

Image Improvement Using The Combination of Wavelet and Multiwavelet Transform

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Abstract

This paper introduces method of image enhancement using the combination of both wavelet and Multiwavelet transformation. New technique is proposed for image enhancement using one smoothing filter.

A critically- Sampled Scheme of preprocessing method is used for computing the Multiwavelet. It is the 2nd norm approximation used to speed the procedures needed for such computation.

An improvement was achieved with the proposed method in comparison with the conventional method.

The performance of this technique has been done by computer using Visual Basic 6.0 package.

Introduction

Image improvement is a technique which reduces image noise, removes artifacts, and preserve details.

In this paper, wavelet transform is used as a sub-step of this technique.

The wavelet transform [1] has a long and successful history as an efficient image processing tool. However, as a result of a separable extension from 1-D bases, wavelets in higher dimensions can only capture very limited directional information. Different directions are mixed in certain wavelet sub-bands. For instance, 2-D wavelets only provide three directional components, namely horizontal, vertical, and diagonal.

Furthermore, the 45° and 135° directions are mixed in diagonal sub-bands. With the directional extension for wavelets proposed in [2] that mixing problem can be improved, but not totally resolved. However, the wavelet transform is still very attractive for image processing applications.

Multiwavelets are a relatively new addition to the wavelet theory, and have received considerable attention since their introduction [3]. Contrary to ordinary wavelets, Multiwavelet offers simultaneous orthogonal, symmetry, and short support. Similar to performing wavelet decomposition with filters, Multiwavelet decomposition can be realized with filter-banks. The filter coefficients in this case are, however, matrices instead of scalars. Therefore, two or more input streams to the Multiwavelet filter-bank are required to perform the decomposition. Several methods have been developed for obtaining multiple input streams from a given single input stream [3].

This paper uses A Critically Sampled Scheme of Preprocessing 2nd norm approximation with its inverse as one approach of Multiwavelet.

Discrete Wavelet Transform

The transformation is a process that translates one object from a given domain to another in order to have some important implicit information, which can be used for its recognition [4]. One of the conventional transformations is the Fourier transform which usually transforms the signal from its time domain to the frequency domain [5]. The next form of the Fourier transform developed to an efficient transform is called the Wavelet Transform (WT) [6]. The

Wavelet can be regarded as the most efficient transform that deals with image, sound, or any other pattern since it provides a powerful time-space (time-frequency) representation [7].

The effect of the wavelet transform on image is defined as" it abstracts the image in universal space, this contains all information into an approximately orthogonal (statistical independent) spaces (represent projection of the subject) contained in this universal space. By changing the scale in each projection, the algebraic sum of all these projections gives the original subject before abstraction process" [8,9].

This type of transformation can be applied on one as well as on two dimensional signals by using a special Transformation matrix which is known as a filter denoted by D4 wavelets. D4 wavelet or (transformation matrix) can be reconstructed by using four coefficients:-

$$C_0 = (1+\sqrt{3}) / 4\sqrt{2}$$

$$C_1 = (3+\sqrt{3}) / 4\sqrt{2}$$

$$C_2 = (3 - \sqrt{3}) / 4\sqrt{2}$$

$$C_3 = (1-\sqrt{3}) / 4\sqrt{2}$$

Depending on the previous four coefficients D4 the transformation matrix must be a square matrix $N \times N$ and depends on the dimension of the input signal which must be also a square matrix $N \times N$.[6]

Multiwavelet transform

Multiwavelet filter banks require a vector-valued input signal. There is a number of ways to produce such a signal for 2-D signal image data. One of the methods is to split first each row or column into two half-length signals, and then use these two half signals as the channel inputs into the multi-filter.

A native approach is to simply take the odd samples for one signal and the even samples for the second signal. As Strela points out (Strela, 1996), [4].

This approach does not work well because it destroys the assumed characteristics of the input signal. It is generally presumed that image data will be locally well-approximated by low-order polynomials, usually constant, linear or quadratic. The high pass filters are Designed to give a uniformly zero output when the input has this form. Taking alternative data points as the filter input alters the character of the input signal. Hence the filter output will no longer be forced to zero, reducing compression performance.

