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# DIGITAL IMAGE WATERMARKING USING DIFFERENT WAVELETS

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## ABSTRACT

Due to the extensive use of digital media applications, multimedia security and copyright protection has gained tremendous importance. Digital Watermarking is a technology used for the copyright protection of digital applications. In this project, a comprehensive approach for watermarking digital image is introduced. We propose a hybrid digital watermarking scheme based on Discrete Wavelet Transform (DWT) and sub band analysis. here we are doing watermarking using different wavelets like haar, daubenchies, coiflet, symlet and bi-orthogonal wavelets and comparing their performance using performance parameters like mean square error and peak signal to noise ratio.

**KEYWORDS:** Digital Media, Discrete, Watermarking, Wavelet

## INTRODUCTION

The expansion of digital technology has brought about what may be called “the creator’s society.” Works of art or science that were unimaginable ten years ago may be created with a wave of the mouse. Unfortunately, this advancement of technology creates a dilemma for intellectual property holders: it is also far simpler today to copy intellectual data than it was even ten years ago. Whereas ten years ago fast copying of digital data was reserved for those who could afford large amounts of computing power, Moore’s Law has put the ability to rip CD’s and copy videos within the reach of the masses[1].

The watermark technique is advantageous precisely because it does not greatly alter the file. Lawful consumers may enjoy the contents of the data without the distraction of the watermark. Indeed, most consumers will not be aware that a watermark has been embedded. In case of dispute, the embedded data may be recovered by the true property holder in order to determine rightful ownership.

**Digital Water Marking:** Digital Watermarking is focused on preventing information from being removed from digital content. The goal is to provide a robust way of associating digital information with a specific digital content either visibly or invisible. The main goals of digital watermarking (but not limited to) fall into the following categories:

- Copyrights protection (ownership)
- Information authentication

## WAVELET TRANSFORM

The fundamental idea behind wavelets is to analyze the signal at different scales or resolutions, which is called multire solution. Wavelets are a class of functions used to localize a given signal in both space and scaling domains. A family of wavelets can be constructed from a mother wavelet. Compared to Windowed Fourier analysis, a mother wavelet is stretched or compressed to change the size of the window. In this way, big wavelets give an approximate image of the signal, while smaller and smaller wavelets zoom in on details. Therefore, wavelets automatically adapt to both the high frequency and the low-frequency components of a signal by different sizes of windows. Any small change in the wavelet representation produces a correspondingly small change in the original signal, which means local mistakes are not influence the entire transform. The wavelet transform is suited for non stationary signals, such as very brief signals and signals with interesting components at different scales.

Wavelets are functions generated from one single function ψ, which is called mother wavelet, by dilations and translations

$$\psi_{a,b}(x) = |a|^{-1/2}\ \psi(\frac{x-b}{a})$$

Where ψ must satisfy ∫ ψ (x) dx = 0.

The basic idea of wavelet transform is to represent any arbitrary function f as a decomposition of the wavelet basis or write f as an integral over a and b of $\psi_{a,b}$ .

Let $a = a_0^m, b = nb_0a_0^m$ with m, n € integers, and $a_0>1, b_0>0$ fixed. Then the wavelet decomposition is

$$f = \sum c_{m,n}(f)\psi_{m,n} .$$

In image compression, the sampled data are discrete in time. It is required to have discrete representation of time and frequency, which is called the discrete wavelet transform (DWT).

Wavelet Transform (WT) was used to analyze non-stationary signals, i.e., whose frequency response varies in time. Although the time and frequency resolution problems are results of a physical phenomenon and exist regardless of the transform used, it is possible to analyze any signal by using an alternative approach called the multi resolution analysis (MRA). MRA analyzes the signal at different frequencies with different resolutions. MRA are basically designed to give good time resolution and poor frequency resolution at high frequencies and good frequency resolution and poor time resolution at low frequencies. This approach is useful especially when the signal considered has high frequency components for short durations and low frequency components for long durations. Which are basically used in practical applications?

**Discrete Wavelets**

The wavelet transform has three properties that make it difficult to use directly in the form of (1). The first is the redundancy of the CWT. In (1) the wavelet transform is calculated by continuously shifting a continuously scalable function over a signal and calculating the correlation between the two. It is seen that these scaled functions is nowhere near an orthogonal basis and the obtained wavelet coefficients is therefore be highly redundant. For most practical applications this redundancy is removed. Even without the redundancy of the CWT one still have an infinite number of wavelets in the wavelet transform and would like to see this number reduced to a more manageable count. This is the second problem.

