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Color image steganography in YCbCr space

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ABSTRACT

Steganography is a best method for in secret communicating information during the transference of data. Images are an appropriate method that used in steganography can be used to protection the simple bits and pieces. Several systems, this one as color scale images steganography and grayscale images steganography, are used on color and store data in different techniques. These color images can have very big amounts of secret data, by using three main color modules. The different color modules, such as HSV-(hue, saturation, and value), RGB-(red, green, and blue), YCbCr-(luminance and chrominance), YUV, YIQ, etc. This paper uses unusual module to hide data: an adaptive procedure that can increase security ranks when hiding a top secret binary image in a RGB color image, which we implement the steganography in the YCbCr module space. We performed Exclusive-OR (XOR) procedures between the binary image and the RGB color image in the YCBCR module space. The converted byte stored in the 8-bit LSB is not the actual bytes; relatively, it is obtained by translation to another module space and applies the XOR procedure. This technique is practical to different groups of images. Moreover, we see that the adaptive technique ensures good results as the peak signal to noise ratio (PSNR) and stands for mean square error (MSE) are good. When the technique is compared with our previous works and other existing techniques, it is shown to be the best in both error and message capability. This technique is easy to model and simple to use and provides perfect security with unauthorized.

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1. INTRODUCTION

Widley attention has been gived these years to the subject of information security when data transfering on insecure channels, that is give its interest for data security, and it stay an active topic. One of the very most serious elements within data security during received and sending is Data Hiding. This attempt to hide secret "messages" in such a method that they cannot be seen and the hiding cover is very difficult to decode. Two subsets can be used to hide the wanted data, namely steganography and watermarking. Steganography is used for secure connection, while watermarking is used for copyright preservation [1-5]. These cases highlight the idea of "transforming secret information" from one to another in such a way that the outputing data can be understood and read only by those who know how to obtain or decode the designed secret information data, i.e., those who possess the encryption data. However, within the process of encryption, the data – even though unreadable – remains to some extent accessible to easy decryption. The "steganography" approach has been solved this problem in secret data transmission [6-9].

Images are the most commonly used method to cover items in the steganography approach, with the aim of securing serious data. Within image steganography, “color image steganography” has been found more serious than the so-called “grayscale image steganography” due to the fact that a large space is available to hide data or information in color images. Several color spaces, such as red, green, and blue (RGB), hue, saturation, and value (HSV), luminance and chrominance (YCbCr), YUV, and YIQ, are widelly used to display colour images. “Color image steganography” usually be conducted in any colour space security field. The YCbCr technique is a perfact given way for steganography. The human eye is not sensitive to changes in chrominance although it is very sensitive to changes in luminance; thus, a littel changes in the colour spaces of the chrominance band will not cover or change the overall image quality [10, 11]. The Y and Cb are the luminance components, but the color space of the Cr components consists of the blue and red chrominance components, respectively.

We propose a modification to the model proposed by [2-3] together with a set of extensions that are designed to enhance computational efficiency and data complexity. Using the proposed method, we convert an RGB image into YCbCr space before employing exclusive-OR (XOR) operations between the color image and the secret image. XOR operations are then repeated on the result with the green band’s LSB. The data outputs of this process are subsequently saved in the blue band. As the encrypted data in the 8-bit LSB does not represent the real data, which is acquired by converting the images to an alternative space and then executing an XOR. This approach is referred to as the improved least significant bit steganography method for processing images that are in RGB color format. The proposed method delivers images that are of an enhanced quality after the information have been concealed within them. The generated message bits are concealed in three planes of the color image after the plane has been sliced [12]. This process is executed in such a way that the internal noise in the setgo-image is maintained at a minimum while any changes that are made are so minor that they cannot be observed by the human eye. The outcomes of the proposed method indicate that it represents a reliable and secure approach by which the quality of an image can be enhanced.

