International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868
Foundation of Computer Science FCS, New York, USA
Volume 4– No.10, December 2012 – www.ijais.org

Blue Channel Replacement Technique for DCT-Compressed Image

Mukta Gupta
Computer Science & Engineering
Kanpur Institute of Technology
Kanpur (U.P.), India

Prem Shanker Yadav
Computer Science & Engineering
Kanpur Institute of Technology
Kanpur (U.P.), India

Anubhav Bewerwal
Computer Science & Engineering
S.S.S.I.S.T.
Sehore, (M.P.), India

ABSTRACT

In this paper, a new methodology is used to preserve confidential information (for e.g. If we like to preserve an information which is in image form i.e. confidential image) which is a blue channel replacement technique, in order to hide maximum amount of data in an image without degrading its quality. In the proposed technique, the emphasis is placed on maximizing the embedding capacity and imperceptibility. Finally, the performance of the scheme is evaluated by using performance metrics such as Peak Signal to Noise Ratio (PSNR), Root Mean Square Error (RMSE). Several experiments have been performed and have been compared and it has been observed that the RMSE is inversely proportional to PSNR from the results obtained with the already existing schemes.

Keywords

Peak signal to noise ratio; Blue channel replacement technique; RMSE; Confidential image; Host image

1. INTRODUCTION

A new blue channel replacement technique is presented with improved quality parameters like Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). The proposed technique can encode any compressed image files (JPEG, BMP, PNG, GIF) having 24 bits per pixel in order to protect confidential image from unauthorized access. The technique has low computational complexity, so can be applied to very small images as well as large images. In this technique, 8 bits of blue channel have been replaced with pixel of compressed confidential image. The results show that quality parameter values of PSNR are much higher than all the previous existing techniques.

The objective of compression is to reduce the number of bits as much as possible, while keeping the resolution and the visual quality of the reconstructed image as close to the original image as possible[3].The need for sufficient storage space, large transmission bandwidth, and long transmission time for image, audio, and video data. At the present state of technology, the only solution is to compress multimedia data before its storage and transmission, and decompress it at the receiver for play back. For example, with a compression ratio of 32:1, the space, bandwidth, and transmission time requirements can be reduced by a factor of 32, with acceptable quality [1].

Compression can be classified by the method. It employs redundancy or by the method it compresses the data. Most methods for irreversible, or "lossy" digital image compression, consist of three main steps: Transform, quantizing and coding, as illustrated in figure 2.2 [2].

In order to compress our image using DCT following steps are followed:

1. The image first is broken into 8x8 blocks of pixels.

2. The DCT is applied to each block, it is working from left to right, top to bottom, to convert the spatial domain gray level of pixels into coefficients in frequency domain

3. Each block is compressed using quantization table.

4. The array of compressed blocks that comprise the image is stored in a drastically reduced amount of space.

5. When desired, the image is reconstructed through decompression, known as a process that uses the Inverse Discrete Cosine Transform (IDCT).

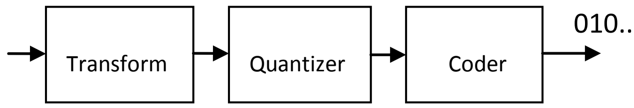

Fig.1.1 Three steps of Digital Image Compression

2. RELATED WORKS

2.1. Least Significant Bit Hiding (LSB) Scheme

This method is probably the easiest way of hiding information in an image. In the LSB technique, the LSB of the pixels is replaced by the message to be sent. The message bits are permuted before embedding, which has the effect of distributing the bits evenly, thus on average only half of the LSB's will be modified.

2.2. Pixel-Value Differencing (PVD) scheme

The alteration of edge areas in the human visual system cannot be distinguished well, but the alteration of smooth areas can be distinguished well. That is, an edge area can hide more secret data than a smooth area. With this concept, Wu and Tsai proposed a novel steganography technique using the pixel-value differencing (PVD) method to distinguish edge and smooth areas. The PVD technique can embed more data in the edge area which guarantees high imperceptibility.

2.3. Lie-Chang's scheme

The Steganographic technique has to possess two important properties. These are good imperceptibility and sufficient data capacity. A scheme which satisfied both properties was proposed by Lie-Chang [11]. The scheme is an Adaptive LSB technique using Human Visual System (HVS). HVS has the following characteristics: Just Noticeable Difference (JND), Contrast Sensitivity Function (CSF), Masking and Spectral Sensitivity. The characteristic of HVS used by Lie-Chang is JND (also known as the visual increment threshold or the luminance difference threshold). In this scheme, JND is defined as the amount of light ΔI necessary to add to a visual field of intensity I such that it can be distinguished from the background. In HVS, the curve for ΔI versus I can be analytically and mathematically modeled. The JND technique is simple and has a higher embedding capacity than other schemes. Also, this technique has high embedding capacity about overall bright images and has high distortion of a cover image when the embedding capacity is increased, but does not concern overall dark images.

