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INFRANGIBLE APPROACH OF DIGITAL IMAGE WATERMARKING USING DCT IN FULL COUNTER PROPAGATION NEURAL NETWORK

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Abstract

In recent years, internet revolution resulted in a rapid growth in multimedia applications. The rapid advancement of internet has made it easier to send the image accurate and faster to the destination. Besides this, it is easier to modify and misuse the valuable information through hacking at the same time. Digital watermarking is one of the best solutions for copyright protection of multimedia data. A watermark is a form, image or text that is impressed onto paper, which provides evidence of its authenticity. In this paper, an invisible watermarking technique is implemented.

Keyword: Image watermarking, Full counterpropagation neural network, DCT

I Introduction

Watermark is a piece of information, which provides ownership of the document. Digital Image watermarking is idea of embedding such a watermark image into the cover image.A different digital image watermarking technique is proposed, In which we have used three watermarked images embedded in encoded cover image and operation is performed in full counter propagation neural network. We have also given an overview of image watermarking and different security issues. Various attacks are also performed on watermarked images and their impact on quality of images is also studied .Quality factors like PSNR,NC and a Error Rate are also discussed. Image Watermarking in transform domain using counter propagation algorithm has been used for embedding the watermark images into the the cover image. This work is implemented through MATLAB.

A Digital water marking technique based on full counter propagation neural network for improving the robustness , imperceptibility and security based on comparison of error metrics is proposed [1].In this , digital image watermarking has done transform domain. In which the Error metrics or parameter like PSNR, NC are compared at extraction of watermarked image. Gunjal and Mathalkar [2] given the overview an overview of transform domain robust digital image watermarking algorithms. They have focused on Discrete Wavelet Transform as per ISO norms JPEG2000 has replaced Discrete Cosine Transform by Discrete wavelet Transform. Pooja and Kavita [3] has implemented three different digital watermarking techniques each from Spatial Domain (LSB) and Transform Domain (DCT and DWT) for evaluating their performance using various parameters such as PSNR, MSE, similarity ratio(SR), correlation(CORR) and BCR against robustness for attacks.

Specific design method were explained [4] which is different in the sense that watermark was embedded in synapses of FCNN instead of Cover image. The quality of the watermarked image was almost the same as the original cover image. In addition, because of the watermark was stored in the synapses, most of the attacks could not degrade the quality of the extracted watermark image. In the report [5] of Mahmoud El-Gayyar and Prof. Dr. Joachim von zur Gathen they have summarized the types of digital watermarking techniques and had given the brief description of fragile watermarking .They had also introduced a secure fragile watermarking system exploiting non-deterministic information and contextual information.

Image Watermarking in transform domain using counter propagation algorithm has been used for embedding the watermark images into the the cover image. Beyond the limit of traditional technique we have used three watermark images that are to be embedded into the cover image. This way we have made watermark security more firm. Its hard to extract three different watermark images from any image.So, the robustnees ,Imperceptibility and security has also increased. This work is implemented through MATLAB.

II Watermarking using DCT

Transform domain watermarking is also known as frequency domain watermarking. In this technique the

digital cover image is first transformed into frequency domain . Then its low frequency components are obtained. Then this low frequency components like DCT, DWT and STFT are modified to contain text or signal.

The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. The dct2 function computes the two-dimensional discrete cosine transform (DCT) of an image. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT. For this reason, the DCT is often used in image compression applications. For example, the DCT is at the heart of the international standard lossy image compression algorithm known as JPEG. (The name comes from the working group that developed the standard: the Joint Photographic Experts Group.)

The two-dimensional DCT of an M-by-N matrix A is defined as follows.

$$Bpq = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} A_{mn} \cos \frac{\pi(2m+1)p}{2m} \cos \frac{\pi(2n+1)q}{2n}, \begin{matrix} 0 \leq p \leq M-1 \\ 0 \leq q \leq N-1 \end{matrix}$$

The values B_{pq} are called the DCT coefficients of A. (Note that matrix indices in MATLAB® always start at 1 rather than 0;therefore,theMATLABmatrixelements A(1,1) and B(1,1) c orrespond to the mathematical quantities A_{00} and B_{00}, respectively.)

