VISIBLE VIDEO WATERMARKING USING ADAPTIVE TRANSFORMATION TECHNIQUE

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ABSTRACT

Nowadays, digital multimedia content (audio or video) can be copied and stored easily and without loss in fidelity. Therefore, it is important to use some kind of property rights protection system. Digital watermarking technology is a general-purpose technology with a wide variety of possible applications. The technology offers a means of conveying information inside a digital media file (for example, inside a photo, movie, or song). It frequently is used to signal basic identifying information about the specific media file in which it is contained, much like a file header does. Video sequences compressed by modern techniques offer another type of domain, motion vectors. Watermarking in this domain slightly alters length and direction of motion vectors. Further, watermarks for video sequences can be classified by the range of application – e.g., hidden information carried by a watermark can be spread overall frames of the video sequence, then the whole sequence is necessary to retrieve that information, or each frame contains watermark with the same information, then only a single frame should be enough. In one frame, one single element of the watermark can be embedded into one pixel, into a block of pixels or even into the whole frame. In this project we are implementing video watermarking using Desecrate Wavelet Transform (DWT).

Keywords: Watermarking, desecrate wavelet transform, digital media content.

1. INTRODUCTION

Digital watermarking technology is a general-purpose technology with a wide variety of possible applications. The technology offers a means of conveying information inside a digital media file (for example, inside a photo, movie, or song). It frequently is used to signal basic identifying information about the specific media file in which it is contained, much like a file header does. Digital watermarking does not inherently pose risks to privacy. Over the last decade, it has been widely deployed in numerous digital files for a range of purposes, and CDT is not aware of any cases where its use has contributed to significant privacy controversies or abuses. Like many technologies, however, it could raise privacy issues if deployed in ways that fail to take privacy questions into account. This paper seeks to offer a set of principles for addressing potential privacy consequences when deploying digital watermarking applications.

Nowadays, digital multimedia content (audio or video) can be copied and stored easily and without loss in fidelity. Therefore, it is important to use some kind of property rights protection system. Most content providers follow the wishes of production companies and use copy protection system called Digital Rights Management (DRM). DRM protected content is encrypted during the transmission and the storage at recipient's side and thus protected from copying. But during playing it is fully decrypted. Besides recipients must have a player capable of playing DRM encrypted content, the main disadvantage of DRM is that once the content is decrypted, it can be easily copied using widely available utilities. Disadvantages of DRM can be eliminated by using another protection system, watermarking. Watermarking can be a part of information hiding science called steganography. Steganographic systems permanently embed hidden information into a cover content so that it is not noticeable. Thus, when anybody copies such content, hidden information is copied as well. Three aspects of information hiding systems contend with each other:

- Capacity.
- Security.
- Robustness.

Capacity refers to amount of information that can be hidden, security to ability of anybody to detect hidden information, and robustness to the resistance to modifications of the cover content before hidden information is destroyed. Watermarking prefers robustness, i.e., it should be impossible to remove the watermark without severe quality degradation of the cover content, while steganography demands high security and capacity, i.e., hidden information is usually fragile and can be destroyed by even trivial modifications.

