RESEARCH ARTICLE OPEN ACCESS

A New Technique to Digital Image Watermarking Using DWT for Real Time Applications

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ABSTRACT
Digital watermarking is an essential technique to add hidden copyright notices or secret messages to digital audio, image, or image forms. In this paper we introduce a new approach for digital image watermarking for real time applications. We have successfully implemented the digital watermarking technique on digital images based on 2-level Discrete Wavelet Transform and compared the performance of the proposed method with Level-1 and Level-2 and Level-3 Discrete Wavelet Transform using the parameter peak signal to noise ratio. To make the watermark robust and to preserve visual significant information a 2-Level Discrete wavelet transform used as transformation domain for both secret image and original image. The watermark is embedded in the original image using Alpha blending technique and implemented using Matlab Simulink.
***Keywords* –**Digital Watermarking Technique, Discrete wavelet transform, Luma component, Alpha Blending, Levels.

I. INTRODUCTION

The advent of the Internet has resulted in many new opportunities for the creation and delivery of content in digital form. Internet applications include electronic advertising, real time image and audio delivery, digital repositories and libraries, and Web publishing [1]. An important issue that arises in these applications is the protection of the rights of all participants. This has led to an interest towards developing secure protection mechanisms. One such effort that has been attracting increasing interest is based on digital watermarking techniques.

Digital watermarking is the process of embedding information, or a watermark into a digital multimedia objects such that the watermark is detected or extracted later to make an assertion about the object [2]. Watermarking has proven to be a reliable mean to provide copy protection and authenticity proof for digital media. The concept of watermarking has penetrated into the field of security. Currency, such as dollar bills, checks, postal stamps, and official documents from government is seen to carry watermarks. Besides these paper-based applications, watermarking will be used to provide the same degree of security to digital media data, such as audio, text and images. The purpose of this paper is to study and implement Discrete Wavelet Transform (DWT) domain image watermarking system for real time image. DWT has excellent spatial localization, frequency spread and multi-resolution characteristics, which are similar to the theoretical models of the human visual system. In order to detect and retrieve this hidden watermark computer processing must be performed. This is accomplished using a hardware-based or software-based device to apply a watermark to the image [3]. Since the process of embedding a watermark is computationally intensive, a hardware implementation may be needed. Field Programmable Gate Array (FPGA) devices have improved on speed, memory capacity, flexibility, and power dissipation over the years. For image watermarking, the FPGA should provide the benefits of parallel processing and specific-architecture design. Therefore, the goals are to select a watermarking method appropriate for working on a low-power secure application, and to develop a hardware implementation of the watermarking algorithm for digital image.

Paper Organization:

The paper is organized is as follows. In section II Related work is discussed. Section III explains embedded watermark process. Section IV explains development of watermarking model. Section V explains results. Section VI, finally draws the conclusion.

II. RELATED WORK

Zhang and Yong Ping [4] proposed a novel watermarking algorithm which uses features of lower frequency sub-band of wavelet coefficient to limit the positions for watermarking. The positions are taken as indexes of points to embed watermarking and may these positions to medium frequency space to carry watermarking.

Thongkor et al., [5] presents image watermarking based on DWT coefficients modification for social networking services. Here decomposition is done on the blue component of original host image by the DWT to obtain the coefficients in LL sub-band, and some of them are used to carry watermark signal. Tabassum T and Islam [6] proposed a digital image watermarking technique based on identical frame extraction in 3-Level DWT. Here the host image is divided into image shots. Then from each image shot one image frame called identical frame is selected for watermark embedded. Each identical frame is decomposed into Level-3 DWT, and then selects the higher sub-band coefficients to embed the watermark. Deb et al., [7] proposed a combined DWT and discrete cosine transform based digital image watermarking technique for copyright protection. Here watermarking bits are embedded in the low frequency band of each DWT block of selected discrete wavelet transform sub-band. Sridhar B and Arun C [8] proposed secure multiple image watermarking techniques using DWT with the motivation to maintain the quality of the image in which the original image was interlaced into even and odd rows of images and deinterlaces the two images. Wavelet based approach is employed for hiding watermark images.