The third problem is that for most functions the wavelet transforms have no analytical solutions and they can be calculated only numerically or by an optical analog computer. Fast algorithms are needed to be able to exploit the power of the wavelet transform and it is in fact the existence of these fast algorithms that have put wavelet transforms where they are today. Let us start with the removal of redundancy.

### Sub-Band Analysis

A time-scale representation of a digital signal is obtained using digital filtering .Techniques. Recall that the CWT is a correlation between a wavelet at different scales and the signal with the scale (or the frequency) being used as a measure of similarity. The continuous wavelet transform was computed by changing the scale of the analysis window, shifting the window in time, multiplying by the signal, and integrating over all times. In the discrete case, filters of different cutoff frequencies are used to analyze the signal at different scales. The signal is passed through a series of high pass filters to analyze the high frequencies, and it is passed through a series of low pass filters to analyze the low frequencies.

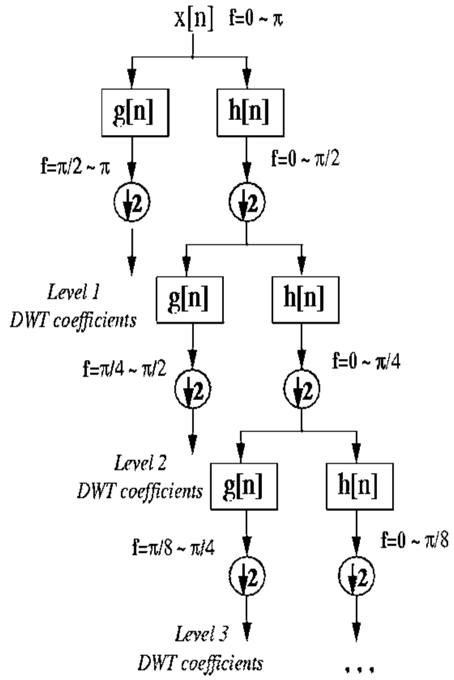


**Figure 1: Decomposition of Signal x[n] into Low Pass and High Pass Filters h[n] and g[n]**

The Sub band Coding Algorithmas an example, suppose that the original signal x[n] has 512 sample points, spanning a frequency band of zero to ∏ rad/s. At the first decomposition level, the signal is passed through the high pass and low pass filters, followed by sub sampling by 2. The output of the high pass filter has 256 points (hence half the time resolution), but it only spans the frequencies ∏/2 to ∏ rad/s (hence double the frequency resolution).

These 256 samples constitute the first level of DWT coefficients. The output of the low pass filter also has 256 samples, but it spans the other half of the frequency band, frequencies from 0 to ∏/2 rad/s. This signal is then passed through the same low pass and high pass filters for further decomposition. The output of the second low pass filter followed by sub sampling has 128 samples spanning a frequency band of 0 to ∏/4 rad/s, and the output of the second high pass filter followed by sub sampling has 128 samples spanning a frequency band of ∏/4 to ∏/2 rad/s.

The second high pass filtered signal constitutes the second level of DWT coefficients. This signal has half the time resolution, but twice the frequency resolution of the first level signal. In other words, time resolution has decreased by a factor of 4, and frequency resolution has increased by a factor of 4 compared to the original signal. The low pass filter output is then filtered once again for further decomposition. This process continues until two samples are left.

For this specific example there would be 8 levels of decomposition, each having half the number of samples of the previous level. The DWT of the original signal is then obtained by concatenating all coefficients starting from the last level of decomposition (remaining two samples, in this case). The DWT is then have the same number of coefficients as the original signal.

### Wavelet Decomposition

There are several ways wavelet transforms can decompose a signal into various sub bands. These include uniform decomposition, octave-band decomposition, and adaptive or wavelet-packet decomposition. Out of these, octave-band decomposition is the most widely used.

