A Novel Approach for Eminent Data Hiding Based on Secret-Fragment-Visible Mosaic Images and Pixel Transformation for Secure Image Transmission

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Abstract

Hiding the data in digital images has been area of interest in the digital image processing domain. Although so much work has been carried out in the literature to resolve the issues like increasing the data capacity, creating the secret image alike of target image but most of the works fails to meet the practical requirements. This paper presents an approach where mosaic image generation has done by dividing the secret image into fragments and transforming their respective colour characteristics into corresponding blocks of the target image. Usage of the Pixel colour transformations helps to yield the lossless recovered image based on the untransformed colour space values. Generation of the key plays an important role to recover the data from the secret image in lossless manner. Finally the same approach can be performed on videos also which helps to eliminate the flickering artifact to achieve the lossless data recovery in motion related videos. The experimental results shows good robust behavior against all incidental and accidental attacks and compare to the conventional algorithms performance evaluation has been increased in a significant way. The result of the proposed technique outperforms present techniques and the results are simulated using MATLAB.

Keywords: Image Transmission, Visual quality, Data hiding, Digital image

1. Introduction

Digital images have become very common in the present society needs, especially in the applications where security and privacy are essential features. The concept of image processing lead to the evolution of different image acquisition devices like still and video cameras, web cameras. Our work is to designate a novel technique for solving the safety data hiding procedure.

Currently, images from various sources are frequently utilized and transmitted through the internet for various applications, such as online personal photograph albums, confidential enterprise archives, document storage systems, medical imaging systems, and military image databases. These images usually contain private or confidential information so that they should be protected from leakages during transmissions.

This paper is organized as follows. The section 1 describes the introduction of the data hiding and necessity in the field. The section 2 named as Literature Survey as it explained various existing approaches and section 3 evaluated the proposed Methodology. The

section 3.1 discussed the Mathematical basics for proposed work, The section 4 derived the Algorithmic flow and section 5 includes Simulation results. Finally the sections 6 and 7 described conclusion and future scope of the paper.

2. Literature Survey

Recently, many methods have been proposed for secure image transmission, for which two common approaches are image encryption and data hiding. Image encryption is a technique that makes use of the natural property of an image, such as high redundancy and strong spatial correlation, to get an encrypted image based on Shannon's confusion and diffusion properties [1-4, 13-15].In this, the encrypted image is a noise image so that no one can obtain the secret image from it unless he/she has the correct key. However, the encrypted image is a meaningless file, which cannot provide additional information before decryption and may arouse an attacker's attention during transmission due to its randomness in form. An alternative to avoid this problem is data hiding that hides a secret message into a cover image so that no one can realize the existence of the secret data, in which the data type of the secret message investigated in this paper, is an image. Existing data hiding methods mainly utilize the techniques of LSB sub situation, histogram shifting, difference expansion, prediction-error expansion, recursive histogram modification, and discrete cosine/wavelet transformations. However, in order to reduce the distortion of the resulting image, an upper bound for the distortion value is usually set on the payload of the cover image.

A discussion on this rate distortion issue can be found in. Thus, a main issue of the methods for hiding data in images is the difficulty to embed a large amount of message data into a single image. Specifically, if one wants to hide a secret image into a cover image with the same size, the secret image must be highly compressed in advance. For example, for a data hiding method with an embedding rate of 0.5 bits per pixel, a secret image with 8 bits per pixel must be compressed at a rate of at least 93.75% beforehand in order to be hidden into a cover image. But, for many applications, such as keeping or transmitting medical pictures, military images, legal documents, etc., that are valuable with no allowance of serious distortions, such data compression operations are usually impractical. Moreover, most image compression methods, such as JPEG compression, are not suitable for line drawings and textual graphics, in which sharp contrasts between adjacent pixels are often destructed to become noticeable artifacts. In this paper, a new technique for secure image transmission is proposed, which transforms a secret image into a meaningful mosaic image with the same size and looking like a preselected target image. The transformation process is controlled by a secret key, and only with the key can a person recover the secret image nearly lossless from the mosaic image. The proposed method is inspired by Lai and Tsai, in which a new type of computer art image, called secret-fragment-visible mosaic image, was proposed.