Anand Bora et al., [9] present the competitive analysis of Digital Image watermarking techniques. They have shown that transform domains are better candidates for the digital watermarking than spatial technique since former has good robustness as well as visual impact. Sourour Karmani et al., [10] proposed an improved hardware watermarking scheme for images and video frames based on 2D-DWT multi resolution analysis which gives an interesting properties of security and robustness. Akhil Pratap Singh and Agya Mishra [11] presents a new digital watermarking technique for grayscale image based on alpha blending process using a robust technique based on DWT. Nilanjan Dey et al., [12] proposed a wavelet based stegnographic technique for the color image in which both the true color cover image and the true color secret image are decomposed into RGB colors. Each plane of image is decomposed into four subbands using DWT. Nikita Kashyap and Sinha G R [13] proposed a new method in which watermark is embedded based on alpha blending process using DWT.

III. EMBEDDED WATERMARK PROCESS

DWT Domain Watermarking Criteria: Several criteria can be used to classify watermarking systems. Three of such criteria are the type of domain, the type of watermark, and the type of information needed in the detection or extraction process [10].

The systems that embed the watermark in the pixel domain are less robust to image manipulations, and semi-blind and blind systems are more prone to false positives (detecting the watermark in an unmarked image) and false negatives (not detecting the watermark in a marked image). In order to evaluate the feasibility of the algorithm, there are 2 requirements need to be considered, namely Timing Requirements and Complexity in Implementation.

Timing Requirements means the program running time has to be short as possible and the less design complexity of the technique leads to efficient implementation.

The major watermarking techniques available are, A novel image hiding scheme based on block difference, Data Hiding in Images by Adaptive LSB substitution based on the Pixel-Value Differencing, LSB substitution based on predictive approach and Alpha Blending Technique [11,12].

Alpha blending technique is the simplest technique amongst the selected algorithms. In this technique translucent foreground image and background image is combined to produce a new blended image.

The degree of foreground colour translucency may range from completely transparent to completely opaque. If the foreground colour is completely opaque, the blended colour will be the foreground colour. Conversely, if it is completely transparent, the blended colour will be the background colour.

IV. PROPOSED WORK

The design flow for the proposed work is as fallows. In the process, the luma component of the input original image is taken and two dimensional 2-level DWT is applied, which decomposes the image into low frequency and high frequency components.

The same method is fallowed for the watermark which is to be embedded in the input original image. The technique used for inserting the watermarking is alpha blending process. In this technique the decomposed components of the input original image and the watermark are multiplied by a scaling factor and added. According to the alpha blending technique the watermark image is obtained by the Equation 1 given by

$$WMI = k*(LL2) + q*(WM2) \qquad \text{------------1}$$

Where WMI = low frequency component of watermarked image, LL2 = Low frequency component of the original image obtained by 2-Level DWT, WM2 = Low frequency component of watermark image and k, q = scaling factors for the original image and watermark respectively. Finally 2-Level Inverse Discrete Wavelet transform is applied to the watermarked image coefficient to generate the final secure watermarked image.

