ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016
National Conference on Digital Signal Processing, Information and Communication Engineering
Govt. Polytechnic College, Kasaragod
Vol. 5, Special Issue 4, November 2016

Discrete Wavelet Transform for Digital Watermarking

Biju M J

Head of Department, Department of Computer Engineering, GWPC Thrissur, India

Abstract: The digital watermarking is a process of information hiding. Digital watermarks allow users to legally use content, while adding security to the content to prevent illegal usage. Digital image watermarking algorithms based on the discrete wavelet transform have been widely recognized to be more powerful than others. This is due to the wavelets' excellent spatial localization, frequency spread, and multi-resolution characteristics, which are similar to the theoretical models of the human visual system. This paper presents a review on different digital image watermarking techniques based on discrete wavelet transform.

Keywords: Information hiding, discrete wavelet Transform, spatial localisation, multi-resolution, human visual system.

I. INTRODUCTION

Digital image processing is a rapidly developing area with various raising applications in engineering. A digital image [1] is a representation of two dimensional images as a finite set of digital values called picture elements or pixels. Therefore, processing a digital image by using a digital computer is called digital image processing. For providing security to digital data, various techniques are used like encryption, decryption, cryptography, steganography and digital watermarking. The digital watermarking is an application of the digital image processing.

Watermarking is a pattern of bits inserted into digital image, audio, video or text file that identifies the file's copyright information such as author and rights [2]. Watermarking is an approach to make sure that data is protected. Watermarking is designed to be completely invisible. Once the watermarking is done, user can send the watermarked image to other computer so that other user is able to read the watermark or the hidden message in the image only if the same algorithm is used. Thus, the watermark can be protected without being revealed. A digital watermark is digital data that can be embedded into all forms of media content. Digital watermarks can be easily detected and read by computers, networks and a variety of digital devices, validating the original content and/or initiating actions.

Unlike printed watermarks, which are intended to be somewhat visible, digital watermarks are designed to be completely invisible. It is prominently used for tracing copyright infringements and for banknote authentication. Digital watermarks cannot be removed or altered, making them a very important tool when fighting copyright infringement on the Web. Digital watermarks allow users to legally use content, while adding security to the content to prevent illegal usage.

Every watermarking system has some very important desirable properties like effectiveness, image fidelity, payload size, false positive rate, robustness. The efficiency of digital watermarking algorithms is totally based on the robustness of the embedded watermark against various types of attacks. Digital watermarking is a method used to improve the ownership over image by replacing low level signal directly into image. Digital watermarking is a developing field and used in various applications.

Every digital watermarking technique includes two algorithms: the embedding algorithm and the detecting algorithm [3]. Fig.1 shows the watermark embedding process in which the watermark is embedded in the cover image by using the embedding algorithm. And Fig 2. Shows the watermark detection process in which the embedded watermark is recovered by using the detection algorithm.

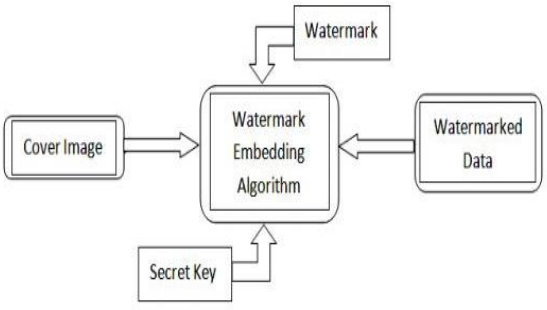

Figure 1. The watermark embedding process

Watermarking techniques can be divided into four categories based on the type of document to be watermarked which is Text Watermarking, Image Watermarking, Audio Watermarking and Video Watermarking.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016
National Conference on Digital Signal Processing, Information and Communication Engineering
Govt. Polytechnic College, Kasaragod
Vol. 5, Special Issue 4, November 2016

Digital Image Watermarking use digital image for embedding the hidden information, after embedding the watermarked image is generated and the watermarked image is more robust against attacks.