2. COLOR SPACES

Transform solutions describe a new space coordinate system or source that can eliminate model requirement and enable scalar quantisation and free model handling. The new source, when well selected, can lead to additional efficient coding by providing lower distortion at same data rate and vice versa.

2.1. RGB color space

Color space is a mathematical model to exemplify color data as three or four different color modules. Different color representations are used for different uses such as computer graphics, image processing, TV broadcasting, and computer vision [2]. Different color space is presented for color image. They are: RGB constructed color space (RGB, standardized RGB), Hue Produced color space (HSI, HSV, and HSL), Luminance constructed color space (YCBCr, YIQ, and YUV), and perceptually unbroken color space (CIEXYZ, CIELAB, and CIELUV).

There are a number of ways of implementing the RGB color model, depending on the capacity of the system employed for color characterization. Converting the color space means changing the representation of the color from one form to another. This conversion is frequently used so that a drawn image can be moved between color regions. This method is most frequently used for the creation of converted image appearances that match the original image as closely as possible. The RGB model employs an additive color mixture and, because of this, details the reasonable light weight that needs to be emitted to provide a particular light-weight color that is advancement by providing a new form from darkness. With the RGB technique, individual values are stored for red, green and blue [3]. The RGB color space is the most frequently employed option for graphic displays on PCs, and because of the colors displayed (red, green, and blue units), the specified color will not be produced by the area unit. Thus the RGB color space offers an option whereby the color show system's design and appearance may be varied. Furthermore, such systems provide space unit victimization for the RGB color house, possibly cashing in the overextended variations of extant software package routines. While such color houses have been in existence for some years, the RGB color house does not offer good economy in relation to "real-world" images.

The three elements of RGB should be combined in the information involved in order to offer colors on the RGB color cube. This technique may create a buffer with identical picture element depths and which illustrates the resolution for all parts of RGB. In addition, using the RGB color area as a workspace for processing images is not generally optimal in terms of economy. As an example, if the intensity or color of a specific picture element is to be switched, the three RGB color values ought to be derived from the buffer store. Were the system provided with a picture directly contained within the intensity and color format, some stages of this process would be accelerated [13].

2.2. YCbCr color space

YCbCr are the most common transforms that helps one abstract the Intensity (Luma) and the consistent chromaticity which define the colour information in each of the bands. In both models, Y is a luminance signal implied in 8 bits and it almost represents the grayscale different of a colour image [14]. The “chroma model of CCIR601 coding mode” is the definition of the YCbCr color system; this is frequently employed in color TV displays and a number of color display systems. The Y is an essential element for the color space, the luminance element showing the brightness (luma), and Cb and Cr, which declare the chrominance elements. Cb represents blue subtract luma (B – Y) while Cr represents red subtract luma (R – Y). There are several reasons that the YCbCR color system space should be used with color display systems, as detailed in [15]:

1. The illumination variation problem can be solved using the luminance component (Y) and, as the color is independent, it allows for easy programming.
2. In accordance with [14], it provides a more compact covering color cluster than alternative color spaces.
3. Under a number of different illumination conditions, it offers the least overlap of covering and non-covering data.
4. It is extremely serviceable for use in applications that compress video, such as JPEG and MPEG [15-19].
5. It encompasses a group of color spaces employed for video systems and is specified for the standard-definition television used for the ITU-R BT.601 standard which operates with digital system videos.
6. It has an accompanying RGB color space; digital component videos are represented by two primary color spaces. JPEG-YCbCris is employed by JPEG image formats, with the YCbCr being rescaled, while the Y, Cb, and Cr components are converted into digital bits (0 or 1). For forward and backward transformations for RGB to JPEG-YCbCr, the following matrices can be employed:

