INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN : 2277-7881
VOLUME 1, ISSUE 2, JUNE 2012

AN ADAPTIVE IMAGE WATERMARKING ALGORITHM BASED ON NEURAL NETWORK

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I. Introduction

A digital image is a numeric representation (normally binary) of a two-dimensional image. Depending on whether the image resolution is fixed, it may be of vector or raster type. Without qualifications, the term "digital image" usually refers to raster images also called bitmap images.Raster images have a finite set of digital values, called picture elements or pixels. The digital image contains a fixed number of rows and columns of pixels. Pixels are the smallest individual element in an image, holding quantized values that represent the brightness of a given color at any specific point.

Typically, the pixels are stored in computer memory as a raster image or raster map, a two-dimensional array of small integers. These values are often transmitted or stored in a compressed form.

Raster images can be created by a variety of input devices and techniques, such as digital cameras, scanners, coordinate-measuringmachines, seismographic profiling,airborne radar, and more. They can also be synthesized from arbitrary non-image data, such as mathematical functions or three-dimensional geometric models; the latter being a major sub-area of computer graphics. The field of digital image processing is the study of algorithms for their transformation.

II.Preliminaries

The following characteristics of human vision characteristics (HVS) were pointed out by Lewis etc . High frequency and diagonal (+45o) the direction of noise, very light or very dark area noise, the rich texture area noise is not sensitive by human eye.

1. Discrete cosine transform

With the character of discrete Fourier transform (DFT), discrete cosine transform (DCT) turn over the image edge to make the image transformed into the form of even function. It's one of the most common linear transformations in digital signal process technology. Two dimensional discrete cosine transform (2D-DCT) is defined as

$$F(jk) = a(j)\,a(k)\sum_{m=0}^{N-1}\sum_{n=0}^{N-1} f(mn)\cos\left[\frac{(2m+1)j\pi}{2N}\right]\cos\left[\frac{(2n+1)k\pi}{2N}\right]$$

1. **Discrete wavelet transform**

Wavelet transform is a time domain localized analysis method with the window's size fixed and forms convertible. According to the character of HVS, human eyes are sensitive to the change of smooth district of image, but not sensitive to the tiny change of edge, profile and streak. Therefore, it's hard to conscious that putting the watermarking signal into the big amplitude coefficient of high-frequency band of the image DWT transformed. Then it can carry more watermarking signal and has good concealing effect.

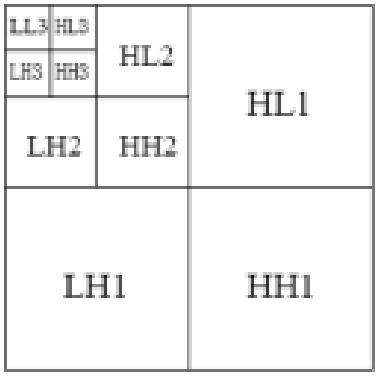


Figure 1.Sketch Map of Image DWT Decomposed.

Figure 1 shows decompose of image ,After the original image has been DWT transformed, it is decomposed into 4 frequency districts which is one low-frequency district (LL) and three frequency districts(LH,HL,HH).. The frequency districts of LH, HL and HH respectively represents the level detail, the upright detail and the diagonal detail of the original image

I. Watermarking embedded Procedure

Figure 2 shows the block diagram of emeded watermark with following methods

1) The input image is transformed into first order wavelet transform .

2) The low frequency components are blocked by Discrete Cosine transform.

3) The watermark signal is training signal to *neural network recovery***.**

The Hopfield network is used with neural network training .The watermark signal is coded first 0 of binary image is changed to -1.1 is not changed W' is gotten .W' is divided in n1×n2 sub-blocks the last translated to one dimensional signal training mode is set to P.

5) *watermark pre-treatment*-watermark signal is scrambled by key times then the watermark signal is embeded in low frequency components of high frequency band.

6)Image containing watermark and watermarked image is gotten by IDCT and IDWT respectively

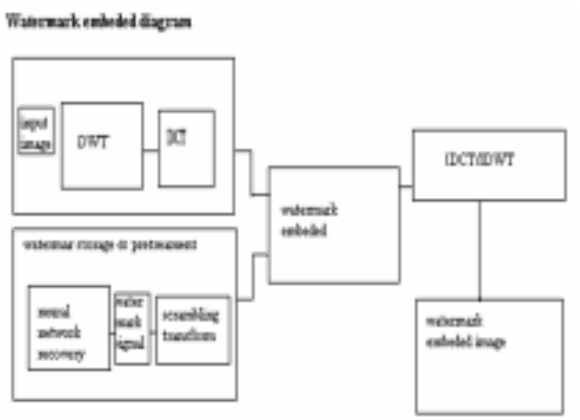


Figure 2.watermark embeded diagram

IV. Watermark Extraction Procedure

According to the embedding process, watermark can be extracted through the corresponding inverse operation. Watermark extraction process diagram as Figure3 shows.