The mosaic image is the result of rearrangement of the fragments of a secret image in disguise of another image called the target image preselected from a database. But an obvious weakness of Lai and Tsai is the requirement of a large image database so that the generated mosaic image can be sufficiently similar to the selected target image. In this, the users are not allowed to select freely their interested image for use as the target image. Thus, the proposed method is to remove this weakness of the above method while keeping its merit, i.e., it is aimed to design a new method that can transform a secret image into a secret fragment visible mosaic image of the same size that has the visual appearance of any freely selected target image without the need of a database.

After a target image is selected arbitrarily, the given secret image is first decomposed into rectangular fragments called tile images, which then are fit into similar blocks in the target image, called target blocks, according to a similarity criterion based on colour variations. Next, the colour characteristic of each tile image is transformed to be that of

the corresponding target block in the target image, resulting in a mosaic image which looks like the target image. Relevant schemes are also proposed to conduct nearly lossless recovery of the original secret image from the resulting mosaic image. The proposed method is new in that a meaningful mosaic image is created, in contrast with the image encryption method that only creates meaningless noise images. Also, the proposed method can transform a secret image into a disguising mosaic image without compression, while a data hiding method must hide a highly compressed version of the secret image into a cover image when the secret image and the cover image have the same data volume.

3. Proposed Methodology

We developed a novel method based on color Transformations between blocks. In the initial part of the planned technique, every tile image T within the given secret image is match to a target block B in a preselected target image. Since the colour characteristics of T and B are totally different from one another, the way to amendment their colour distributions to form them look alike is the main issue here. Color transfer theme in this face t that converts the colour characteristic of an image to be that of another within the l αβ colour area. This idea is a solution to the difficulty and is adopted during this paper, except that the RGB colour area rather than the lαβ one is employed to reduce the amount of the desired data for recovery of the original secret image. More specifically, let A and B be described as 2 pixel sets {p1, p2, p3,…….. p_n} and {$p_1^{'}, p_2^{'}, …… p_n^{'}$} severally.
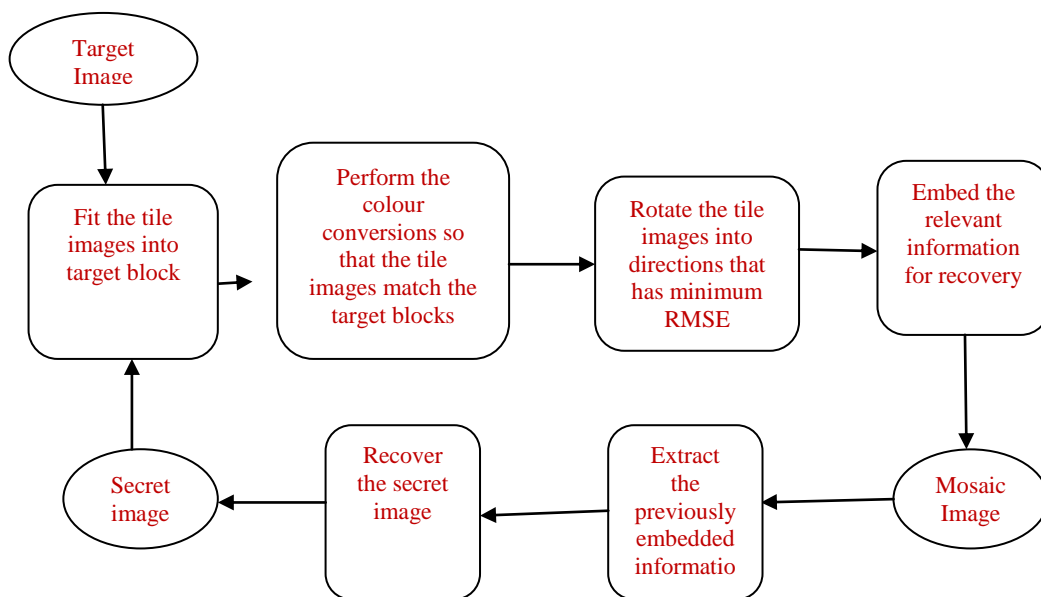

