A Reversible Image Authentication Technique based Watermarking in ICA-DWT Combined Approach

Siva kannan S*, G. Thirugnanam, P. Mangaiyarkarasi
Department of EIE, Annamalai University, Chidambaram, India
***Corresponding author: E-Mail: sivakannan87@gmail.com**

ABSTRACT

The authors propose new method to a blind reversible watermarking technique. In this paper, we proposed a novel watermarking technique for image watermarking using ICA-DWT combined approach, to achieve high accuracy. In the proposed technique, first image is divided into N/2 x M/2 Images. Then ICA is applied to N/2 x M/2 images. ICA1 (highest energy) has taken for applying DWT. Finally two watermark images are embedded into the 2nd DWT low frequency sub bands of each image block. We designed ICA-DWT algorithm on FPGA and applied to image to insert two individual watermarks. The Results obtained from the proposed scheme proves to handle the problems that arise in watermarking such as tampering of the content, collage attack, effectively thereby reducing distortions that can occur in an image in a large extent. Additional benefits such as reversal property that are used in medical field, defense purposes can also be applied here.

KEY WORDS: Watermarking, Information-Hiding, Authentication, ICA, DWT, FPGA.

1. INTRODUCTION

The fast growth of innovations in the field of Multimedia and Digital Image Processing Technologies has led to the misuse of various processes such as copying and editing of digital content, which has led to the loss of secure information. This causes the data to be easily encroached upon. A classic example is where the content of an image can be tampered or remodeled, while transmitting over wireless communications. Hence the conservation of the data has become a mandatory operation for the application of its use in the field of academics and industry. This is overcome by using the Watermarking Technique. In this technique three categories of Watermarking, that is Robust, Semi-Fragile and Fragile Watermarking are used.

Robust Watermarking is the first method which is used to prevent and rectify intentional and unintentional changes in the image whereas the second method that is used to avoid minor errors is the Semi-Fragile Watermarking technique. A third method, called Fragile Watermarking is very specific in correcting intended threats on the image. Protection of copyright in the images and biometrics are the applications of Robust Watermarking Technique. The algorithms under image authentication utilize spatial and the transform domains for the purpose of detecting errors in watermarked images.

In the spatial domain, watermarking is done by altering the collection of selected pixels in the image without significant distortion. In the transform domain, the transformed frequency components of the cover image are modified for the purpose of embedding the watermark.

A very common method is to apply ICA at the detection to obtain the watermark. An alternate method is to use the information based on original results, for obtaining ways to embed the watermark. Recently there have been many schemes initiated to protect the information security of the image and verifies its trust worthiness.

In 2006, Maeno came up with a proposal in which two semi-fragile watermarking schemes were used to increase accuracy and to obtain a robust system against the lossy compression. In 2008, a dual watermarking scheme was proposed by Lee and Lin for authentication. Chuang and Hu in 2008, proposed a methodology by using an image authentication on vector quantization. In 2013, Preda came up with a proposal of a novel image authentication using DWT to improve the quality of watermarked images. In this, by using mean quantization technique the watermark bit was inserted onto selected coefficients. Al-Otum (2014), came up with a scheme of modifying watermarked image based on DWT quantization technique. The image quality was found to be lower than that of Preda's findings.

It has been perceived from literature that the accuracy of these error Detection schemes was much better than other methods as it provided low distortion of watermarked images. Added to this, few schemes were irreversible, where the cover image was permanently distorted and could not be recovered back.

In our proposed technique, we introduce an image watermarking algorithm using Independent Component Analysis and Discrete Wavelet Transform. The cover image is separated into N/2 x M/2 observation images. And then we have applied ICA to all the observation images, now we have four independent components. Then choose the one component from high frequency level. Selected sub band is wavelet transformed. The two independent watermark information or image is embedded into 2nd DWT low frequency sub bands of each image block.

It has been proved that the proposed scheme has the capability of resisting against different attacks which includes size differences of tampered regions, content tampering, collage attacks etc, Make the whole image Inverse DWT (IDWT) and Inverse ICA transformed and get the cover image and watermark.

2. PROPOSED SYSTEM

Watermark Embedding: Original image is divided into four observation image (N/2 x M/2 images). Then ICA applied to the N/2 x M/2 observation image to get four individual components. Highest energy component IC1 taken for applying DWT. Then, the horizontal component HL & vertical component LH is taken out for Second level DWT decomposition as shown in fig.2. Then the two watermark images are inserted into 2nd DWT low frequency sub bands of each image block. i.e HL1 & LH1.