The DCT is an invertible transform, and its inverse is given by

$$A_{mn} = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} \alpha_p \alpha_q B_{pq} \cos \frac{\pi(2m+1)p}{2m} \cos \frac{\pi(2n+1)q}{2n}, \begin{matrix} 0 \leq p \leq M-1 \\ 0 \leq q \leq N-1 \end{matrix}$$

$$\alpha_p = \begin{cases} \frac{1}{\sqrt{M}} & p = 0 \\ \sqrt{\frac{2}{M}} & 1 \leq p \leq M-1 \end{cases} \alpha_p =$$

$$\begin{cases} \frac{1}{N} & q = 0 \\ \sqrt{\frac{2}{N}} & 1 \leq q \leq N-1 \end{cases}$$

The inverse DCT equation can be interpreted as meaning that any M-by-N matrix A can be written as a sum of MN functions of the form

$$\forall \alpha_p \alpha_q B_{pq} \cos \frac{\pi(2m+1)p}{2m} \cos \frac{\pi(2n+1)q}{2n}, \begin{matrix} 0 \leq p \leq M-1 \\ 0 \leq q \leq N-1 \end{matrix}$$

These functions are called the basis functions of the DCT. The DCT coefficients B_{pq}, then, can be regarded as theweights applied to each basis function. For 8-by-8 matrices, the 64 basis functions are illustrated by this image.

The 64 Basis Functions of an 8-by-8 Matrix is shown in the figure Horizontal frequencies increase from left to right, and vertical frequencies increase from top to bottom. The constant-valued basis function at the upper left is often called the DC basis function, and the corresponding DCT coefficient B_{00} is often called the DC coefficient.
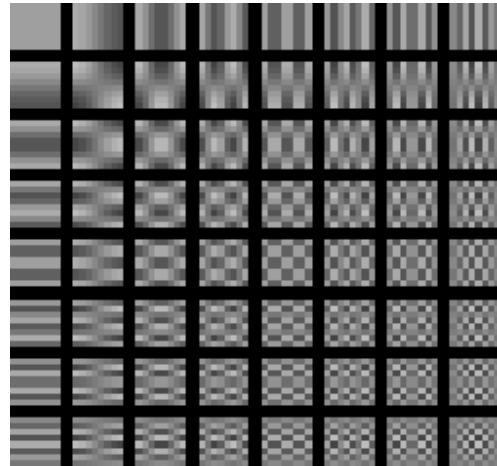

Fig.1. Image block of JPEG cover image

III Full Counterpropagation Neural Network

It is first introduced by R. Hecht-Nielsen in 1987.FCNN is multilayer networks based on a combination of input, clustering, and output layers. Application of FCNN is basically in the area of Data compression,Function appoximation and associte patterns. This is a multilayer networks based on the various combining stucture of input ,clustring and output layers.compared to the back propagation networks,it reduces the time by one hundreds times. FCNN is a type of CPN which works on the principle of "competition learning". In Digital watermarking FCNN can be easily trained with choosen set of weights to derive the watermark.In supervised learning of FCNN the weights from the cluster units to the output units are adapted to produce the desire response. Full counter propagation is an efficient method to represent a large number of vector pairs by adaptively constructing a look up table. It Produces an approximation input to output relationship.
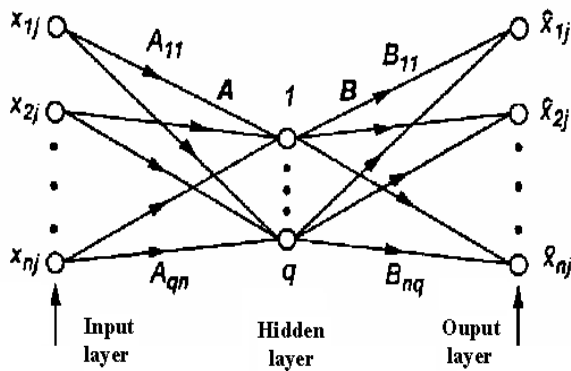
Fig. 2. Architecture overview of FCNN

