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Digital Image Watermarking in Multimedia Data Compressions using Robust 3-Level Discrete Wavelet Transform and Alpha Blending

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***Abstract* - The watermark means the insertion of predefined patterns into the multimedia data, so that the reduction in quality is minimized and remains at an imperceptible level. Many digital watermarking algorithms have been proposed in special and transformational fields. Spatial techniques still have a relatively low bit capacity and are not sufficiently resistant to lossy image compression and other image processing operations. For example, a simple noise can remove the watermark. On the other hand, frequency domain based techniques can incorporate more bits for watermarks and are more robust against attacks. Certain transformations such as the discrete cosine transform (DCT) and the discrete wavelet transform (DWT) are used for watermarks in the frequency domain. In this work, we compare the DCT watermark algorithms and in particular the DWT watermark algorithms based on robustness criteria. In other words, the robustness of various transformation watermark algorithms is assessed using different attacks. One of the main reasons for considering DWT watermark algorithms is that several multimedia standards like JPEG2000 and MPEG-4 are based on DWT. These new standards have created new requirements such as progressive and low bit rate transmission and coding by regions of interest. Digital watermarking is a technique in which a watermark signal is integrated into the host image to authenticate it. The incorporation and extraction of watermarks takes place in the high frequency range of the discrete wavelet transformation (DWT), since small changes in this area are not perceived by the human eye. This watermark scheme deals with extracting the watermark information in the absence of an original image, so that the blind scheme was obtained. The peak signal-to-noise ratio (PSNR) is calculated to measure image quality. The experimental evaluation of the proposed method shows very good results with regard to robustness and transparency to various attacks such as median filtering, Gaussian noise and JPEG compression. Our project presents a digital watermark algorithm with discrete wavelet transform (DWT) based on signs of human vision. Using this technique, the watermark signal is integrated into the high frequency band of the wavelet transform domain.**

Keywords: Digital Image, Watermarking, Multimedia, Data Compressions, 3-Level Discrete Wavelet Transform, Alpha Blending.

I. INTRODUCTION

The development of compression algorithms for multimedia data such as the MPEG-2/4 and JPEG standards and the increase in the transmission speed of network data have enabled the widespread use of applications based on digital data. In other words, digital multimedia data is spreading quickly everywhere. On the other hand, this situation created the possibility of duplicating and / or manipulating the data. In order to continue transmitting data over the Internet, the reliability and originality of the data transmitted must be verifiable. Multimedia data must be protected and secured.

One way to solve this problem is to incorporate invisible data into the original data to mark their ownership. There are many techniques for hiding information that can be divided into different categories, for example B. Convert strings, steganography, anonymity and watermarks. Conversion channel techniques have been defined in the context of multi-level secure systems. The conversion channels generally process the properties of the communication channels in an unexpected and unforeseen manner to transmit data through the medium without being recognized by a person other than the entities exploiting the secret channel. Steganography consists of preventing the detection of encrypted data that has been protected by cryptographic algorithms. Anonymity is a technique for finding ways to hide the meta-content of messages sent as the sender and the recipient.

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Digital watermarks require additional robustness against possible attacks compared to steganography algorithms. It should also be noted that watermarks are not intended to protect the content of a message and are therefore different from cryptography. In this work, we focus on the robustness of the digital watermarking algorithms in the transformation zone against frequent attacks.

II. DIGITAL WATERMARKING

A visible or invisible signature integrated into an image to show authenticity or proof of ownership. The hidden watermark must be inextricably linked to the host image and robust enough to resist falsification while maintaining image quality. Intellectual property remains accessible by watermark while it is permanently marked. These digital signature approaches are used to authenticate ownership claims and protect protected information, prevent unauthorized copying and distribution of images on the Internet, and ensure that no digital images have been altered.