2. LITERATURE SURVEY

The advance of computer technologies and the proliferation of the Internet have made reproduction and distribution of digital information easier than ever before. Copyright protection of intellectual properties has, therefore, become an important topic. One way for copyright protection is *digital watermarking* [1]–[7], which means embedding of certain specific information about the copyright holder (company logos, ownership descriptions, etc.) into the media to be protected. Digital watermarking methods for images are usually categorized into two types: *invisible* and *visible*. The first type aims to embed copyright information imperceptibly into host media such that in cases of copyright infringements, the hidden information can be retrieved to identify the ownership of the protected host. It is important for the watermarked image to be resistant to common image operations to ensure that the hidden information is still retrievable after such alterations. Methods of the second type, on the other hand, yield visible watermarks which are generally clearly visible after common image operations are applied. In addition, visible watermarks convey ownership information directly on the media and can deter attempts of copyright violations. Embedding of watermarks, either visible or invisible, degrade the quality of the host media in general. A group of techniques, named *reversible* watermarking [8]–[19], allow legitimate users to remove the embedded watermark and restore the original content as needed. However, not all reversible watermarking techniques guarantee *lossless image recovery*, which means that the recovered image is identical to the original, pixel by pixel. Lossless recovery is important in many applications where serious concerns about image quality arise. Some examples include forensics, medical image analysis, historical art imaging, or military applications. Compared with their invisible counterparts, there are relatively few mentions of lossless visible watermarking in the literature. Several lossless invisible watermarking techniques have been proposed in the past. The most common approach is to compress a portion of the original host and then embed the compressed data together with the intended payload into the host [5], [13]–[15]. Another approach is to superimpose the spread-spectrum signal of the payload on the host so that the signal is detectable and removable [3]. A third approach is to manipulate a group of pixels as a unit to embed a bit of information [16], [17]. Although one may use lossless invisible techniques to embed removable visible watermarks [11], [18], the low embedding capacities of these techniques hinder the possibility of implanting large-sized visible watermarks into host media. As to lossless visible watermarking, the most common approach is to embed a monochrome watermark using deterministic and reversible mappings of pixel values or DCT coefficients in the watermark region [6], [9], [19]. Another approach is to rotate consecutive watermark pixels to embed a visible watermark [19]. One advantage of these approaches is that watermarks of arbitrary sizes can be embedded into any host image. However, only *binary* visible watermarks can be embedded using these approaches, which is too restrictive since most company logos are colorful.

3. PROPOSED METHODOLOGY

Video Preprocess

Our watermark scheme is based on levels DWT. All frames in the video are transformed to the wavelet domain. Moreover, scene changes are detected from the video by applying the histogram difference method on the video stream.

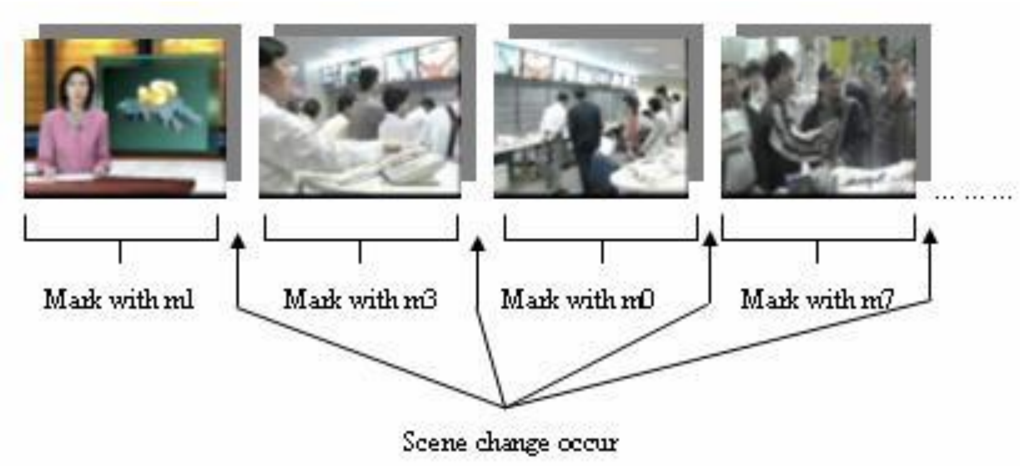

Fig. 1: Scene change detection.

After scene change detection, as shown in Fig. 1, independent watermarks are embedded in video frames of different scenes. Within a motionless scene, an identical watermark is used for each frame. The watermark for each scene can be chosen with a pseudo-random permutation such that only a legitimate watermark detector can reassemble the original watermark.