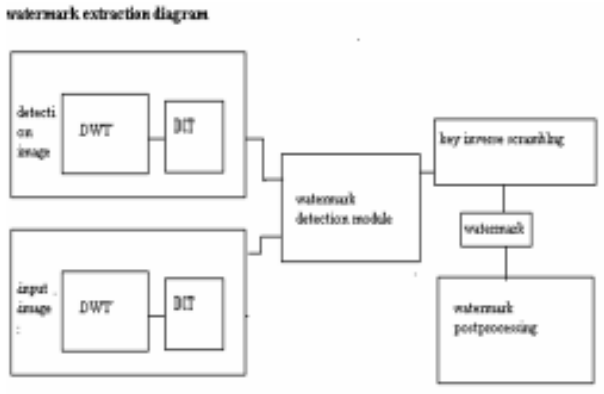


Fig 3 watrermark extraction diagram

1) The detection image and the original image are processed by first-order DWT, and T and I are gotten through block DCT.

2) Watermark is extracted through T and I input watermark detection module;

3) The extracted watermark is gotten through the extracted watermark signal R' is processed according to the key inverse scrambling;

4) The extracted watermark is input to Hopfield network, then does data post-processing, the recover watermarking is gotten after data mongering.

V. Watermarking System Evaluation Standard

The subjective and objective combining ways of evaluation are adopted in general watermarking system, because subjective method is often influenced by observer visual experience environment and other factors. Therefore, it is necessary to adopt quantitative evaluation method as the supplement. The peak value signal-to-noise ratio (PSNR) is adapted to measure distortion degree of watermark image about the original image in this paper.

$$PSNR(f,w) = 10\log_{10}\left[\frac{\max f^2(\max_{(m,n)} f^2(m,n))}{1/N_p(\sum_{(m,n)}(f w(m,n)-f(m,n))^2}\right]$$

Normalization correlation (NC) is used to measure the similarity degree of watermarking extraction and watermarking signal, the definition for it is:

$$NC = \frac{\sum_m \sum_n w(m,n) \times w'(m,n)}{\sum_m \sum_n (w(m,n))^2}$$

VI. SOFTWARE TOOL

The software tool used for implementing algorithem is Matlab tool.The software code and supporting tools are based on the leading software in the field: *MATLAB* ® and the *Image Processing Toolbox*™ from the MathWorks, MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include the following:

- Math and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including building graphical user interfaces

MATLAB is an interactive system whose basic data element is a matrix. This allows formulating solutions to many technical computing problems, especially those involving matrix representations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C.

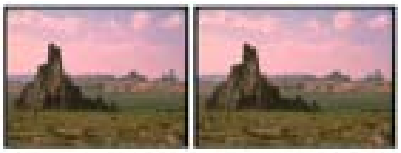
.In university environments, MATLAB is the standard computational tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the computational tool of choice for research, development, and analysis. MATLAB is complemented by a family of application-specific solutions called *toolboxes*. The Image Processing Toolbox is a collection of MATLAB functions (called *M-functions* or *M-files*) that extend the capability of the MATLAB environment for the solution of digital image processing problems. Other toolboxes that sometimes are used to complement the Image Processing Toolbox are the Signal Processing, Neural Networks, Fuzzy Logic, and Wavelet Toolboxes.

The *MATLAB & Simulink Student Version* is a product that includes a full-featured version of MATLAB, the Image Processing Toolbox, and several other useful toolboxes.

The Student Version can be purchased at significant discounts at university bookstores and at the MathWorks website..

7. Result and discussion

1. The 256×256 "mountain" diagram is used as experiment image; The 32×32 binary image "Ep" is used as watermark image, Figure 3 (a) the original image, and (b) image containing watermark (c) watermark image, (d) extracted watermarking, (e) watermarking after neural network recovery.



a-b

(c) (d) (e)

Figure 3. transparency experiment image

2. Comparision table of NC1,NC2

NC1 Normalization correlation coefficient of watermark through neural network recovery is compared with NC2 of direct extracted watermark.

Compression ratio	70%	50%	30%
PSNR	33.7	30.12	25.5
NC1	1	1	1
NC2	1	0.876	0.578

Conclusion

An adaptive watermarking algorithm which based on a neural network according to the human vision characteristics. The watermarking is embedded in the high frequency regions of not eye-sensitive, through wavelet multi resolution and discrete DCT treatment method.Normalization correlation (NC1) coefficient of watermark through neural network recoveryis compared with NC2 of direct extracted watermark when Original image containing watermark image transforms into different degree of JPEG compress.

As JPEG compression ratio is high NC1 should not decrease as NC2 .quality of watermarking image greatly improves.

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