS

This research paper investigate the effectiveness of wavelet for edge detection by comparing its effectiveness again some other promising edge detection techniques. We tried to explore the wavelet based method for edge detection and visual results of edge detection techniques. DWT splits the image in to the sub-bands or sub parts. So with the help of sub-bands , it gives better edge information means true and thin edges. So we conclude from our experimental results that discrete wavelet transform has much better results for edge detection than other edge detection operators.

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