2.4. MSB3 edge-detection

Generally, the human eye is highly sensitive to overall pictures of the field of view, while having low sensitivity to fine details. Such characteristic of HVS is called the CSF. One of several computational models which explain the CSF is proposed by Mannos-Sakrison [12]. According to Mannos-Sakrison scheme, if additional data is embedded in the pixels of high spatial frequency, one is able to satisfy both the increment of hiding capacity and good imperceptibility. In order to judge whether any pixel has the high spatial frequency or the low spatial frequency in a digital image, the edge detection algorithm is generally used. The GAP algorithm is one of the edge detection algorithms. For the input value of the GAP algorithm, we use the technique of the using three bits from the MSB. Due to this, the pixels that are selected from an embedding phase must be equal to pixels that are selected from an extracting phase. Three bits are embedded in a pixel if the pixel-value is smaller than the first threshold value (intensity 88) and is judged with the edge region. MSB3 Edge-Detection is summarized through the following steps:

Step 1: Execute MSB3 Edge-Detection at a cover image, in order to sort out edge- regions in the cover image.

Step 2**:** If any pixel value is smaller than the first threshold value and exists on the edge region, embed three bits of secret data in the pixel.

2.5. Image Steganography Based on 2k Correction and Edge- Detection Scheme

In this method, author used the just noticeable difference (JND) technique and method of contrast sensitivity function (CSF). This is an MSB3 edge-detection which uses part information of each pixel-value. In order to have better imperceptibility, a mathematical method which is the 2k correction is used. If one supposes the secret data is hidden at a pixel of cover image, some differences occurred between cover-pixel and stego-pixel. Because of these differences, the cover image is distorted and the quality of cover image is dropped. $2k$ correction corrects each pixel-value as $2k$. That is, supposing that k-bits are embedded in a pixel value, the method *adds* or *subtracts* $2k$ to each pixel-value, and finally the corrected pixel value becomes closer to the original-pixel. Hence, the secret data in the stego-pixel is not changed.

3. Description of Blue channel replacement Technique

So far the techniques which have been used focuses only on the two or four bits of a pixel in an image that resulted in low peak to signal noise ratio and high mean square error. This work is concentrated on 8 bits of a pixel of blue channel of a true image (24 bits pixel image), resulting better image quality.

In a computer, images are represented as arrays of values. These values represent the intensities of the three channels R (ed), G (reen), B (lue), where a value for each of the three channels describes a pixel.

In this technique, a methodology in which user select an image called Host image in which he wants to hide the confidential image which has been compressed by using DCT technique.

The bits of blue channel of pixels of host image have been replaced by confidential image. Firstly confidential image is converted into binary form and its binary form is placed in blue channel of first pixel. Blue channel is selected because a research was conducted by Hecht [4], which reveals that the visual perception of intensely blue objects is less distinct than the perception of objects of red and green.

4. Proposed Improved Technique

Step1: A Host image of any file format having 24 bit per pixel is selected. Due to low computational complexity, it can be applied to any size of images.

Step2: After selecting Host image, confidential image is selected which is a compressed image using DCT technique.

Step 3 : (a) Embedding algorithm

i. Extract all the pixels in the given Host image and store it in the array called H_Array.

ii. Extract all the pixels in the given DCT compressed image and store it in the array called C_Array.

iii. Choose first pixel and pick pixel from C_Array and place it in Blue channel pixel. If there are more pixels in C_Array, then place rest in the Blue channel of next pixels, otherwise follow Step (iv).

iv. Place some terminating symbol to indicate end of the key. '0' has been used as a terminating symbol in this algorithm.

v. Place pixels of C_Array in each blue channel of next pixels by replacing it.

vi. Repeat step (v) till all the pixels has been embedded.

vii. Again place some terminating symbol to indicate end of data.

viii. Obtained image will hide all the pixels that we input. Confidential image is embedded using above algorithm and Stego image (Host image + confidential image) is produced.