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 0.257 & 0.504 & 0.098 \\ -0.148 & -0.291 & 0.439 \\ 0.439 & -0.368 & -0.071 \end{bmatrix} . \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.164 & 0.000 & 1.596 \\ 1.164 & -0.392 & -0.813 \\ 1.164 & 2.017 & 0.000 \end{bmatrix} . \begin{bmatrix} (Y-16) \\ (Cb-128) \\ (Cr-128) \end{bmatrix} \quad (2)$$

3. RELATED WORK

A novel approach was put forward by Masud Karim, centered on LSB [20]. This method involves the use of a secret key, with concealed information undergoing encryption and being stored with the image's LSP positions altered. This method offers extremely secure storage. In [21], a methodology was put forward for hiding secret information across the RGB planes on the basis of the human visual system (HVS). Using such a method, the stego image is of low quality.

In Sachdeva, and Kumar [22] Hid a top-secret message by using the "Vector Quantization (VQ)" table, which offers improvements in message capacity and stego size. With reference to concealing text messages, [23] offered improvements in the support of security for steganography. Every preceding approach is employed to hide text messages within images with lower distortion levels and without losing RGB images. These methods do not address operating issues with signal processing items. [24] proposed a different approach, using minimum deviation techniques for fidelity, rooted in the decision embedding method. In this instance, replacement positions are randomly selected between MSP and LSB with modification of two bits per byte up to the fourth bit towards MSB. [25] used a "discrete wavelet transform (DWT)" for embedding text messages in color images. The "Blowfish" encryption method involved in crafting a text message by employing SSCIA coding and discrete Fourier transform (DFT) coding for concealment of images in storage or transmission in [26].

With the cover image, the specific sacred images are not concealed using the suggested method; the transmission of these images takes place through concealment of the keys. In the work of [27] and [28] the YCbCr method was employed. Additionally, in [29] DWT and inverse wavelet transform (TWT) are employed to hide a single grayscale within the color image; in [30] enhancements were made to capacity by employing solely IWT through the concealment of apparel grayscale images within a single color image. Employing these methods improves the stego image quality. The method put forward here offers greater security for the encryption technique because the keys are encrypted using an alternative encryption methodology.

4. PROPOSED METHOD

In the proposed technique, the cover image is transformed into YCbCr spaces, after which the XOR procedure is applied to (LSB) bytes to take benefit of three different channels and the requirement of a pixel. Three different arrays (Y- represents the luminance component; Cb- and Cr-represent the chrominance components) is being the 24-bit color image. The binary secret pixel data of the image will be hidden in the LSB of the blue part. Two XOR operations were used before saving information to protect the data.

Our method was implemented in Matlab using the GUI toolbox. Table 1 and Table 2 show the introduction of the needle values. The proposed method was executed in Matlab R2017b (9.3.0.713579). Our work is shown as a flow chart in Figure 1.

4.1. Embedding pseudocode

The embed processing for hid a binary image into RGB_color image in YCrCb space is described as follows:

The steps of hiding a Binary Image processing:

Begin
Input: (BI) -Binary Image and (CI)-Color Image.
Output: (SC-Img) –Cover Stego Image.

Sp1: *Rearrange pixel bytes of (BI) so to become the same area of (CI).*
Sp2: *Convert (CI) from RGB Space to YCbCr Space.*
Sp3: *Divide (CI) into three parts (Y, Cb, and Cr).*
Sp4: *Implements XOR between (CI_Y _LSB and BI_LSB).*
Sp5: *Apply XOR agin between (the result of Sp4 and CI_Cb _LSB).*
Sp6: *Insert the output data of sp5 to CI_Cr_LSB.*
Sp7: *Exchange YCbCr Space to RGB Space of the color image,*
Sp8: *Save the (CI)-color Image*
Finish

4.2. Reconstructed pseudocode

The stpes of recovery the Binary Image processing:

Begin
Input: (SC-Img) -Stego color Image.
Output: (BI) -Binary Image.