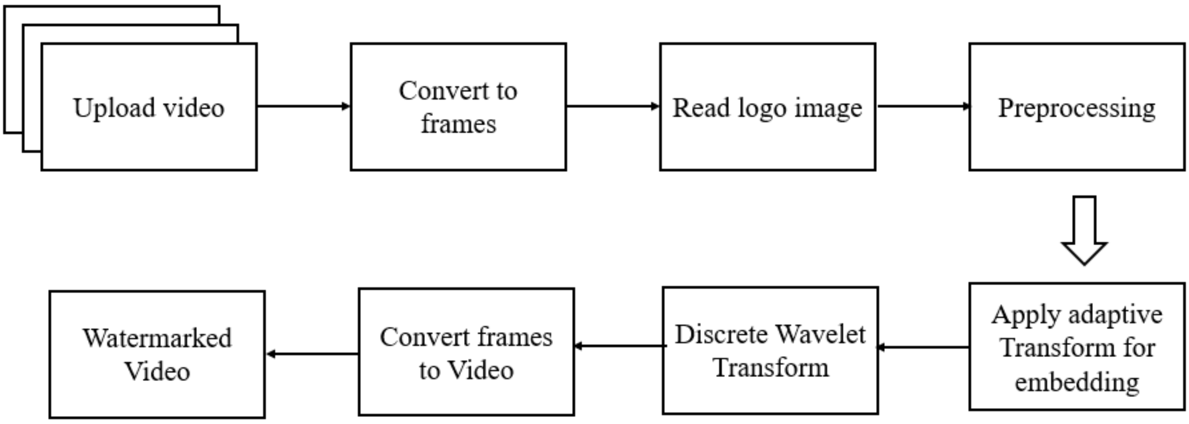

Fig. 2: Proposed block diagram of visible video watermarking system.

Watermark Embedding

Watermark is then embedded to video frames by changing position of some DWT.

coefficient with the following condition:

if W[j] = 1,

Exchange C[i] with max(C[i], C[i+1], C[i+2], C[i+3], C[i+4]) else

Exchange C[i] with min(C[i], C[i+1], C[i+2], C[i+3], C[i+4])

where **C[i]** is the ith DWT coefficient of a frame, and **W[j]** is the jth pixel of a certain watermark. The sequence of watermark coefficients used is stated in Fig 1.2

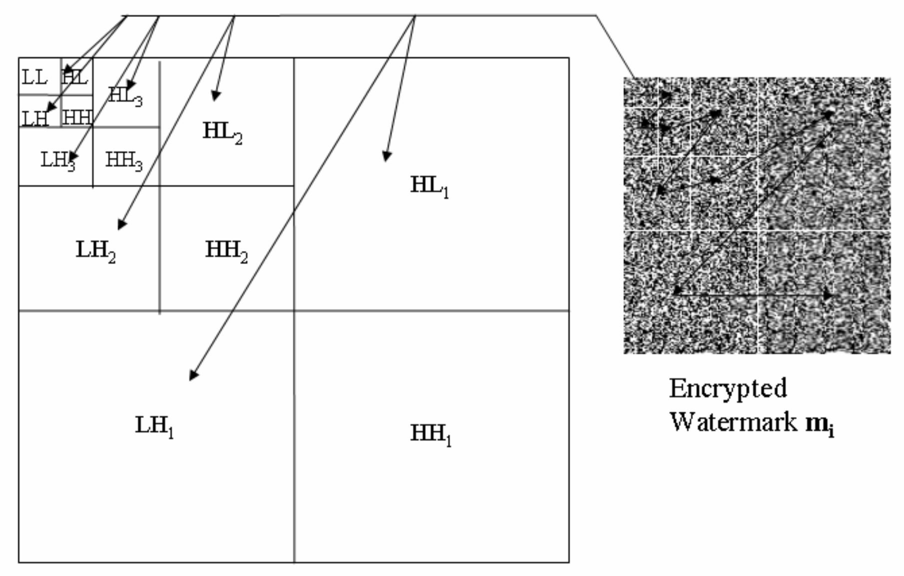

Fig. 3: Usage of watermark coefficients.

The Discrete Wavelet Transform

Calculating wavelet coefficients at every possible scale is a fair amount of work, and it generates an awful lot of data. What if we choose only a subset of scales and positions at which to make our calculations? It turns out rather remarkably that if we choose scales and positions based on powers of two—so-called dyadic scales and positions—then our analysis will be much more efficient and just as accurate. We obtain such an analysis from the discrete wavelet transform (DWT).

An efficient way to implement this scheme using filters was developed in 1988 by Mallat. The Mallat algorithm is in fact a classical scheme known in the signal processing community as a two-channel sub band coder. This very practical filtering algorithm yields a fast wavelet transform — a box into which a signal passes, and out of which wavelet coefficients quickly emerge. Let’s examine this in more depth.