Around this problem: one may first pre-filter the two-half length signals before passing them into the multi-filter.

Discrete Multiwavelet Transform using a Critically- Sampled Scheme of preprocessing 2^{nd} norm Approximation)

By using this method of preprocessing (Approximation-based scheme of preprocessing), the DMWT matrix has the same dimensions of the input image which should be a square matrix $N \times N$ where N must be power of 2.[2][8]

Transformation matrix dimensions which should be equal to image dimensions after preprocessing will be $N \times N$ for a *Critically- Sampled Scheme of Preprocessing*.

A Computer Test: A general computer program computing a single-level DMWT using a Critical-Sampled Scheme of Preprocessing (2^{nd} norm approximation) are written using Visual Basic V.6.0 for a general $N \times N$ image as shown in figure (1).

Mean filter :Mean filtering is a simple, intuitive and easy to implement method of *smoothing* images, *i.e.* reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images.[11]

How It Works :The idea of mean filtering is simply to replace each pixel value in an image with the mean ('average') value of its neighbors, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean. Often a 3×3 square kernel is used, as shown in Figure 1, although larger kernels (*e.g.* 5×5 squares) can be used for more severe smoothing. (Note that a small kernel can be applied more than once in order to produce a similar but not identical effect as a single pass with a large kernel.)[12]

$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$

3×3 averaging kernel often used in mean filtering

Computing the straightforward convolution of an image with this kernel carries out the mean filtering process. Mean filtering is most commonly used as a simple method for reducing noise in an image. In general the mean filter acts as a low pass frequency filter and, therefore, reduces the spatial intensity derivatives present in the image.[12]

A Technique for Image Enhancement using DMWT and DWT with Smoothing

In this section, a new technique is proposed for image enhancement using one smoothing filter of type mean filter which is applied two times on some parts of the processed image with a combination between DMWT and DWT, as shown in the figure (3). The steps of the proposed method are as follows:-

1. Apply Multiwavelet transformation on the input image, as shown in figure (3-a).
2. Apply mean filter on specific parts (high pass components) of the resultant image (L_1H_1 , L_1H_2 , L_2H_1 , L_2H_2 , H_1L_1 , H_1L_2 , H_1H_1 , H_1H_2 , H_2L_1 , H_2L_2 , H_2H_1 , H_2H_2), as shown in figure (3-b), and leave the low-pass components as it is which is used in the next step.

L_1L_1	L_1L_2	L_1H_1	L_1H_2
L_2L_1	L_2L_2	L_2H_1	L_2H_2
H_1L_1	H_1L_2	H_1H_1	H_1H_2
H_2L_1	H_2L_2	H_2H_1	H_2H_2

3. Obtain the Wavelet transformation coefficients for each part of the low-pass components ($L_1H_1, L_1L_2, L_2L_1, L_2L_2$), as shown in figure (3-c). Each part will give four sub-band (LL, LH, HL, HH) as shown below:-

LL	LH	LL	LH	L_1H_1	L_1H_2
HL	HH	HL	HH		
LL	LH	LL	LH	L_2H_1	L_2H_2
HL	HH	HL	HH		
H_1L_1		H_1L_2		H_1H_1	H_1H_2
H_2L_1		H_2L_2		H_2H_1	H_2H_2

4. Each part will be processed as the previous way then repeat step (2) on the resultant high-pass components only ($L_1H_1, L_1H_2, L_2H_1, L_2H_2, H_1L_1, H_1L_2, H_1H_1, H_1H_2, H_2L_1, H_2L_2, H_2H_1, H_2H_2$) by applying mean filter on that components and leave the low-pass components, as shown in figure (3-d).

5. Inverse the Wavelet transformation coefficients, as shown in figure (3-e)

6. Inverse the Multiwavelet transformation coefficients of the resultant image from the previous step two times to get the reconstructed image, as shown in figure (3-f).

Figure (2) will illustrate the fill block diagram for the proposed algorithm.

Evaluation tests

The goal of this system is to enhance a color image (using the BMP image format). BMP (Bitmap) file format is used for bitmap graphics on the window platform only.[10]

Unlike other file format, which stores image data from top to bottom and pixels in Red, Green, Blue order, the BMP format stores image data from bottom to top and pixels in Blue, Green, Red order.