The watermarks add the additional requirement of robustness. However, an ideal watermark system would incorporate a large amount of information which could not be deleted or changed without completely rendering the cover object unusable. Watermarks therefore mainly prevent illegal copying or claim ownership of digital media. A watermark is a pattern of bits that are inserted into multimedia data, such as digital images, audio or video files, to identify the copyright information of the file (author, rights, etc.). A simple example of a digital watermark could be a visible signature or a seal placed on an image to determine the owner of that image. The name "watermark" is derived from the improperly visible markings that are printed on organizational stationery. Unlike printed watermarks, which should be slightly visible, digital watermarks are designed to be completely invisible or inaudible with audio clips. In addition, the bits that represent the watermark must be distributed in the file so that they cannot be identified and manipulated. The integration technique must perceptually leave the original information unchanged and the watermark data must be captured using an extraction algorithm.

The further development of digital multimedia tools has made storage and distribution of multimedia content very easy. Security issues have emerged and there is an urgent need to protect digital content from counterfeiting, piracy and malicious tampering.

2.1 The Requirements of Digital Watermarking

It is clear that the watermark information cannot be stored in the file header since anyone with a computer or digital editing station can convert the information to a different format while deleting the watermark. Therefore, the watermark really needs to be integrated into the multimedia signals. Figure 2.1 shows an integration diagram for watermarks. The input data consists of the multimedia data and the original watermark. The watermark data is generated by a production algorithm which can use a secret key, a signature or a combination of several secret keys and original data. In other words, the standard tattoo process begins with an integration phase. At this point, a cover media file is displayed and the watermark information is integrated using a secret key. The watermark information and the secret key must be selected and available before the integration phase.

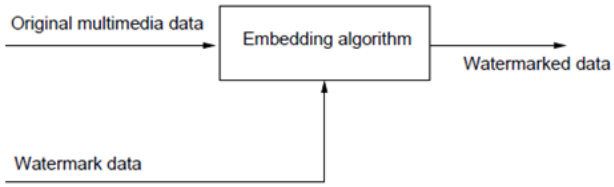

Figure 1: Block diagram of a watermark embedding scheme

Finally, the output from the watermark integration process is the watermark data. The main requirements for the digital watermark are summarized below. However, the relative importance of these properties depends on the application.

III. PROPOSED SYSTEM

A 3-step DWT-based image watermarking technique was implemented in this system. Here, a multi-bit watermark is embedded in the low frequency subband of a title image using the alpha blending technique, which can be restored by an extraction technique. The technique used to insert the watermark is the alpha blend. With this technique, the decomposed components of the host image and the watermark are multiplied and added by a scale factor. In this process, a three-step DWT is first applied to a watermark image and a title image, which divide the image into sub-bands. The watermark is then restored using the formula of the alpha blend of the watermarked image.

3.1 Description of Proposed System

A 3-level DWT based image watermarking technique was implemented. This technique can integrate the invisible watermark into the image using the alpha merge technique, which can be restored by an extraction technique.

DWT is the multi-resolution description of an image, the decoding of which can be processed sequentially from low resolution to higher resolution. The DWT divides the signal into high and low frequency parts. The high frequency part

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contains information on the on-board components, while the low frequency part is again divided into high and low frequency parts. High frequency components are normally used for watermarks because the human eye is less sensitive to edge changes.

In two-dimensional applications, we first perform DWT in the vertical direction for each level of decomposition, followed by DWT in the horizontal direction. After the first decomposition step, there are 4 sub-bands: LL1, LH1, HL1 and HH1. The LL sub-band of the previous level is used as input for each successive decomposition level. In order to perform a breakdown of the second level, the DWT is applied to the LL1 band, which divides the LL1 band into four LL2, LH2, HL2 and HH2 sub-bands. To perform the third level decomposition, the DWT is applied to the LL2 band, which divides this band into four sub-bands - LL3, LH3, HL3, HH3. This leads to 10 sub-bands per component. LH1, HL1 and HH1 contain the highest frequency bands present in the picture mosaic, while LL3 contains the lowest frequency band. The DWT decomposition in three stages is shown in Figure 1.