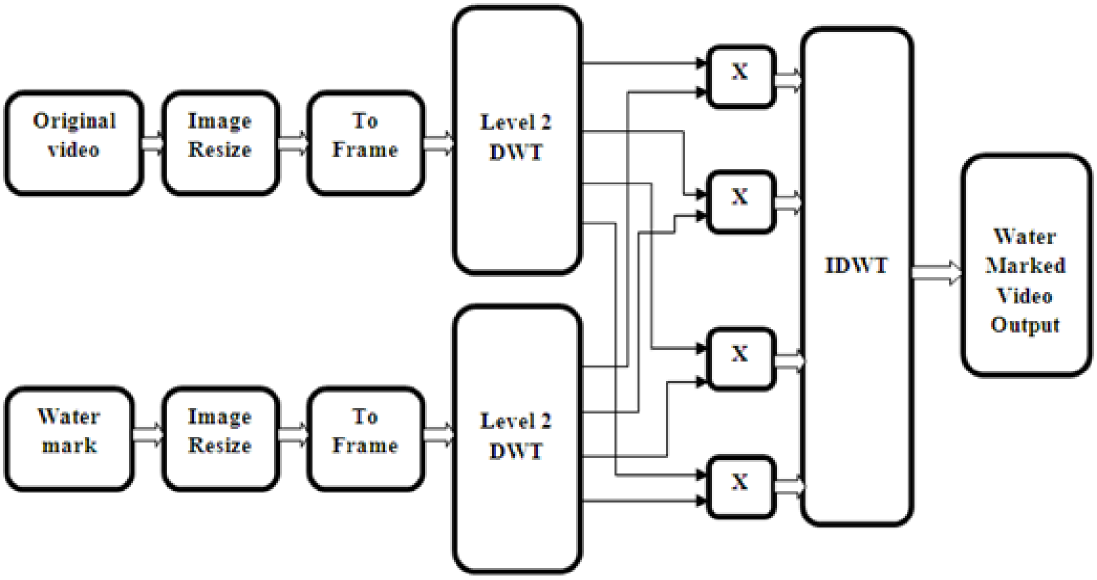

Fig. 1: Watermarking Image/video model.

The software reference model for the image watermarking is as shown in Figure 1. The model consists of input image blocks, one for main image and another for coded image. Images are resized based upon the evaluation preserving the information in the image. Two level DWT is applied on the image frames and the products are given to the IDWT which gives the water marked image. The functionality of each block is explained as fallows.

A. Input Image/image block

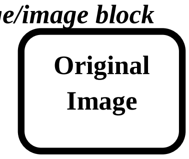

Fig. 2: Input Image Block

The input image block is shown in Figure 2. The input image/image block reads image frames and/or audio samples from a multimedia files and imports them into a simulink model.

B. Resize block

Fig. 3: Images Resize Block.

Figure 3 gives the image resize block. The resize block enlarges or shrinks an image by resizing the image along one dimension. Different interpolation algorithm can be used such as bilinear, bicubic etc.

C. Frame Conversion

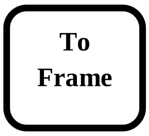

Fig. 4: Frame Conversion Block.

The frame conversion block is as shown in Figure 4. The frame conversion block specifies the frame status of the output signal. The block does not rebuffer or resize two-dimensional inputs.

D. DWT

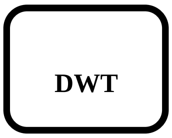

Fig. 5: DWT Block.

The DWT block is as shown in Figure 5. The DWT block computes the discrete wavelet transform of each column of a frame-based input. By default, the output is a sample-based vector or matrix with the same dimensions as the input. DWT is a mathematical tool that translates an image form spatial domain to frequency domain. The transformation is based on small waves, called wavelets, of varying frequency and limited duration.

The DWT splits the image into high and low frequency parts. The high frequency part contains edge information, whereas the low frequency part is split again into high and low frequency parts. High frequency part is used for watermarking since the human eye is less sensitive to changes in edges. Figure 6, 7 gives a Decomposition using Level-1 DWT and Level-2 DWT respectively.

The Level-1 DWT decomposes an image into lower resolution image (LL1) as well as horizontal (HL1), vertical (LH1) and diagonal (HH1) components. For Level-2 decomposition, the DWT algorithm is again applied on the LL1 component which further decompose the LL1 component into four subbands LL2, HL2, LH2 and HH2.

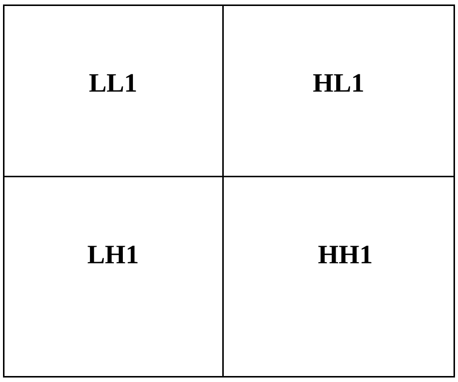

Fig. 6: DWT Decomposition with Level-1.

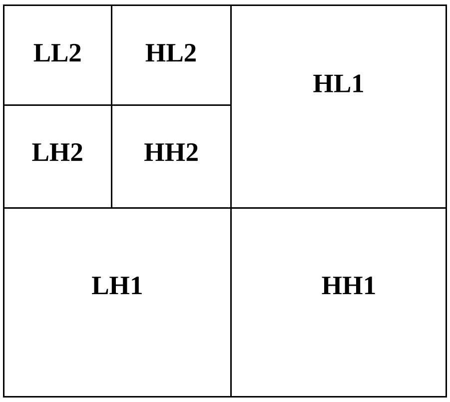

Fig. 7: DWT Decomposition with Level-2.

E. Product block

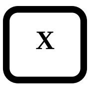

Fig. 8: Product Block.