Sp1: *Read (SC-Img)-stego image and split to RGB Spaces image.*
Sp2: *Exchanging the RGB color stego_image (SC-Img) to YCbCr space by performing Sp1.*
Sp3: *Divid (SC-Img)-stego image to three parts such as (Y-part, Cb-part, and Cr-part).*
Sp4: *Perform XOR between (Cr _LSB and Cb_LSB of (SC-Img).*
Sp5: *Apply XOR between the output data of Sp4 and Y _LSB of (SC-Img).*
Sp6: *Keep and Save the result bits and display Secret Binary Image (BI)*
Finish

5. EXPERIMENTAL RESULTS

This et alion will discuss the results of the experiment regarding the concealment of the necessary data employing the steganography method put forward in this paper. There is a proposal for a new methodology to make information more secure, presenting new concepts for the improvement of the capabilities of steganography for embedding secret messages in the most insignificant byte after undertaking two XORs within the YCbCr space. The programming language employed to implement this is MATLAB Version R2017b (9.3.0.713579). For this research, we employed a different image that does not match the size of the image illustrated in Table 1 and Table 2. Even when the hidden image was open, a person without authority could extract a random image but be unable to acquire the concealed data, and this is the advantage of the algorithm that we propose. In analyzing the peak signal-to-noise ratio (PSNR), comparisons are made between the base work and the proposed PSNR work as shown in Table 3. Thus we propose a new modern methodology for steganography for images within color scale images that have the capability of supporting more secure data. Information is concealed within the cover image, not totally within the pixel data image.

This algorithm is applied to the color image, with the results illustrated in Figure 2 Figure 3 and Figure 4, where to checkers our employees standing for MSE and PSNR. The PSNR technique was employed for evaluation of the stego image methodology quality. PSNR definition matches those in [12, 13, and 18]:

$$\textbf{PSNR=10}\ \log_{10}\left[\frac{R^2}{MSE}\right]$$

Where MSE is defined as [5, 7, 11, and 12]:

$$\text{MSE}=\frac{1}{\text{nxm}}\sum_{k=1}^{n}\sum_{l=1}^{m}(\text{img}_{kl}-\text{img}_{\text{sc}_{kl}})^2$$

Where MSE is defined as [5, 7, 11, and 12]:

$$\text{MSE}=\frac{1}{\text{nxm}}\sum_{k=1}^{n}\sum_{l=1}^{m}(\text{img}_{kl}-\text{img}_{\text{sc}_{kl}})^2$$

Where:

n: is the size of the row to the image
m: is the size of column to the image
img_{kl} : is the cover image
$img_{sc_{kl}}$: is the stego image

If the MSR value is low, the quality of the image was good. A better image quality is shown by a greater PSNR, which means that the signal power is better to increase the image display. In general, in terms of human sensitivity, a watermarked image is considered suitable when its PSNR is more than 30 dBs. In adding, the correlation method is used to estimate the robustness of the watermarking procedure, while PSNR is used to estimate the “transparency of the watermarking technique” [5, 21, and 26]. This measures the et alion of pixels that will be altered when the projected process is applied to these test images. The three dissimilar binary image sizes are 16.9 KB, 24.0 KB, and 28.1 KB.