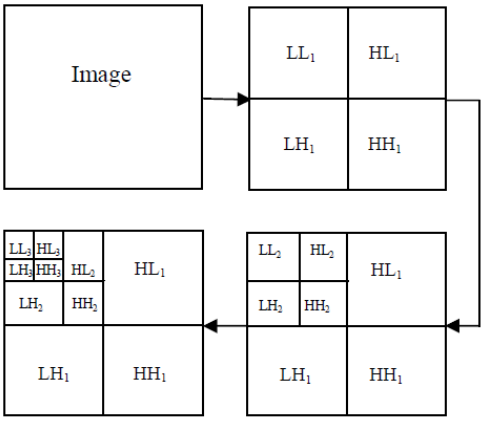

Figure 2: 3-Level discrete wavelet decomposition

DWT is currently used in a variety of signal processing applications, e.g. B. in audio and video compression, elimination of audio noise and simulation of wireless antenna distribution. The wavelets have concentrated their energy over time and are well suited for the analysis of transient signals varying over time. As most of the actual signals vary over time, the wavelet transformation is very suitable for many applications.

3.2 The DWT Process

A signal is divided into two parts, the high and the low frequencies. The part with low frequencies is again divided into two parts with high and low frequencies. The high frequency part is essentially the edge component of the signal.

The DWT and IDWT for two-dimensional images z [m, n] can be defined by:

DWTn [DWTm[x[m,n]]]

3.3 DWT pyramid decomposition

An image can be broken down into a pyramid structure with various band information, such as HH, LH, LL and HL frequency bands.

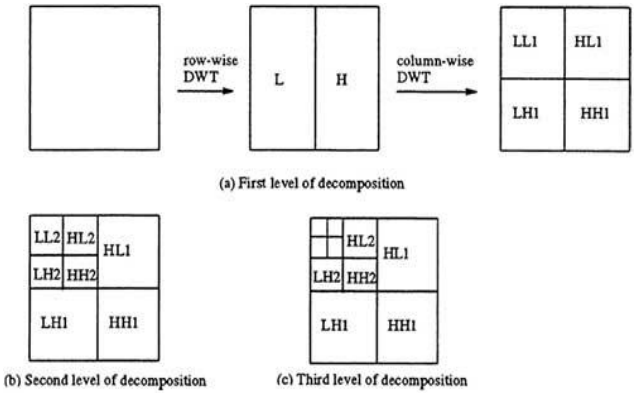

Figure 3: 3-Levels of decomposition

The host image and the watermark are transformed into a wavelet domain. In two-dimensional applications, we first perform DWT in the vertical direction for each level of decomposition, followed by DWT in the horizontal direction.

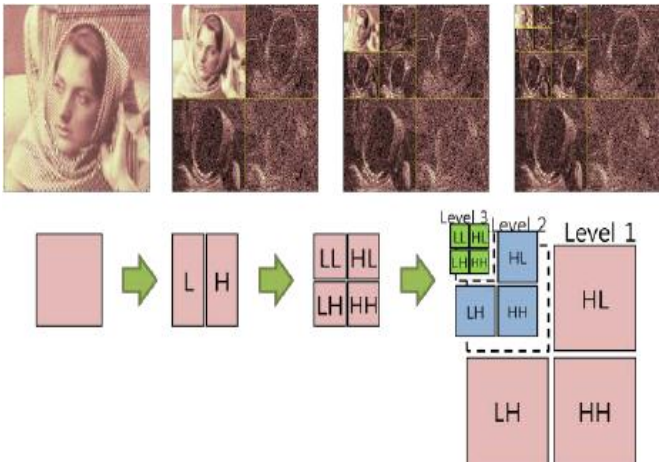

Figure 4: DWT pyramid decomposition of image

After the first decomposition step, there are 4 sub-bands: LL1, LH1, HL1 and HH1. The LL sub-band of the previous level is used as input for each successive decomposition level. In order to perform a breakdown of the second level, the DWT is applied to the LL1 band, which divides the LL1 band into four LL2, LH2, HL2 and HH2 sub-bands. To perform third level ventilation, the DWT is applied to the LL2 band, which breaks this band into four sub-bands - LL3, LH3, HL3, HH3.