Figure 1. Block Diagram of the Proposed Methodology

3. 1. Mathematical Basics for Proposed Work

Let the color of every pi be denoted by $(r_i, g_{i,} b_i)$. which of every p'_i by $(r_i^{'}, g_{i,}^{'} b_i^{'})$. At first, we tend to work out the means and standard deviations of T and B, severally in every of the 3 colour channels R, G, and B by the subsequent formulas:

$$\mu_C = \frac{1}{n} \sum_{i=1}^{n} ci$$

$$\mu'_c = \frac{1}{n}\sum_{i=1}^{n} c'_i \quad \dots\dots\dots\dots\dots\dots\dots(1)$$

$$\sigma_c = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(c_{i-}\mu_c)^2}$$

$$\sigma'_c = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(c'_i - \mu'_c)^2}\dots\dots\dots\dots\dots(2)$$

where c_i and c'_i, denote the C-channel values of pixels p_i and p'_i severally, with C=R,G,or B. Next, we have a tendency to compute new color values $(r'_i, g'_{i,} b'_i)$ for each p_i in T by

$$c''_i = q_c(c_i - \mu_c) + \mu'_c \quad \dots\dots\dots\dots\dots\dots(3)$$

Where $q_c = \sigma_c/\sigma'_c$ is the standard deviation quotient and c=(r,g,or b). It can be verified easily that the new colour mean and variance of the resulting tile image T' are equal to those of B, respectively. To compute the original colour values $((r_i, g_{i,} b_i)$ of p_i from the new ones $(r'_i, g'_{i,} b'_i)$, we use the following formula which is the inverse of (3)

$$c_i = \frac{1}{q_c}(c''_i - \mu'_c) + \mu_c \dots\dots\dots\dots\dots\dots(4)$$

Furthermore, we've to bid into the created mosaic image sufficient data concerning the new tile image T' for use within the later stage of convalescent the initial secret image. For this, theoretically we will use (4) to compute the initial pixel price of p_i. However, the concerned mean and normal deviation values within the formula area unit are all real numbers, and it is impractical to embed real numbers, every with several digits, in the generated mosaic image. Therefore, we limit the numbers of bits we want to represent the relevant parameter values in (3) and (4). Specifically, for every color channel we tend to enable each of the means of T and B to have 8 bits with its worth within the vary of 0 to 255, and also the standard deviation quotient q_c in (3) to have seven bits with its worth within the vary of 0.1 to 12.8. That is, each mean is modified to be the closest value within the range of 0 to 255, and each q_c is modified to be the closest value in the range of 0.1 to 12.8. We don't enable q_c to be zero 0 otherwise the first picture element worth cannot be recovered back by (4) for the reason that $1/q_c$ in (4) isn't outlined once q_c=0.

3.2 Choosing Appropriate Target Blocks and Rotating Blocks to Fit Better with Smaller RMSE Value

In transforming the color characteristic of a tile image T to be that of a corresponding target block B as represented higher, how to choose an appropriate B for every T is a problem. For this, we use the standard deviation of the colors within the block as a live to pick out the foremost similar for each T. Specially; we type all the tile pictures to make a sequence of the tiles s_{tile} and every of the target blocks to make another, $s_{t\,arg\,et}$, consistent with the typical values of the standard deviations of the 3 colour channels. Then, we work the primary in s_{tile} into the primary in $s_{t\,arg\,et}$, fit the second in S tile into the second in S target, and so on.

In addition, after a target block B is chosen to fit a tile image T and after the colour characteristic of T is transformed, we conduct a further improvement on the colour similarity between the resulting tile image T' and the target block B by rotating T' into one of the four directions $0°, 90°, 180°, 270°$ which yields a rotated version of T' with the minimum root mean square error (RMSE) value with respect to B among the four directions for final use to fit T into B.