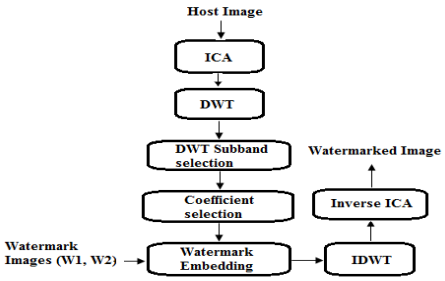


Figure.1. ICA-DWT Approach

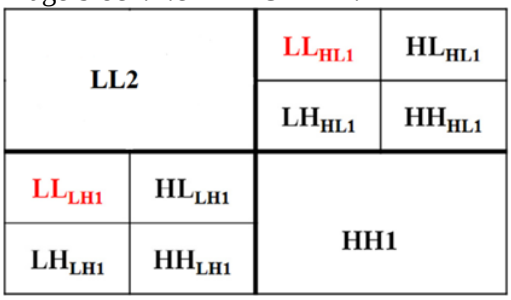


Figure.2. 2D Wavelet Transform after 2 level decomposition

Watermarking Algorithm Using ICA-DWT: The embedding procedures are summarized as follows:

- Image is divided into N/2 x M/2 Observation Images
- Apply ICA to all the observation images
- Select IC1 from Individual Components.
- The received Individual Components is transformed by DWT algorithm to generate transformed coefficients $TB_{m,n}$. Then, two subblocks LH, HL of each $TB_{m,n}$ are continually transformed by 2nd level DWT by Eq.1.

$$D_{m,n}^{sb}(i,j) = DWT(TB_{m,n}(i,j)) \quad (1)$$

Where (i, j) is the corresponding spatial location in the 2nd level DWT, and sb is used to indicate the corresponding sub bands, i.e., LL_{LH1}, LL_{HL1}, shown in Fig.2.

- Select LL_{LH1} & LL_{HL1} for embedding.
- The watermark image resized if necessary to make it size the same of selected sub band.
- The value of scaling factor defined to be suitable for invisible watermarking.
- Modify the coefficients of the LL_{LH1} & LL_{HL1} band by adding watermark coefficients.
- Apply IDWT & ICA to obtain the watermarked cover Image, IW.

Extraction: Extracting procedures are summarized as follows:

- Image is divided into N/2 x M/2 Observation Images
- Apply ICA to all the observation images
- Select IC1 from Individual Components.
- The received Individual Components is transformed by DWT algorithm to generate transformed coefficients $TB_{m,n}$. Then, two sub blocks LH, HL of each $TB_{m,n}$ are continually transformed by 2nd level DWT by Eq.(1).
- Select LL_{LH1} & LL_{HL1} for extraction.
- Extract Watermark images W1 & W2 from LL_{LH1} & LL_{HL1} sub bands.
- Apply IDWT & ICA to obtain the cover Image.

3. RESULTS AND DISCUSSION

In this work segmentation ICA-DWT is implemented in FPGA Altera board. We used 512x512 pixel size image cover picture and 64x64 pixels as watermark for testing. Perceptual transparency and Robustness are the performance evaluation metrics taken here. Perceptual transparency observed cover image should not be destroyed by insertion of watermark. Measure of quality of processed image is done using PSNR.

Table.1. Input Images and Input Watermarks

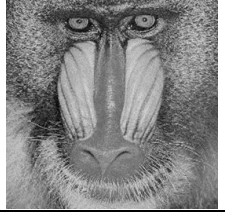
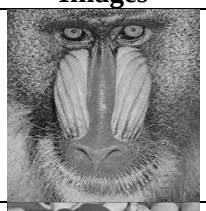
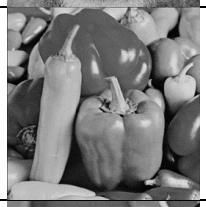
Input Images	Input Watermarks
	

Table.2. Results for host image

Watermarked Images	Recovered Watermark	Weighting factor (F), PSNR (db), Correlation (ρ)
		**F=0.02** **PSNR=49.14** **ρ=1**
		**F=0.06** **PSNR=45.05** **ρ=1**
		**F=0.02** **PSNR=48.15** **ρ=1**

For robustness inspection of the proposed scheme the watermarked image was tested against several types of attacks namely Salt & Pepper noise, Gaussian noise and Speckle noise. We observe that ICA- DWT based watermarking attains the lowest distortion in the watermarked images in the lack of attacks and better performance for most of the attacks from Table.4.