One-Stage Filtering: Approximations and Details:

For many signals, the low-frequency content is the most important part. It is what gives the signal its identity. The high-frequency content on the other hand imparts flavor or nuance. Consider the human voice. If you remove the high-frequency components, the voice sounds different but you can still tell what’s being said. However, if you remove enough of the low-frequency components, you hear gibberish. In wavelet analysis, we often speak of approximations and details. The approximations are the high-scale, low-frequency components of the signal. The details are the low-scale, high-frequency components.

The filtering process at its most basic level looks like this:

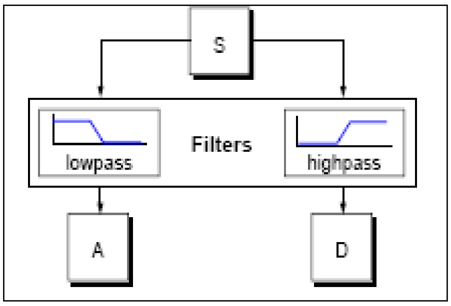

Fig. 4: Filtering process.

The original signal S passes through two complementary filters and emerges as two signals.

Unfortunately, if we perform this operation on a real digital signal, we wind up with twice as much data as we started with. Suppose, for instance, that the original signal S consists of 1000 samples of data. Then the resulting signals will each have 1000 samples, for a total of 2000.

These signals A and D are interesting, but we get 2000 values instead of the 1000 we had. There exists a more subtle way to perform the decomposition using wavelets. By looking carefully at the computation, we may keep only one point out of two in each of the two 2000-length samples to get the complete information. This is the notion of own sampling. We produce two sequences called cA and cD.

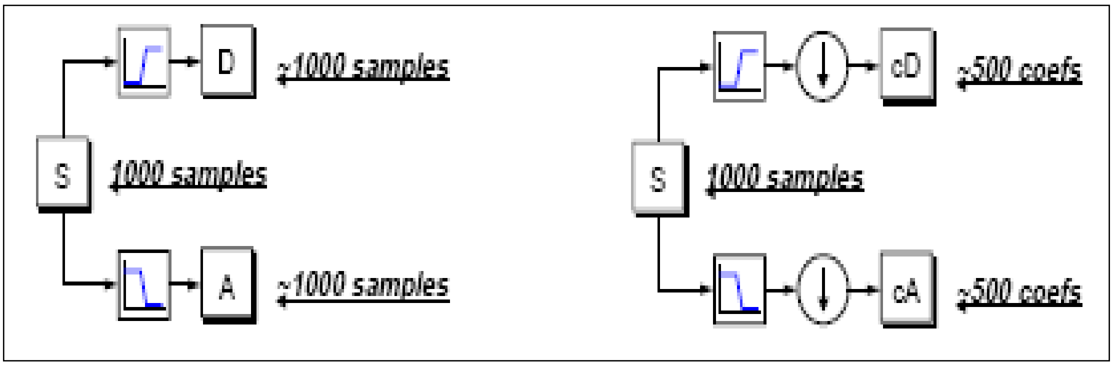

Fig. 5: Sampling process.

The process on the right which includes down sampling produces DWT Coefficients. To gain a better appreciation of this process let's perform a one-stage discrete wavelet transform of a signal. Our signal will be a pure sinusoid with high- frequency noise added to it.

Here is our schematic diagram with real signals inserted into it:

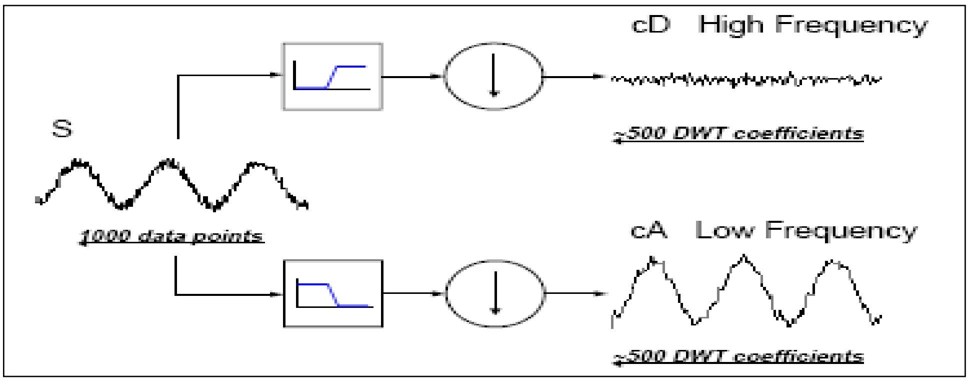

Fig. 6: Schematic diagram.