NODES OF FULL COUNTER NEURAL NETWORK

Neurons:-An artificial neuron is a mathematical function conceived as a model of biological neurons. Artificial neurons are the constitutive units in an artificial neural network. Depending on the specific model used they may be called a semi-linear unit, neuron, binary neuron, linear threshold function, or McCulloch–Pitts (MCP) neuron. The artificial neuron receives one or more inputs (representing dendrites) and sums them to produce an output (representing a neuron's axon). Usually the sums of each node are weighted, and the sum is passed through a non-linear function known as an activation function or transfer function. The transfer functions usually have a sinusoid shape, but they may also take the form of other non-linear functions, piecewise linear functions, or step functions. They are also often monotonically

increasing, continuous, differentiable and bounded. The artificial neuron transfer function should not be confused with a linear system's transfer function.

INPUT LAYER

Input layer consist of input data which possesses N vectors composed of n-elements (i.e n=64) are sequentially applied to the input layer. The number of elements of an input vector is equal to the number of elements in this layer(i.e 8X8) and also equal to the number of pixels in the sample of a picture.

HIDDEN LAYER

The hidden layer is composed from q neurons(q<<n,i.e q=16) and realizes data compression.In the above mentioned example we get reduction factor equal to 4. Input layer and hidden layer can be treated as a transmitter.

OUTPUT LAYER

In the output layer there is n neurons again ,and the decompression has place reproducing the original 64 elements pattern samples. The output layer can be treated as a receiver. Usually the most popular system of a network learning is the back propagation algorithm.

STEPS INVOLVE IN IMAGE WATERMARKING USING NEURAL NETWORK

- Collect data.
- Create the network.
- Configure the network.
- Initialize the weights and biases.
- Train the network.
- Validate the network.
- Use the network.

Before image compression, it is necessary to learn the network first. Learning procedure can be based in practice on any learning image (recommended are images with varied gray level). The learning picture is segmented into clusters composed of 2x2, 3x3 or 4x4 pixels. Each has gray level between 64 (i.e. 0-63).Then the vectors representing these clusters are built and next normalized. These vectors are the input signals for the network.

For example, the image is of the size 80x80 pixels and clusters of the size 2x2 pixels there were 1600 learning vectors and for 4x4 sub images 400 learning vectors.

IV PROPOSED METHODOLOGY

The work is proposed to produce watermarked image by introducing three watermark images, this way we have raised the capacity of information hiding three times more. Additionally the security and robustness of the watermarked image has been raised three times greater. For this, we have used an digital cover image of the size 256X256 pixels and three watermark images of the size 32X32 pixels each. First, the Cover image is transformed into DCT components, and then IDCT is obtained. Then frames of the color red green and blue is extracted. The watermarked images are then inserted into the low frequency components of the of the cover image. At the time of extraction, received image is converted into DCT domain in blocks. We have then extracted the encoding message from the block. Then we have to find the correlation between two messages. On the comparison if the two messages are same. If the comparison found true then the encoded image is converted in to IDCT. Then we to train the FCNN for extracting Watermark .Thus watermark is successfully extracted.

EMBEDDING ALGORITHM:-

Step 1: Let *cover_image(i*1:*i2)* be defined to select a block containing all elements of cover image (i1,i2), such that $x <= i1 <= x+blocksize-1$, $y <= i2 <= y+blocksize-1$.
Find the DCT transformation of cover image blockwise.
dct_block = DCT (*cover_image (i*1: *i2))*

Step 2: The initial index of *dct_block* is set as *pos* = 1 if *message_vector(repeat_times)* = 0 then Embed the *pn_sequence_zero* into *dct_block* as per following equation.
dct_block(jj,ii) = dct_block (jj,ii) +pn_sequence_zero(pos), ψ*jj*, ψ*ii :midband(jj,ii)* ψ*1*,
for $1 < ii < blocksize$, $1 < jj < blocksize$, where for each new pair *(jj,ii)*, *pos* = *pos* + 1

Step 3: Now, encoded image block is obtained by taking the inverse DCT transform.
*encoded_image (i*1: *i2)* = IDCT(*dct_block*) for $x < i1 < x + blocksize - 1$, $y < i2 < y+blocksize - 1$

Step 4: Now, x is incremented. If x crosses the total number of columns, it is reinitialized and next row is taken.
$x = x + blocksize$
$x = 1 \wedge = y + blocksize$ *for (x+8) > nc*