This means that if memory is tight, BMP graphics will sometimes appear drawn from bottom to top. BMP files are usually very large, and when saving a file of BMP format, it should be add ".BMP" files extension to the end of its file name.

Depending on the Multiwavelet transform with an enhancement filter (mean filter).

The system is designed by dividing into three main parts:-

- Multiwavelet transform way using a Critical-Sampled Scheme of Preprocessing (2^{nd} norm approximation) and it's inverse, as shown in figure (3-a and 3-f).
- Wavelet transforms way and its inverse, as shown in figure (3-c and 3-e).
- Smoothing filter which is applied two times, as shown in figure (3-b and 3-d).

The running of this technique is shown in figure (3).

Conclusion

This paper mixed two transforms Wavelets and Multiwavelet uses to obtain enhancement image.

Wavelets are a useful tool for signal processing applications such as image compression, enhancement, and denoising.[1] Until recently, only scalar wavelets were known: wavelets

generated by one scaling function. But one can imagine a situation when there is more than one scaling function. This leads to the notion of Multiwavelet, which have several advantages in comparison to scalar wavelets. Such features as short support, orthogonality, symmetry, and vanishing moments are known to be important in signal processing[5] A scalar wavelet cannot possess all these properties at the same time. On the other hand, a Multiwavelet system can simultaneously provide perfect reconstruction while preserving length (orthogonality), good performance at the boundaries (via linear-phase symmetry), and a high order of approximation (vanishing moments). Thus Multiwavelet offers the possibility of superior performance for image processing applications, compared with scalar wavelets. During a single level of decomposition of an image using a scalar wavelet, the two-dimensional data is replaced with four blocks. These blocks correspond to the sub-bands that represent either low-pass filtering or high-pass filtering in each direction. The procedure for wavelet decomposition consists of consecutive operations on rows and columns of the two dimensional data.

From this paper above we study and conclude that gated image passes through many steps of enhancement. Every step increases the enhance of the image.

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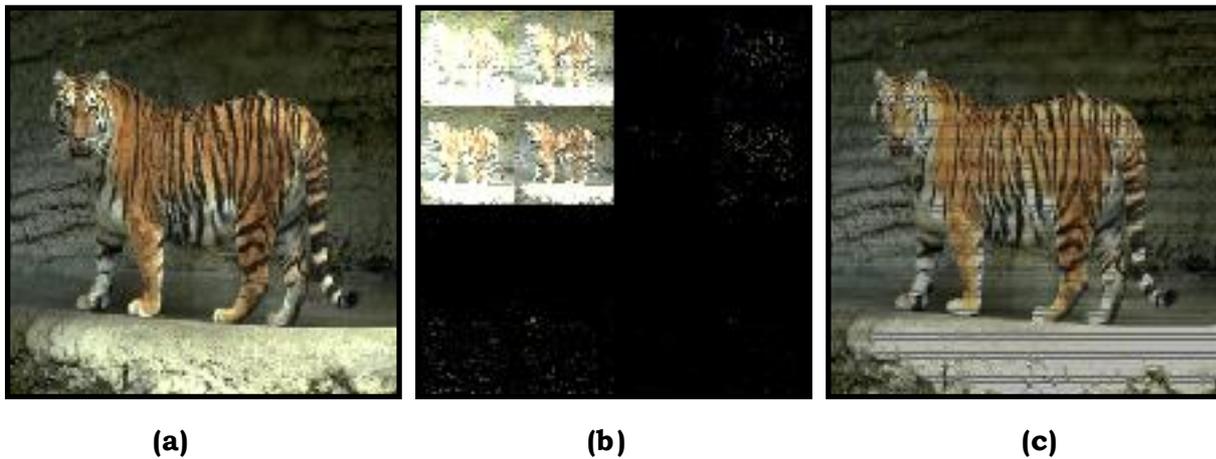


Fig. (1) :- (a) Original, (b) After a Single-Level of *DMWT* Using a Critical-Sampled Scheme of Preprocessing (2^{nd} norm Approximation), (c) After applying the inverse of *DMWT*