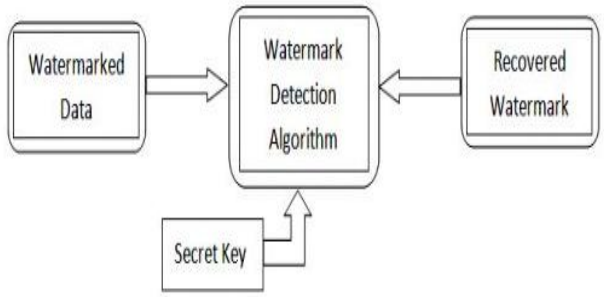

Figure 2. The watermark detection process

Digital image watermarking is derived from Steganography. The main difference between these two processes is that, in steganography the hidden data is on highest priority for sender and receiver but in watermarking source image and hidden image, signature or data is on highest priority. Working of digital image watermarking can be divided in three stages [4].

A. Embedding Stage

The embedding stage is the first stage in which the watermark is embedded in the original image by using the embedding algorithm and the secret key. Then the watermarked image is generated. So the watermarked image is transmitted over the network.

B. Distortion/Attack Stage

In this stage, when the data is transmitted over the network. Either some noise is added with the watermarked image or some attacks are performed on the watermarked image. So, our watermarked data is either modified or destroyed.

C. Detection/Retrieval Stage

In the detection stage, the watermark is detected or extracted by the dedicated detector from the watermarked image by applying some detection algorithm and by using secret key. In addition to this, noise is also detected.

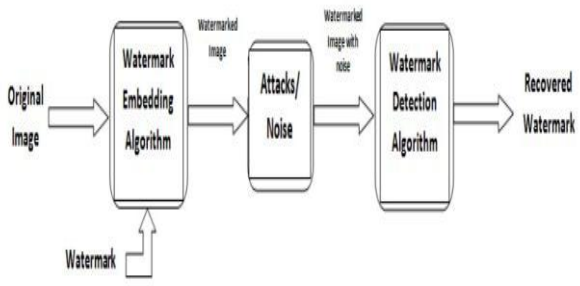

Figure 3. Stages in Digital Image Watermarking

Figure 4. Example of watermark on Indian currency

Digital image watermarking has attracted a lot of awareness in the research community because of its easy availability. And it can convey enough redundant information that could be used to embed watermarks.

In case of images, watermarking techniques are classified based on two working domains: either spatial domain or frequency domain. The spatial domain techniques works directly on pixels. It embeds the watermark by modifying the pixels value. During watermark embedding, no transforms are applied to the host signal. Spatial techniques are not very robust against attacks. The main strengths of this method is that it is conceptually simple and have very low computational complexities. Spatial domain technique is less time consuming as compare to wavelet or frequency domain techniques. Most commonly used spatial domain techniques are LSB.

Watermarking in the frequency domain involves selecting the pixels to be modified based on the frequency of occurrence of that particular pixel. The watermark is then embedded in the transformed coefficients of the image such that the watermark is invisible and more robust for some image processing operations. The coefficients are inverse transformed to obtain the watermarked image.

Discrete Cosine Transformation (DCT), Discrete Fourier Transformation (DFT) and Discrete Wavelet Transformation (DWT) are the main methods of data transformation. This technique is difficult and watermark cannot be easily recovered at the receiver end as compared to the spatial domain technique.

But Frequency based techniques result in a watermark that is dispersed throughout the image, therefore, less susceptible to attack by cropping. This paper surveys different digital image water marking techniques based on discrete wavelet transform.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016
National Conference on Digital Signal Processing, Information and Communication Engineering
Govt. Polytechnic College, Kasaragod
Vol. 5, Special Issue 4, November 2016

II. VARIOUS DIGITAL IMAGE WATERMARKING BASED ON DISCRETE WAVELET TRANSFORM

Wavelet Transform is a modern technique frequently used in digital image processing, compression, watermarking etc. The transforms are based on small waves, called wavelet, of varying frequency and limited duration. Furthermore, the properties of wavelet could decompose original signal into wavelet transform coefficients which contains the position information.

The original signal can be completely reconstructed by performing Inverse Wavelet Transformation on these coefficients. Watermarking in the wavelet transform domain is generally a problem of embedding watermark in the sub bands of the cover image.

The basic idea of DWT in image process is to multi-differentiated decompose the image into sub-image of different spatial domain and independent frequency district. Then transform the coefficient of sub- image [6]. After the original image has been DWT transformed, it is decomposed into 4 frequency districts which is one low-frequency district(LL) and three high-frequency districts(LH,HL,HH). If the information of low-frequency district is DWT transformed, the sub-level frequency district information will be obtained.