Step 5: *repeat_times = repeat_times + 1* Go to step 1 for *repeat_times<= R*
Now, this encoded image has to be supplied to the Full Counter Propagation Network at the input layer along with the desired watermark for training .This encoded image can be represented as a column vector , and used as a cover image in FCNN.
$X = [x1, x2, x3, ... x\ mc,nc]$

where $mc \times nc$ is the total number of pixels in the encoded image.This image is supplied with the watermark $Y = [y1, y2, y3, ... ym]$ to be embedded to the input layer of FCNN as per the procedure. This FCNN after training, gives the watermarked image X=[*x*1, *x*2, *x*3, ... *x mw,nw*] and the desired watermark Y=[y1,*y*2, *x*3, ... *yn*] at the output layer.

Watermark extraction algorithm:-

Step 1: The DCT coefficient of watermarked image is obtained blockwise as under.
dct_block =DCT(*encoded_image(i*1:*i2))* The initial index of *dct_block* is set as *pos* = 1 Embedded sequence is obtained as under.
sequence (pos) = dct_block (jj,ii), ∀*ii*, ∀*jj*: for $1 < jj < blocksize$, $1 < ii < blocksize$, *midband (jj, ii)*=1where, for all new pair *(jj, ii)* , pos = pos+1

Step 2: Correlation of the obtained sequence is done with zero sequence.

correlat(repeat_times)=corr(pn_sequence_zero,sequence)
Now, x is incremented. If x crosses the total number of columns, it is reinitialized and next row is taken.
$x = x + blocksize$ $x = 1 \wedge y = y + blocksize$ *for x+8>nw*

Step 3: *repeat_times = repeat_times+1* Go to step 1 for *repeat_times<=R*

Step 4: Now, correlation of all sequences derived above is checked with *pn_sequence_zero* to mark the presence of '0' bit.
*message_vector(kk)* = 0 for *correlate(kk)>*0.55 and *message_vector (kk)* = 1 *(otherwise)* ,¥ *kk:*$1 < kk < mm \times nm$

Step 5: *extractflag =1*, if, ¥ *i : message_vector (i) = message(i) and extractflag =0 (otherwise)* for $1 < i < mm \times nm$

Step 6: if *extractflag* = 0

"Image is not authentic and not supplied to counterpropagation network for extracting the watermark." Otherwise ,"Image is authentic and should be supplied to counterpropagation network for extracting the watermark".Now, supply the encoded image X at the input layer of the trained counter propagation network and obtain the watermark at the output layer as per the procedure.

V SIMULATION AND RESULT

It is seen that by taking the DCT encoded cover image, the PSNR remains unaltered by the variation of threshold value. Experiment is performed where three watermarked images are embedded into encoded cover image. When attack 1Salt and pepper noise of d=.0001 is performed over watermarked image, furthermore at detection and recovery stage, watermarked is extracted successfully. While with other attacks (speckle noise, filtering, Gaussian noise) a significant change in parameters PSNR,ER and NC has observed.
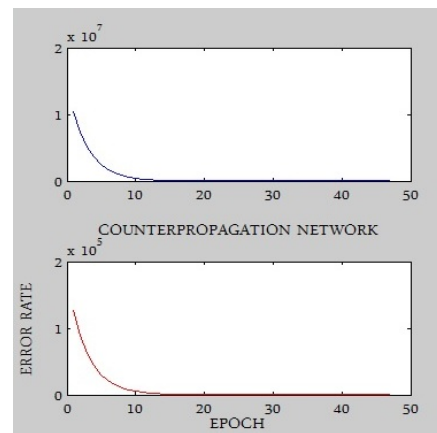
Fig.3.Graph showing Error Rate degradation

VI CONCLUSION

In this paper, attempts have been made to remove the deficiencies in the scheme of digital image watermarking using FCNN .Using the concept of three watermark images also helped to have the authenticity while preserving the other advantages of robustness, imperceptibility and high capacity of watermark. With this change, FCNN can be practically employed to obtain a successful watermarking scheme with better time complexity, higher capacity and higher PSNR. However, trained weight matrix of the FCNN is required to extract watermark from the given image.Three watermark images

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