Table.3. Performance of the ICA-DWT based watermarking against various types of attacks

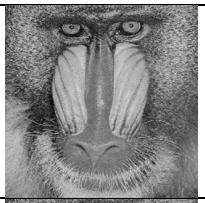
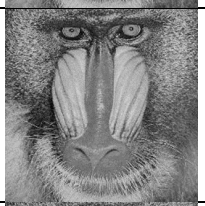
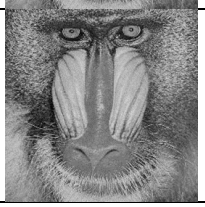
Attack	Watermarked Image	Extracted Image
Salt & pepper noise		
Gaussian noise		
Speckle noise		

Table.4. PSNR Value Of ICA -DWT for different types of Attacks

Image Type	ICA-DWT
Salt & Pepper Noise	49.028
Gaussian Noise	51.014
Speckle Noise	49.872

FPGA Implementation: In order to validate the efficiency of our ICA DWT approach, the fastest folded structure are selected and implemented on alttera stratix platform to process 512 x512 size cover image. The storage memory and the numbers of M9 K memory are extracted. For speed performance throughput, that is outlined because the number of images processed per second, is used.

Table 5. FPGA Implementation

Architecture	Clock Frequency	Image size of size 512x512 for M9k memory	Overall Though put (M9k)
ICA-DWT	350	10	660

4. CONCLUSION

This paper presents a new technique for embedding two individual watermarks into host image using independent component analysis and discrete wavelet transform. Watermark images are embedded into the ICA transformed vertical sub band & horizontal sub band of wavelet coefficient. Before embedding, this watermark images has been taken for ICA in order to improve its robustness. By applying this algorithm, the experimental results have demonstrated that the proposed algorithm is imperceptible, because the average PSNR for all test images is 47.44dB. Moreover, the proposed watermarking system is more robust, being this can also be used in some of medical applications, it can keep the image quality well.

REFERENCES

Al-Otum HM, Semi-fragile watermarking for grayscale image authentication and tamper detection based on an adjusted expanded-bit multiscale quantization-based technique, J Visual Commun Image Represent, 25 (5), 2014, 1064–1081.

Chuang JC, Hu YC. An adaptive image authentication scheme for vector quantization compressed image, J Visual Commun Image Represent, 22 (5), 2011, 440–449.

Grzeszczak Mandal M.K, Panchanathan S, VLSI implementation of discrete wavelet transform, IEEE Trans, Very Large Scale Integr. Syst, 4 (4), 1996, 421–433.

Hajisami A, Hosseini S, Application of ICA in Watermarking, in, Mithun Das Gupta (Ed.), Watermarking, In Tech, 1, 2012.

Lin PY, Lee JS, Chang CC, Dual digital watermarking for internet media based on hybrid strategies, IEEE Trans Circuits Syst Video Technol,19 (8), 2009, 1169–1171.

Lo CC, Hu YC, A novel reversible image authentication scheme for digital images, Signal Process, 98, 2014, 174–185.

Maeno K, Sun Q, Suto M, New semi-fragile image authentication watermarking techniques using random bias and non-uniform quantization, IEEE Trans Multimedia, 8 (1), 2006, 32–45.

Mansouri A, Ahaitouf A, Abdi F, An efficient VLSI architecture and FPGA implementation of high-speed and low power 2-D DWT for (9, 7) wavelet filter, IJCSNS Int. J. Comput. Sci. Network Secur, 9 (3), 2009, 50–60.

Preda RO, Semi-fragile watermarking for image authentication with sensitive tamper localization in the wavelet domain, Measurement, 46 (1), 2013, 367–373.

Sivakannan S, Thirugnanam G, Sheeba Joice C, An Efficient ICA and DWT Combined Approach for Medical Image Watermarking Technique, World Applied Sciences Journal, 34 (9), 2016, 1197-1203.

Wioletta and Marek R, Ogiela, Digital images authentication scheme based on bimodal biometric watermarking in an independent domain, Journal of Visual Communication and Image Representation, 2016.