A two- dimensional image after three-times DWT decomposed can be shown as Fig.5**.** Where, L represents low-pass filter, H represents high- pass filter. An original image can be decomposed of frequency districts of HL1, LH1, HH1.The low-frequency district information also can be decomposed into sub-level frequency district information of LL2, HL2, LH2 and HH2. By doing this the original image can be decomposed for N level wavelet transformation.

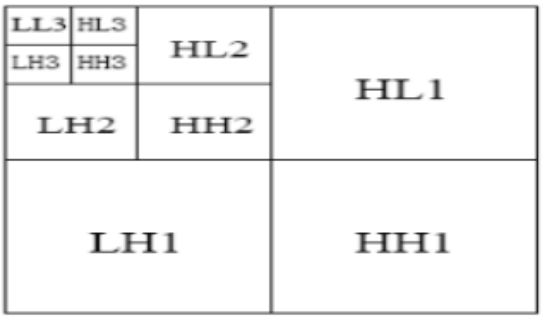

Fig 5. Sketch Map of Image DWT Decomposed

Due to its excellent spatio-frequency localization properties, the DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. M. Barni et al. [5] have developed an improved wavelet-based watermarking algorithm which embeds the watermark code by modifying the DWT coefficients of the image. They exploit a model derived from image compression techniques for adapting the watermark strength to the characteristics of the HVS. The watermark weighing function is calculated as a simple product of data extracted from HVS model. In contrast to conventional methods operating in the wavelet domain, masking is accomplished pixel by pixel by taking into account the texture and the luminance content of all the image sub bands. The watermark is detected by computing the correlation between the watermarked coefficients and the watermarking code, and the detection threshold is chosen in such a way that the knowledge of the watermark energy used in the embedding phase is not needed, thus permitting it to adapt the image at hand. They experimentally proved that the performance of this algorithm was very good and the behaviour of the watermark detector with respect to image cropping was good.

Victor et al. [7] have developed an algorithm that relies upon adaptive image watermarking in high resolution sub-bands of DWT. Weighting function is the product expression of data extracted from the HVS model. The watermarking algorithm analyzed is adaptive to image characteristics and it is realized using pixel by pixel masking in the DWT domain to embed the watermark with maximum energy. The detection process consists of cross-correlation between the marked image and pseudorandom sequences, and the original image is not required. Simulation of this method shows its robustness.

Wang and Lin [8] proposed wavelet tree based watermarking algorithm. In this method, the host image is transformed into wavelet coefficients using a discrete-time wavelet transform (DTWT). The watermark is embedded in the wavelet coefficients which are grouped into super trees. Each watermark bit is embedded using two super trees. Depending on the value of the watermark bit, one of the super trees is quantized with respect to a quantization index in such a way that the two super trees exhibit a large enough statistical difference, which can be extracted for obtaining decision.

As each watermark bit is embedded in various frequency bands and the information of the watermark bit is spread throughout large spatial regions, therefore the watermarking technique is robust to attacks in both frequency and time domains. This technique is useful for removal of high-pass details in JPEG compression and robust to time domain attacks such as pixel shifting and rotation. In addition to copyright protection, the proposed watermarking scheme can also be applied to data hiding or image authentication.

Deng and Jiang [9] proposed a DWT-based image watermarking algorithm. They proposed a new digital Code-Division Multiple Access (CDMA) watermarking algorithm based on orthogonal wavelet. Harr wavelet basis

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

is changed into a multilevel orthogonal sequence by scaling and translation, which is used to encode the binary image. Then the CDMA encoded watermark is adaptively embedded into the third level detail sub-images of DWT domain. N. Bi et al. [10] proposed a blind image watermarking algorithm based on the multiband wavelet transformation and the empirical mode decomposition. Unlike the watermark algorithms based on the traditional two-band wavelet transform, they embed the watermark bits in the mean trend of some middle-frequency sub images in the wavelet domain. They selected appropriate dilation factor and filters in the multiband wavelet transform to achieve better performance in terms of perceptually invisibility and the robustness of the watermark. Its experimental results showed that this scheme is robust against JPEG compression, Gaussian noise, salt and pepper noise, median filtering and various attacks. G. Sun and Y. Yu [11] proposes a digital watermarking embedding algorithm based on discrete wavelet transform (DWT) for color image. The original color image is transformed into the YIQ color space, and the watermark was embedded in both Y component and Q component. The experimental results showed that the watermarks are robust against JPEG, filter, crop procession and noise etc. The literature review presents the fact that there are large numbers of innovative and inventive image watermarking approaches based on DWT is available. It reviews the attributes of image watermarking. The review reveals the fact that even though information on watermarking schemes is published, a performance evaluation of various schemes is difficult. This survey on different digital watermarking techniques shows different robustness level.