The MATLAB code needed to generate s, cD, and cA is:

s = sin(20*linspace(0,pi,1000)) + 0.5*rand(1,1000);

[cA,cD] = dwt(s,'db2');

Where db2 is the name of the wavelet we want to use for the analysis.

Notice that the detail coefficients cD is small and consist mainly of a high-frequency noise, while the approximation coefficients cA contains much less noise than does the original signal.

[length(cA) length(cD)]

ans = 501 501

You may observe that the actual lengths of the detail and approximation coefficient vectors are slightly *more* than half the length of the original signal. This has to do with the filtering process, which is implemented by convolving the signal with a filter. The convolution "smears" the signal, introducing several extra samples into the result.

Multiple-Level Decomposition

The decomposition process can be iterated, with successive approximations being decomposed in turn, so that one signal is broken down into many lower resolution components. This is called the wavelet decomposition tree.

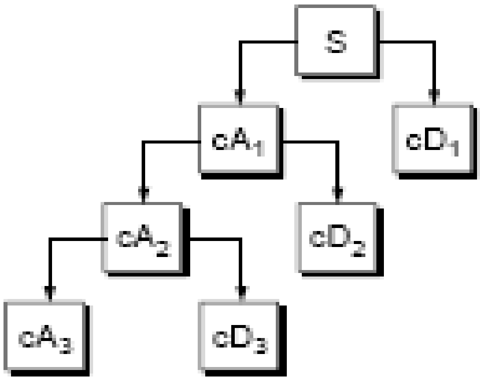

Fig. 7: Multilevel decomposition.

Looking at a signal's wavelet decomposition tree can yield valuable information.

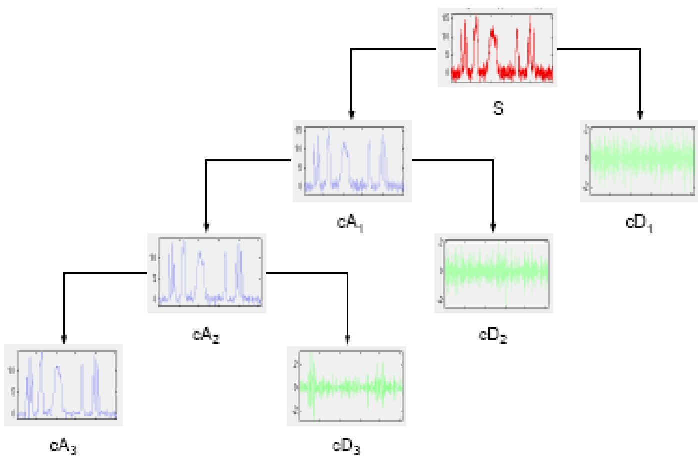

Fig. 8: Signal's wavelet decomposition tree.

Number of Levels

Since the analysis process is iterative, in theory it can be continued indefinitely. In reality, the decomposition can proceed only until the individual details consist of a single sample or pixel. In practice, you'll select a suitable number of levels based on the nature of the signal, or on a suitable criterion such as entropy.

Wavelet Reconstruction

We've learned how the discrete wavelet transform can be used to analyze or decompose, signals and images. This process is called decomposition or analysis. The other half of the story is how those components can be assembled back into the original signal without loss of information. This process is called reconstruction, or synthesis. The mathematical manipulation that effects synthesis is called the inverse discrete wavelet transforms (IDWT). To synthesize a signal in the Wavelet Toolbox, we reconstruct it from the wavelet coefficients:

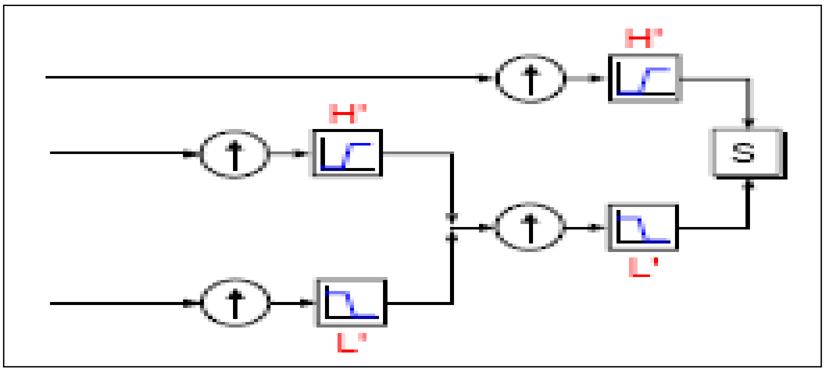

Fig. 9: Wavelet reconstruction.

Where wavelet analysis involves filtering and down sampling, the wavelet reconstruction process consists of up sampling and filtering. Up sampling is the process of lengthening a signal component by inserting zeros between samples:

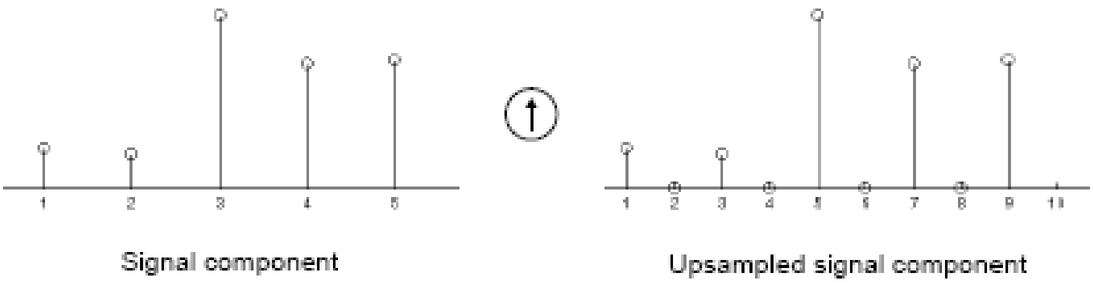

Fig. 10: Analysis of sampling components.

The Wavelet Toolbox includes commands like idwt and waverec that perform single-level or multilevel reconstruction respectively on the components of one-dimensional signals. These commands have their two-dimensional analogs, idwt2 and waverec2.

Reconstruction Filters

The filtering part of the reconstruction process also bears some discussion, because it is the choice of filters that is crucial in achieving perfect reconstruction of the original signal. The down sampling of the signal components performed during the decomposition phase introduces a distortion called aliasing. It turns out that by carefully choosing filters for the decomposition and reconstruction phases that are closely related (but not identical), we can "cancel out" the effects of aliasing.

The low- and high pass decomposition filters (L and H), together with their associated reconstruction filters (L' and H'), form a system of what is called Quadrature mirror filters:

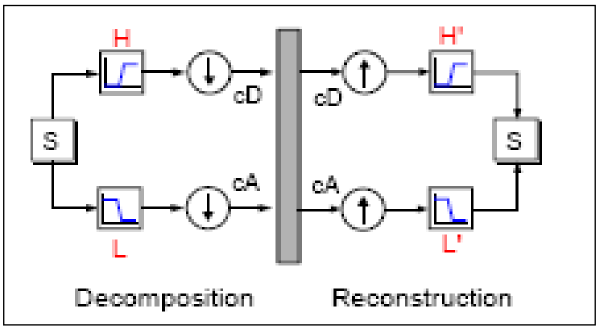

Fig. 11: Decomposition and reconstruction.

Reconstructing Approximations and Details

We have seen that it is possible to reconstruct our original signal from the coefficients of the approximations and details.