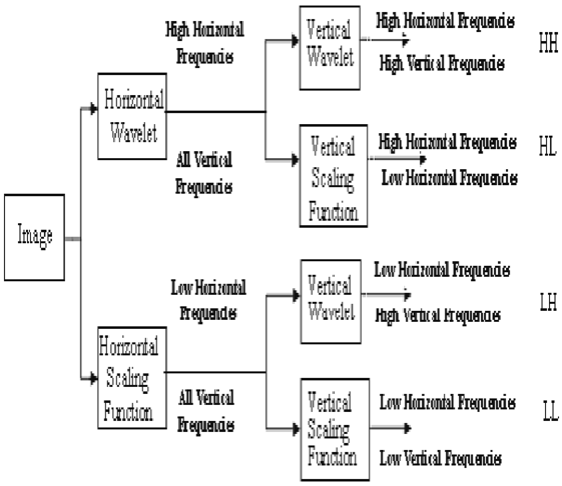


**Figure 2: Pyramidal Decomposition of an Image**

### Haar Transform

The **Haar transform** is the simplest of the wavelet transforms. This transform cross-multiplies a function against the Haar wavelet with various shifts and stretches, like the Fourier transform cross-multiplies a function against a sine wave with two phases and many stretches. The attracting features of the Haar transform, including fast for implementation and able to analyse the local feature, make it a potential candidate in modern electrical and computer engineering applications, such as signal and image compression.

### Daubechies Wavelet

The **Daubechies wavelets**, based on the work of Ingrid Daubechies, are a family of orthogonal wavelets defining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. With each wavelet type of this class, there is a scaling function (called the *father wavelet*) which generates an orthogonal multiresolution analysis.

**Coiflets** are discrete wavelets designed by Ingrid Daubechies, at the request of Ronald Coifman, to have scaling functions with vanishing moments. The wavelet is near symmetric, their wavelet functions have N/3 vanishing moments and scaling functions N/3-1, and has been used.

### Symlet Wavelets

In symN, N is the order. Some authors use 2*N* instead of *N*. The symlets are nearly symmetrical, orthogonal and biorthogonal wavelets proposed by Daubechies as modifications to the db family. The properties of the two wavelet families are similar.

In applied mathematics, **symlet wavelets** are a family of wavelets. They are a modified version of Daubechies wavelets with increased symmetry.

## RESULTS

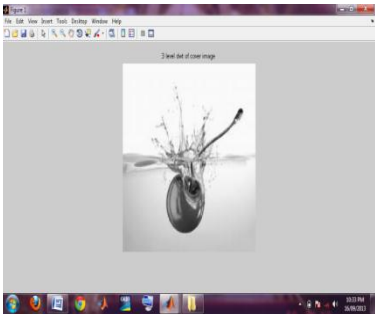

**Figure 3: Level DWT of Cover Image**

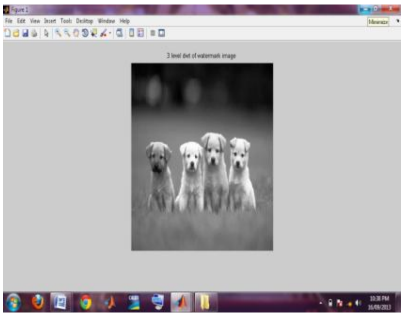

**Figure 4: Level DWT of Watermark Image**

**Figure 5: Watermarked Image Final**

**Figure 6: Extracted Watermark Image**

**Cover Image:** Cherry

**Watermark Image:** Pups

**Table 1**

| Wavelet Transform Type | MSE | PSNR | Extracted MSE | Extracted PSNR |
|---|---|---|---|---|
| Harr | 1.9907e-009 | 201.2356 | 12.7378 | 15.4951 |
| symlet | 1.9929e-009 | 201.2246 | 12.2488 | 16.4535 |
| Doubecheis | 1.9928e-009 | 201.2251 | 12.4346 | 16.4453 |
| Coiflet | 1.9929e-009 | 201.2243 | 11.8379 | 16.6822 |
| Biorthogonal | 1.9926e-009 | 201.2259 | 12.6267 | 21.2354 |

## CONCLUSIONS

Here we have seen that secured image watermarking using different wavelets like haar, daubenchies, symlet, coiflet and bi-orthogonal.all will give good results but from the performance parametrs we will conclude that according to the PSNR bi-orthogonal is the best wavelet, and according to mean square error coiflet is the best one.

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