3.3. Embedding Information for Secret Image Recovery

In order to recover the secret image from the mosaic image, we have to embed relevant recovery information into the mosaic image. In order to recover the secret image from the mosaic image, we've to bid relevant recovery data into the mosaic image. For this, we adopt a way planned by Coltuc and Chassery and apply it to least vital bits of the pixels within the created mosaic image to conduct information embedding. Not like the classical LSB replacement strategies, that substitute LSBs with message bits directly, the reversible distinction mapping technique applies simple integer transformations to pairs of pixel values. Specifically, the method conducts forward and backward integer transformations as follows, respectively, in which (x, y) are a pair of pixel values and (x', y') are the transformed ones.

The method yields high data embedding capacities close to the highest bit rates and has the lowest complexity reported so far. The information required to recover a tile image T which is mapped to a target block B includes: 1) the index of B; 2) the optimal rotation angle of T; 3) the truncated means of T and Band the standard deviation quotients, of all colour channels; and 4) the overflow/underflow residuals. These data items for recovering a tile image T are integrated as a four-component bit stream and computed by M=[log [(Ws×Hs)]/N_T]

BPO in the figure is Bit Plane Order. The two buffers and the bit plane encoder are used to store the image for reference. The image can be extracted whenever the necessity arises. Among 8-bit and 16-bit, the 8-bit was selected for our applications. The output of the encoder used for the decoding process is as usual same in the reconstruction process. The generated alphabet is stored and transmitted to the receiving section for the decoding process without any interruption. In many of the real time application images, the low frequency components consist of more information.

4. Algorithmic Flow

In this proposed method it contains mainly two phases. They are one is mosaic image creation and second one is secret image recovery process.

PHASE 1

Stage 1. Fitting the tile images into the target blocks.

Step 1: Here first we need to compare the sizes of the target and secret image sizes. If they are not equal then we need to resize and equalize them and then divide the secret image into tile images{ $T_1. T_2, T_3 \dots \dots \dots T_n$ } and also the target image as{$B_1, B_2 B_3 \dots \dots \dots B_N$}

Step 2: Then calculate both the mean and standard deviation from the above equations (3)and(4), for each tile image T_i and target image B_j respectively for i,j=1 …n.

Step 3: Now we have the set of tile images as $S_{title} = \{T_1. T_2, T_3 \dots \dots \dots T_n\}$ and target blocks are $S_{target} = \{B_1, B_2 B_3 \dots \dots \dots B_N\}$ then by sorting them according to the mean and standard deviation values we need to map the tile image set to the target blocks in 1-to-1 manner then resulting mapping sequence L.

Step 4: So create the mosaic image F by fitting the tile images into the corresponding blocks according to L.

Stage 2: Rotating Images

Step 1: For each colored transformed tile image T_1 calculate the RMSE values in F with respected to corresponding target block B_{Ji} after rotating T_i into directions of $\theta = 0,90,180,270,360$ respectively.

PHASE 2: secret image retrieval

Stage1: Extracting the secret image recovery information.

Step 1: Extract the bit stream I from the F by reversion scheme and decode them to get the below items1) the number of iterations N_i for embedding $M_i^{'}$ the total number of used pixel pairs N_{pair} in the last iteration.

Step 2: Repeat the above step to extract the $M_i^{'}$.

Step 3: Then decrypt the bit stream $M_i^{'}$ into M_i by the using of key K.

Step 4: Decompose M_t into n bit streams M_1 through M_n for the n to-be-constructed tile images T_1 through T_n in S, respectively.

Step 5: Decode M_i for each tile image T_1 to obtain the following data items: 1) the index j_i of the block B_{ij} in F corresponding to T_i2) the optimal rotation angle $\theta°$ of T_i; 3) the means of T_i and B_{ij} and the related standard deviation quotients of all color channels.

Stage 2: Recover the secret image

Step 6: Extract one by one in a raster-scan order the tile images T_i, i= 1 through n, of the desired secret image S by the following steps: 1) rotate in the reverse direction the block through the optimal angle2) use the extracted means and related standard deviation quotients to recover the original pixel values in T_i according to (4); 3) take the outputs as the final pixel values, resulting in a final tile image T_i.

Step 7: Combine all the final tile images to get desired secret image T.