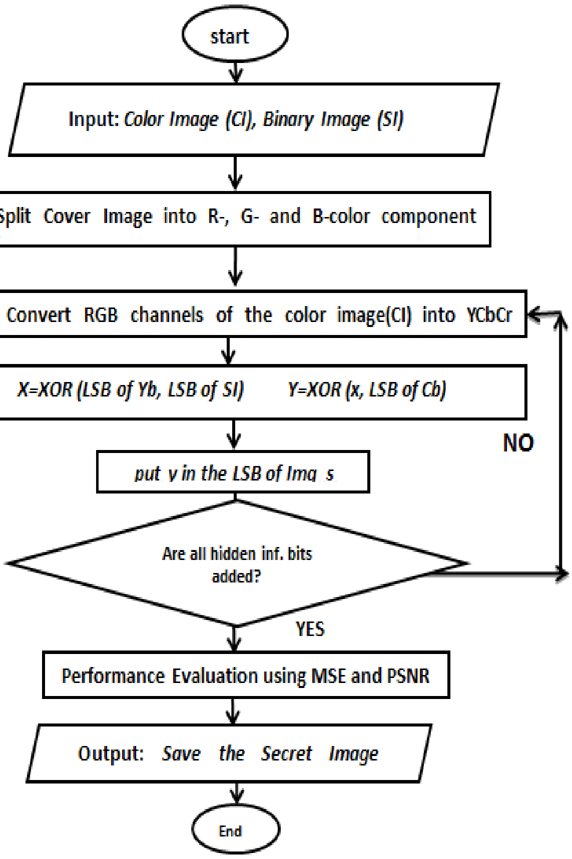

Figure 1. Flow chart of embedding algorithm

Table 1. Size of cover color image and the secrete binary image of three experiments.

cover image	Dimensions of cover image(pixel)	Size of cover image	Dimensions of secrete binary image(pixel)	Size of secrete binary image
Lena	512x512	463KB	400x333	16.9KB
koala	1024x768	762KB	640x360	28.1KB
peppers	512x512	441KB	540x362	24.0KB

Table 2. Value of (PSNR, MSE) using YCbCr channel for different color images (for BPP=8/3)

cover image	PSNR	MSE
Lena	54.7543	0.46647
koala	55.7234	0.41722
peppers	54.958	0.45566

Table 3. The PSNR values of stego_image at several techniques

References Technique	PSNR(dB)
[24]	39.6
[25]	42.4
[26]	36.6
[29]	33.2
[30]	44.7
Proposed	54.7

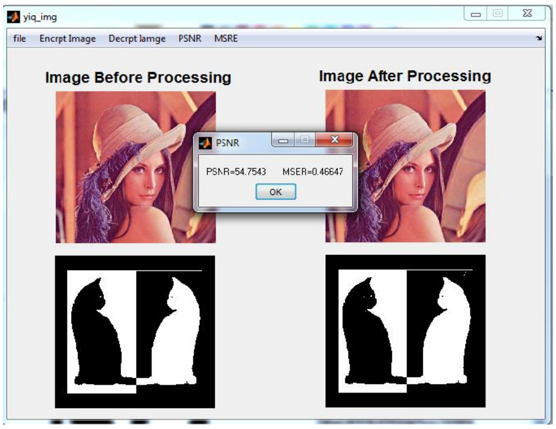

Figure 2. Test 1 of processing method.

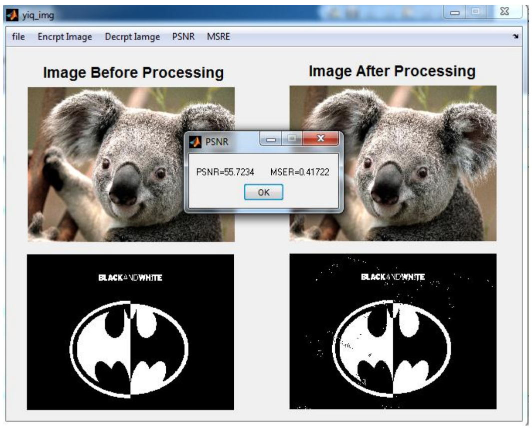

Figure 3. Test 2 of processing method.

Figure 4. Test 3 of processing method.

6. CONCLUSIONS

This research proposes a data hiding procedure in images with greater embedding data; we can use one color image to hide a binary secret image.These secret images can be restored without keeping the image by applying XOR procedures between the secret image and the color image in the YCbCr space, resulting in a high-quality stego image with great PSNR values comparable to those achieved by other present methods. The results found demonstrate the strength of the novel method; by increasing the PSNR to 54.7, that result it was a very good point in image steganography that mean the error will be very simple.

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