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This leads to 10 sub-bands per component. LH1, HL1 and HH1 contain the highest frequency bands present in the image title, while LL3 contains the lowest frequency band.

3.4 Watermark Embedding

For this process, we first apply a 3-level DWT to the host image and divide the image into drawing files, 3 details and 1 approximation. The approximation looks exactly like the original. Likewise, a 3-level DWT is applied to the watermark image. Hair wavelet is used for this. Then the alpha blending technique is used to insert the watermark into the host image. With this technique, the decomposed components of the host image and the watermark are multiplied and added by a scale factor. Since the watermark is embedded in a low frequency approximation, the component of the host image is noticeable or visible in nature.

Alpha blending: formula of the alpha blending the watermarked image is given by:

$$WMI=k*(LL3) +q*(WM3)$$

Where,

WM3 = low frequency approximation of Watermark,
LL3 = low frequency approximation of the original image,
WMI=Watermarked image,
k, q-Scaling factors.

After incorporating the watermark image into the title image, reverse DWT is applied to the watermark image coefficient to create the final and secure watermark image.

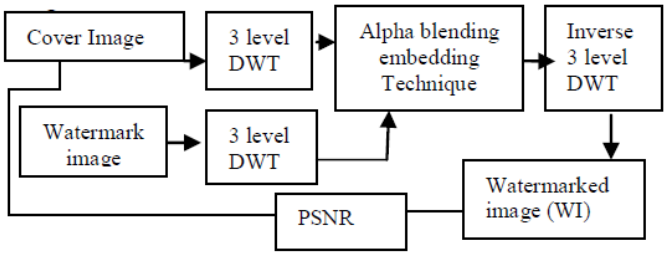

Figure 5: Watermark embedding process by 3-level DWT

3.5 Watermark Extraction

To do this, we first applied 3 layers of DWT to the watermark image and the title image, which divided the image into sub-bands. Then we apply the alpha blend to the low frequency components. Alpha blending: Formula of the alpha blending extraction for Recover watermark is given by

$$RW = (WMI – k*LL3) /q$$

Where,

RW= Low frequency approximation of Recovered watermark,
LL3=Low frequency approximation of the original image,
And WMI= Low frequency approximation of watermarked image.

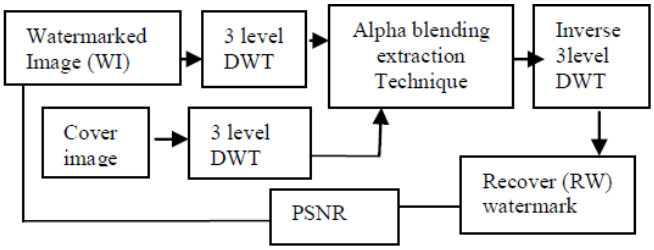

Figure 6: Watermark extraction process by 3-level DWT

After the extraction process, an inverse discrete wavelet transform is applied to the watermark image coefficient to produce the final watermark image. Figure 4 shows the watermark extraction process.

IV. RESULT & DISCUSSION

The GUI for watermarking process is developed using Matlab. Any input image to be watermarked can be chosen using the ‘Load Image’ radio button. All formats such as ‘JPG’,’PNG,’BMP’,’GIF’ can be exported to the GUI window. After selecting the image to be watermarked, the image gets loaded and preview is displayed in the window itself.