The product block is shown in Figure 8. The product block will perform the multiplication or division of the inputs.

F. IDWT

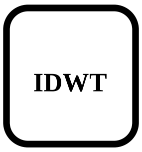

Fig. 9: IDWT Block

The IDWT block is as shown in Figure 9. The IDWT blocks compute the inverse discrete wavelet transform of the input subbands. By default, the block accepts a single sample-based vector or matrix of concatenated subbands. The output is frame based and has the same dimensions as the input.

G. Display block

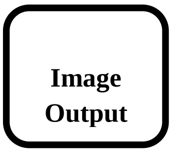

Fig. 10: Image Display.

The Display block is shown in Figure 10. This block is used to display the images and image of the suitable format.

V. RESULTS AND PERFORMANCE ANALYSIS

The result and analysis for the Watermarking model is explained in this section. Figures 11 and 12 shows input original image and watermark information respectively. Figures 13, 14 and 15 shows the DWT Level-1 output watermarked image, DWT Level-2 watermarked image, and DWT Level-3 watermarked image respectively. Analysis of the output Watermarked moving image is performed by considering various parameters such as Levels of DWT, types of filters, tree structure etc. In this paper the main parameter, that is levels of DWT is analysed for the luma component of the output image watermark.

As we go on incrementing levels the compression increases but at the same time the visual significant information is lost. Level-2 DWT preserves visual significant image when compared to level-3 DWT as shown in Figures 14 and 15. Table 1 gives analysis of different levels of DWT and it consists of average and sum of pixels values for different levels of DWT. The Table 1 clearly shows the visual significant information of the image reduces beyond level 2. Table 2 gives the PSNR values for Level-1 and Level-2 and Level-3 DWT for the different values of scaling factor 'p' and 'q'. For all the Levels we have chosen 256x256 sized luma component for both original host image and water marked image. In order to embed watermark in the original image, the value of scaling factor 'k' is varied keeping 'q' constant. Good results are obtained when 'k' value is equal to 0.9 for all the Levels of the DWT. For k = 0.9, the PSNR goes on increasing which is desirable. But visual significant information is lost for Level-3 as shown in Figure 15. Thus we conclude that Level 2 DWT is the best method for watermarking application.

Fig. 11: Original Image.

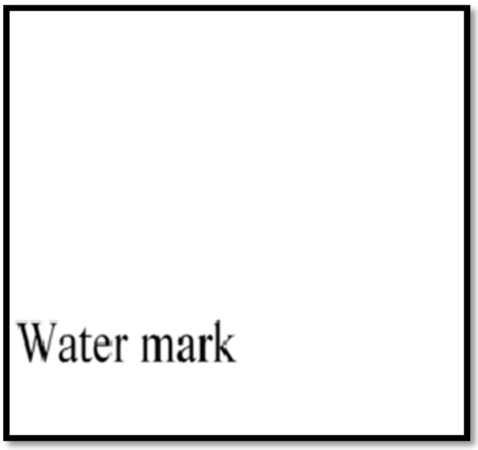

Fig. 12: Information to Watermark.

Fig. 13: DWT Level-1 Output Watermarked Image.

Fig. 14: DWT Level-2 Output Watermarked Image.

Fig. 15: DWT Level-3 Output Watermarked Image.

Table 1: Analysis of DWT levels.

Pixels	DWT		
	Level 1	**Level 2**	**Level 3**
Sum	88.7681	125.4328	177.4224
Average	0.5548	0.7839	1.1088

Table 2: Comparison of Level-1, Level-2 and Level-3 DWT watermarking in terms of PSNR

Sl. No.	**k**	**q**	**PSNR Level-1**	**PSNR Level-2**	**PSNR Level-3**
1.	1.0	0.009	46.55	46.60	46.65
2.	0.9	0.009	45.20	45.32	45.42
3.	0.8	0.009	24.20	24.29	24.35
4.	0.6	0.009	15.35	15.40	15.48
5.	0.4	0.009	11.55	11.60	11.82
6.	0.2	0.009	9.20	9.31	9.42

VI. CONCLUSION

This paper presents DWT domain image watermarking system using Matlab for various security applications and techniques for the watermarking of digital images. Observation is that transform domains are typically better candidates for watermarking systems. The result shows that Level-2 DWT can preserve visual significant information when compared to further levels.

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