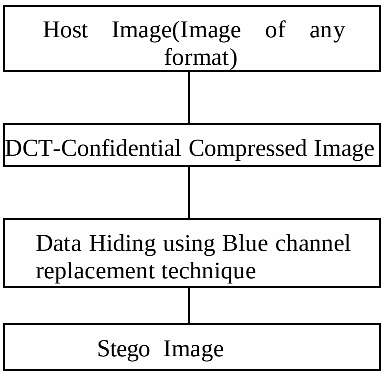

Fig. 4.1 Embedding Technique

(b) Extracting algorithm

i. Consider two arrays, Let they be C_Array and H_Array.

ii. Extract all the pixels in the given image and store it in the array called H_Array.

iii. Now, start scanning pixels from first pixel and extract secret pixels from blue channel pixels and place it in C_Array. Follow Step (iii) till we get terminating symbol, otherwise follow step (iv).

iv. If these extracted pixels match with the original secret pixels which is embedded, then follow Step (v), otherwise terminate the program by displaying message “secret pixel is not matching”.

v. If the embedded secret pixel matches with decoded secret pixel, then again start scanning next pixels and extract secret pixels from blue channel of next pixels. Follow Step (v) till we get terminating symbol, otherwise follow step (vi).

vi. Extract secret image from C_Array.

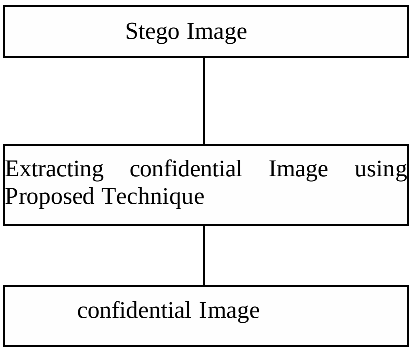

Fig.4.2 Extracting technique

5. EXPERIMENTAL RESULT

Fig.5.1The Host images (a) Lena (512×512) (b) Baboon (512×512) (c) Peppers (512×512) (d) Airplane (512×512)

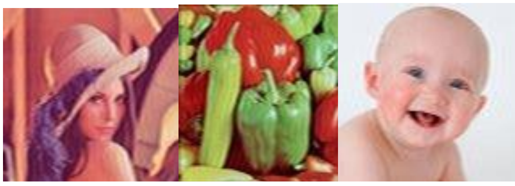

Fig. 5.2 The DCT-compressed Confidential images (a) Lena(512×512) (b) Peppers(512×512) (c) Kid(512×512)

Fig. 5.3 The Stego images (a) Lena (512×512) (b) Baboon (512×512) (c) Peppers (512×512) (d) Airplane (512×512)

Table 5.4: PSNR and RMSE Values of Standard Colored Images(512×512)

Confi-dential Images	Host Images of size (512×512)							
	Lena		Baboon		Peppers		Airplane	
	PSNR	RMSE	PSNR	RMSE	PSNR	RMSE	PSNR	RMSE
Lena	56.3178	0.3912	56.3291	0.3906	56.3319	0.3905	56.3337	0.3904
Peppers	56.3228	0.3909	56.3293	0.3906	56.3133	0.3914	56.3243	0.3909
Girl	56.3267	0.3908	56.3094	0.3915	56.3370	0.3903	56.3248	0.3908

Comparison with Existing Techniques

The utilization of proposed scheme (Blue channel replacement Technique) resulted in comparable or better performance, when compared to the different existing techniques. Results have been observed by computing the performance measure like PSNR and RMSE the results are then compared with previous schemes shown in the Table 5.5.

Table 5.5: The Comparison Results

Host Image	Confidential Image					
	Lena		Peppers		Kid	
	Proposed	*	Proposed	*	Proposed	*
Lena	56.3178	35.33	56.3228	35.58	56.3267	36.45
Airplane	56.3337	35.22	56.3243	35.42	56.3248	36.14

***The Method Proposed by Chin Chang**

6. Conclusions

The blue channel replacement technique using DCT compression gives better results with PSNR value and RMSE values under normal image embedding and extraction conditions. Moreover the proposed technique allows a perfect information recovery without much visual degradation to the original images as indicated by high PSNR values. DCT-domain system for hiding fractal compressed images also gives perfect recovery but at the cost of image quality degradation as indicated by severe drop in PSNR values of extracted images by Blue channel replacement technique and DCT-domain system for hiding fractal compressed images for the same test parameters. Thus, proposed technique gives better results for normal compressed image embedding and extraction as indicated by lower Root Mean Square Error (RMSE) rates and Higher Peak Signal to Noise Ratio (PSNR).

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