III. CONCLUSION

Digital image watermarking has attracted a lot of awareness in the research community because of its easy availability. Wavelet based image watermarking is gaining more popularity because of its resemblance with the human visual system. This paper reviews the fact that a large numbers of innovative and inventive image watermarking approaches based on DWT are available. And different digital watermarking techniques show different robustness level. Digital watermarking is still a challenging research field with many interesting problems, like it does not prevent copying or distribution and also cannot survive in every possible attack. Future work is also planned to perform a comparative performance evaluation of existing watermarking schemes.

ACKNOWLEDGMENT

The author would like to express his sincere gratitude to **Smt. A S Chandrakanta**, Principal and Head of the Institution, for providing the necessary motivation and guidance for the completion of this paper. Also would like to thank my colleagues, family members and the anonymous reviewers and editors for their helpful comments, suggestions and constructive criticism, which will help to improve the presentation of the paper.

REFERENCES

[1] G. Rafael, C. Gonzalez and R. E. Woods Digital Image Processing, 3nd ed., 2008.
[2] Harpuneet Kaur, "Robust Image Watermarking Technique to Increase Security and Capacity of Watermark Data Computer Science & Engineering Department, Thapar Institute of Engineering & Technology, , pp. 1-69. May 2006.
[3] Preeti Parashar and Rajeev Kumar Singh , "A Survey: Digital Image Watermarking Techniques",] International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 7, No. 6, pp. 111-124, 2014.
[4] L. Robert and T. Shanmugapriya," A Study on Digital Watermarking Techniques", International Journal of Recent Trends in Engineering, vol. 1, no. 2, May 2009.
[5] Mauro Barni, Franco Bartolini, , and Alessandro Piva, " Improved Wavelet Based Watermarking through Pixel wise Masking" , IEEE Transactions on Image Processing, Vol 10, No.5, May 2001.
[6] Ankush R. Patil and V. K. Patil, " A Review of Image Water Marking Methods" International journal of Engineering Science and Research Technology, ISSN:2277-9655, July 2016.
[7] Victor V., Guzman, Meana, " Analysis of A Wavelet Based Water Marking Algorithm" IEEE Proceedings of the International Conference on Electronics Communications and Computer, PP.283-287, 2004.
[8] Wang S.H., LinY.P., " Wavelet Tree Quantization for Copyright Protection for Watermarking" IEEE Transactions on Image Processing, pp 154- 165, 2002.
[9] Deng, N., Jiang, " CDMA Watermarking Algorithm Based on Wavelet Basis" Proc 9th International Conference on Systems and Knowledge Discovery, pp. 2148-2152, May 2012.
[10] N. Bi, Q. Sun, D. Huang, Z. Yang, and J. Huang, "Robust Image Watermarking based on Multiband Wavelet and Empirical Mode Decomposition" , IEEE Transactions on Image Processing , vol 16, No.8,pp 1956-1966,2007
[11] G. Sun and Y. Yu , "DWT based Watermarking Algorithm of Color Images" In Proceeding of 2nd IEEE Conference on Industrial Electronics and Applications , May 2007.

BOIGRAPHY

Mr. Biju M J, is now working as HOD in Govt Women's Polytechnic College, Nedupuzha. He secured B.Tech in Computer Science & Engineering from Govt Engg College Thrissur in 2003. He secured his M.Tech in Information Technology from MS University, Tirunelveli in 2012. His area of project was "**Segment based binary coding character recognition algorithm for Indian number plates".** He is empowered with CMI Level 5 certification by Chartered Management Institute, UK. He worked as a Demonstrator, Lecturer and HOD in Various Govt Polytechnic Colleges in Kerala during 1997-2016. He had handled the subjects such as System Programming, Programming Languages, and Operating Systems. His area of interest is Image Processing.