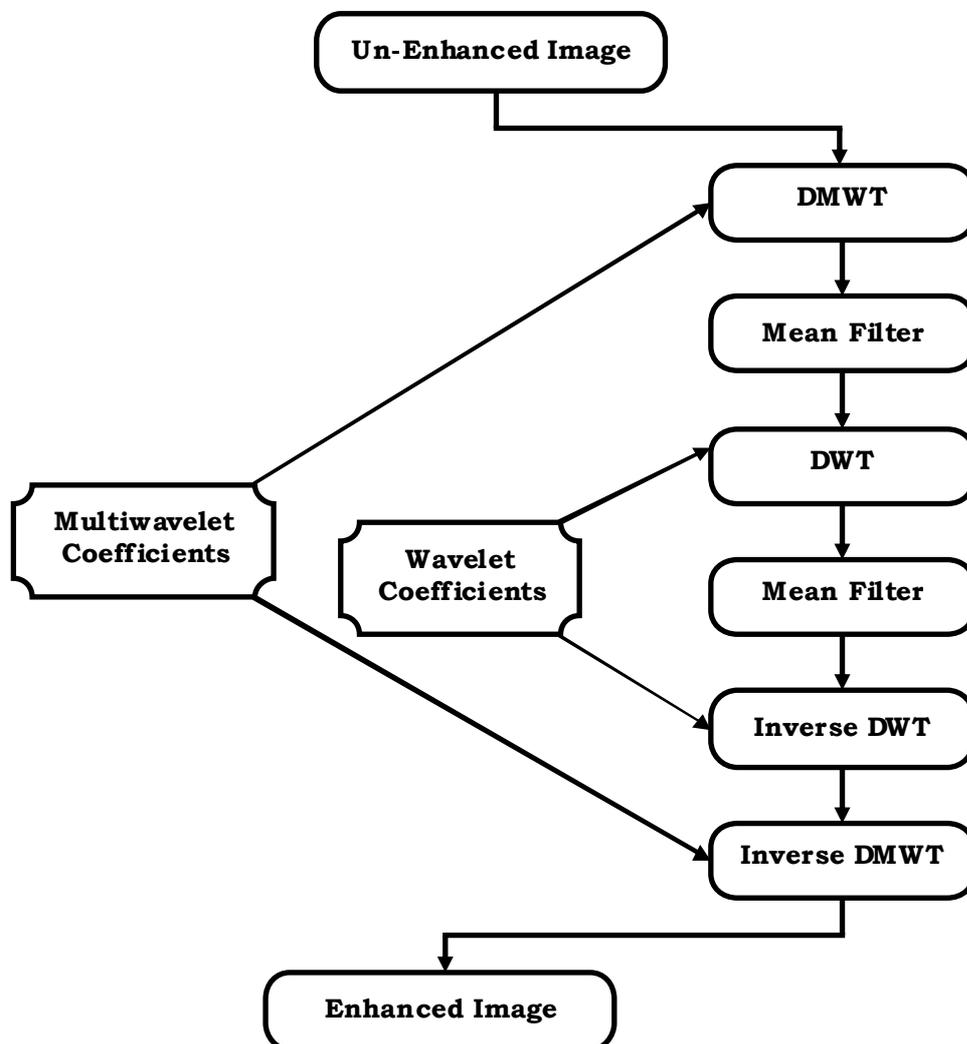


Fig. (2) : A block diagram for the implemented algorithm.