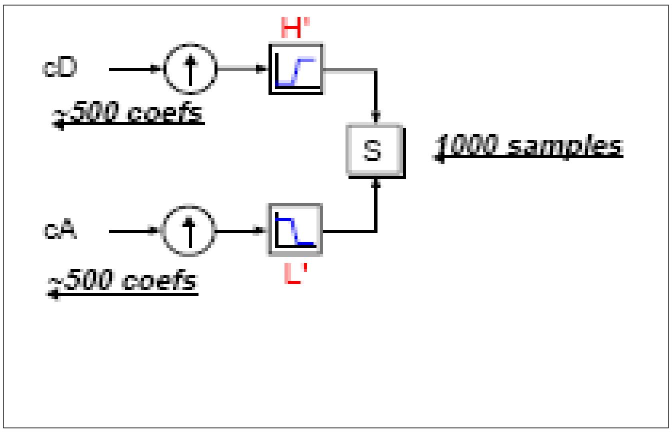

Fig. 12: Reconstructing approximations.

It is also possible to reconstruct the approximations and details themselves from their coefficient vectors.

As an example, let's consider how we would reconstruct the first-level approximation A1 from the coefficient vector cA1. We pass the coefficient vector cA1 through the same process we used to reconstruct the original signal. However, instead of combining it with the level-one detail cD1, we feed in a vector of zeros in place of the detail coefficients vector:

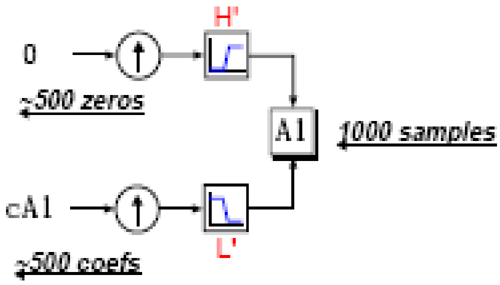

Fig. 13: Reconstruct the first-level approximation.

The process yields a reconstructed approximation A1, which has the same length as the original signal S and which is a real approximation of it. Similarly, we can reconstruct the first-level detail D1, using the analogous process:

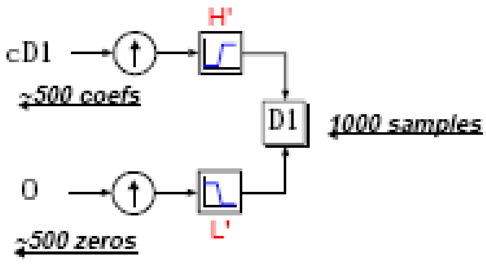

Fig. 14: reconstruct the first level using analogous process.

The reconstructed details and approximations are true constituents of the original signal. In fact, we find when we combine them that:

A1 + D1 = S

Note that the coefficient vectors cA1 and cD1—because they were produced by Down sampling and are only half the length of the original signal — cannot directly be combined to reproduce the signal.

It is necessary to reconstruct the approximations and details before combining them. Extending this technique to the components of a multilevel analysis, we find that similar relationships hold for all the reconstructed signal constituents.

That is, there are several ways to reassemble the original signal:

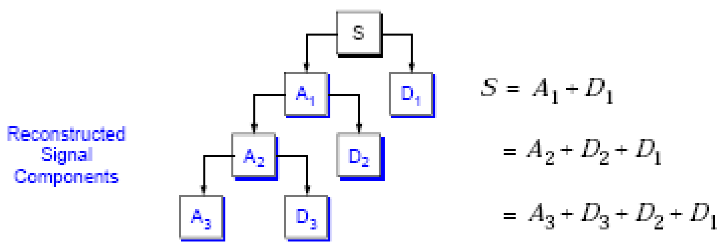

Fig. 15: Reconstructed signal components.

4. RESULTS

Sample images from video

Sample images from logo

Watermarked frames


MIST


MIST


MIST


BBC
FOUR

5. CONCLUSION AND FUTURE ENHANCEMENT

This work focused on implementing visible video watermarking using Discrete Wavelet Transform (DWT). With the easy copying and storage of digital multimedia content, it has become crucial to have a system in place to protect property rights. Digital watermarking technology provides a versatile solution for embedding information within digital media files, allowing for basic identification and protection. The project specifically utilized DWT, a widely used technique in signal and image processing, to embed watermarks in video sequences. By subtly altering the length and direction of motion vectors, the watermark was integrated into the video frames. The range of application for the watermarking technique was explored, including spreading hidden information throughout the entire video sequence or embedding it in individual frames. Further investigation can be carried out to optimize the watermark embedding process, ensuring minimal visual degradation while maintaining the watermark's visibility for detection and extraction.

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