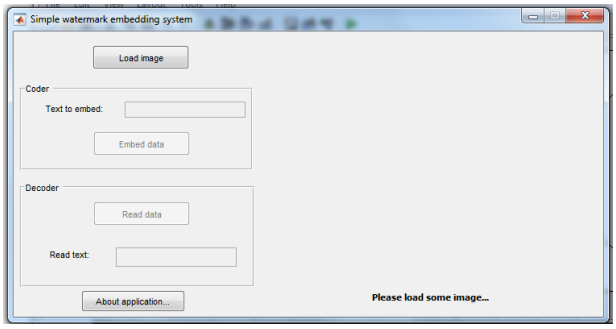

Figure 7: Load input image for watermarking

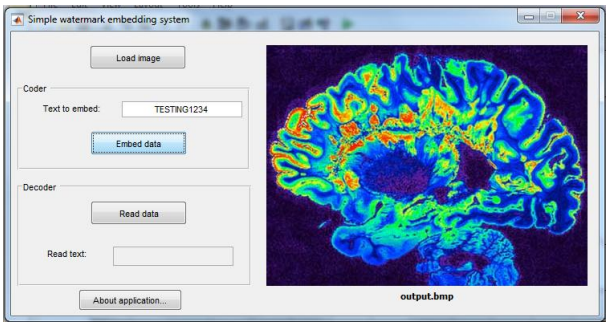

Figure 8: Text input to be watermarked in image

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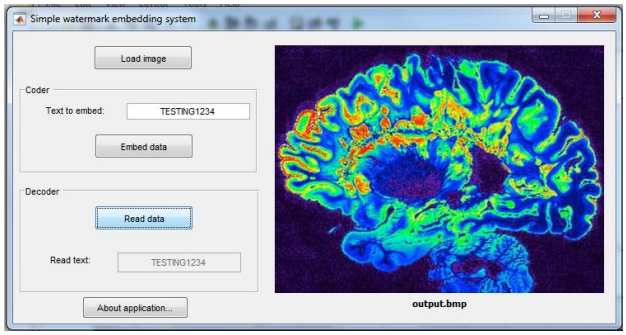

Figure 9: Extracted data from watermarked image

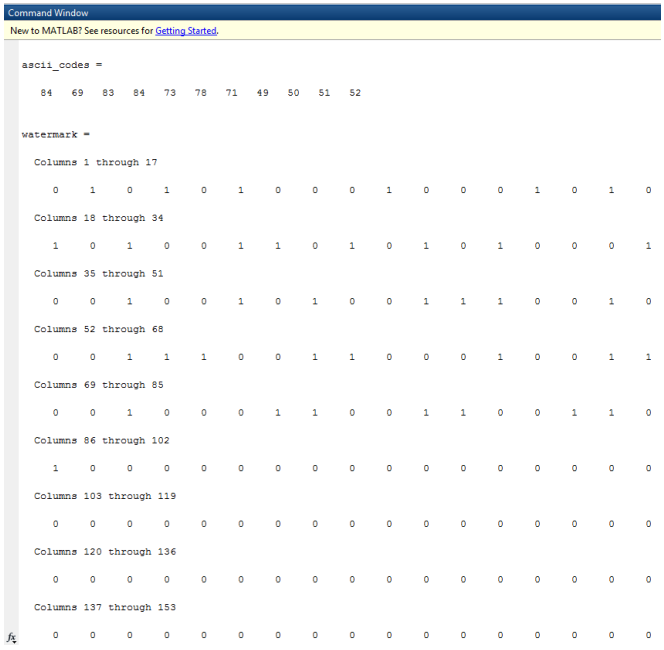

Figure 10: Watermark embed and extraction process in command window

Then the text to be embedded into the watermark can be entered in the text box provide in the 'Encoder' menu box. Entered text can be embedded by clicking 'Embed data' button which then embeds the text into image by the Matlab algorithm. For extracting the watermarked data, watermarked image can be loaded into the GUI using 'Load Image' button and then by clicking 'Read Data' button the embedded text is read from the watermarked image and displayed in the 'Read Text" box. The input and output of the software GUI is as shown in the above figures 7-10.

V. CONCLUSION

An image watermarking technique based on a discrete wavelet transform at three levels was implemented. This technique can integrate the invisible watermark into the salient features of the image using the alpha blend technique. Here, a multi-bit watermark is embedded in the low frequency subband of a title image using the alpha blending technique, which can be restored by an extraction technique. The reconstructed image quality of the watermark image is identical to that of the original images.

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