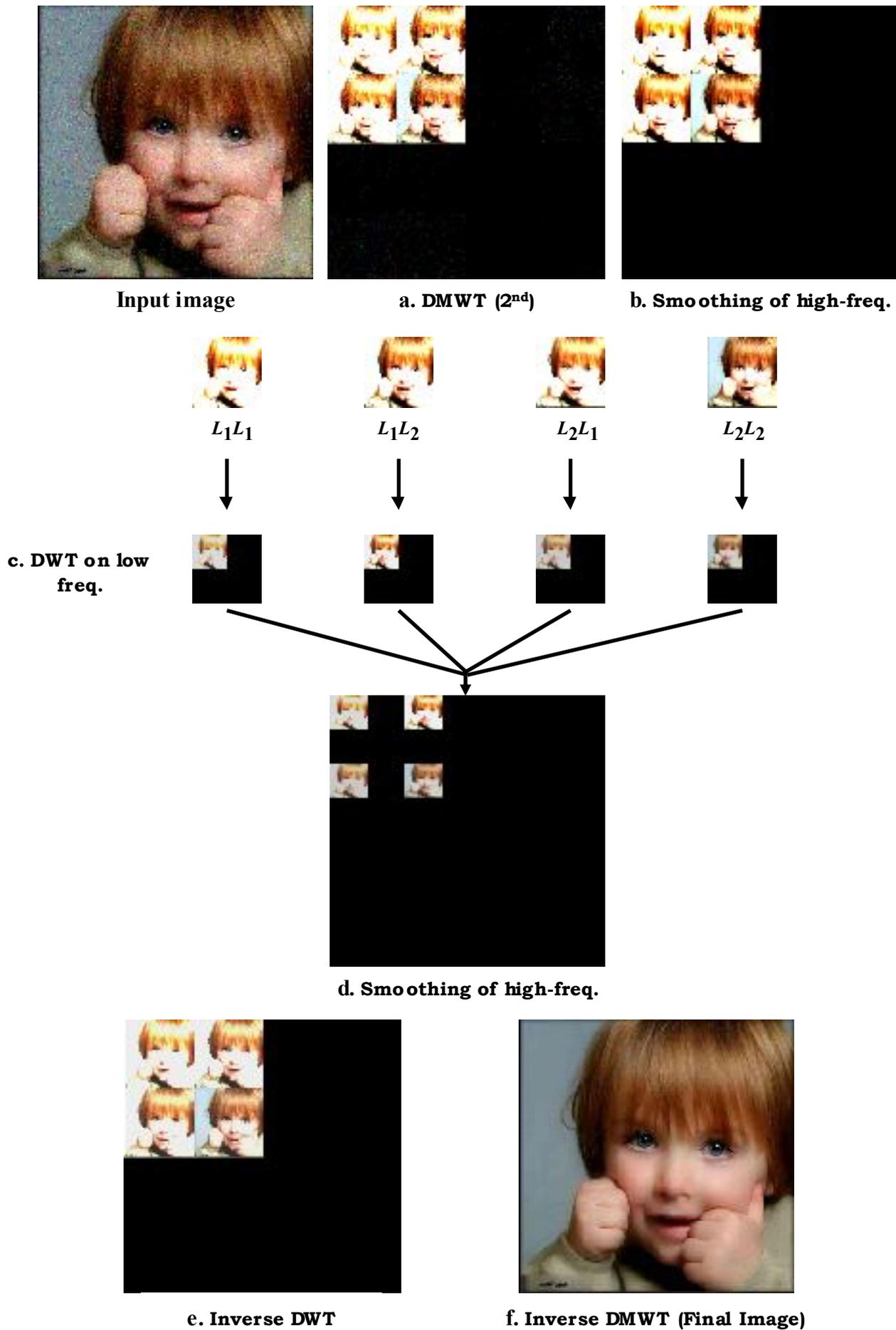


Fig. (3): A step by step of implementing the algorithm

تحسين الصورة باستخدام التحويلين

Wavelet و multiwavelet

معا

بيداء جعفر الخفاجي

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الخلاصة

يتضمن البحث طريقة مقترحة لتحسين الصورة باستخدام تركيب من التحويلين wavelet و multiwavelet فضلا عن استخدام احد فلاتر التنعيم للصورة وهو (mean filter) استخدمت طريقة العينة الحرجة التقريبية في حساب multiwavelet قبل المعالجة. التقريب من الرتبة الثانية استخدم لتسريع الاجراءات والحسابات، اذ ان التحسين المستخدم في الطريقة المقترحة في البحث افضل بكثير من الطرائق التقليدية الاخرى عند المقارنة بينهم. اداء هذه التقنية وتطبيقها استخدام الكمبيوتر ولغة البرمجة Visual Basic 6.0 package