5. Simulation Results

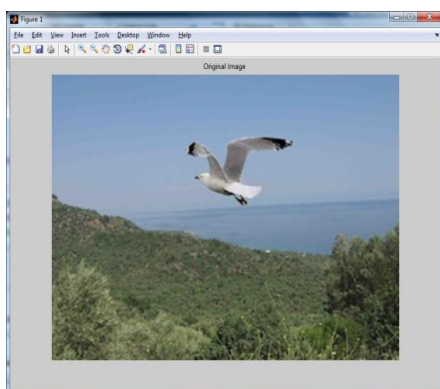The simulation results of the images using MATLAB are included in the preceding section.
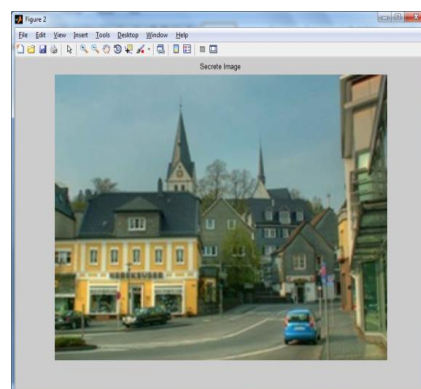

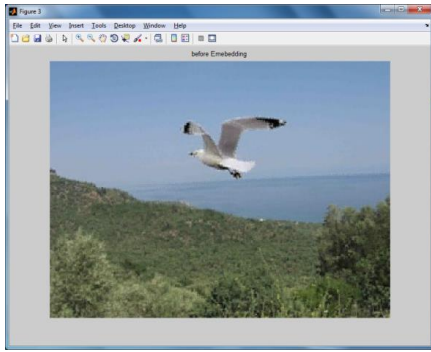**Figure 1. Original Image**

Figure 2. Secret Image

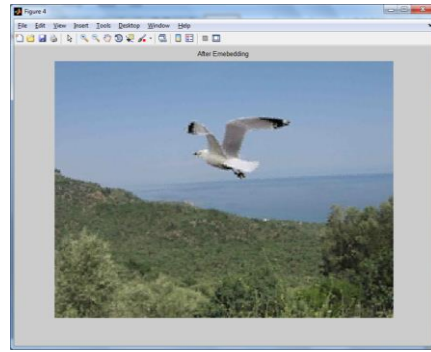**Figure 3. Before Embedding
Mosaic Image**

**Figure 4. After Embedding
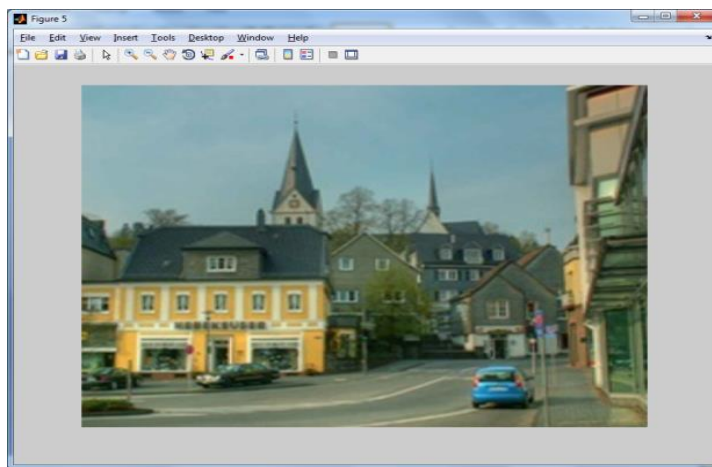Mosaic Image**

Figure 5. Extracted Image

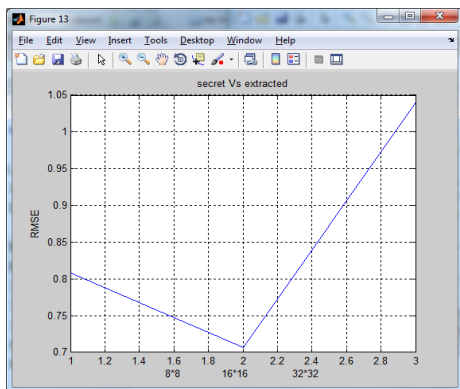We observed the following graphs for various sizes and various parameters.

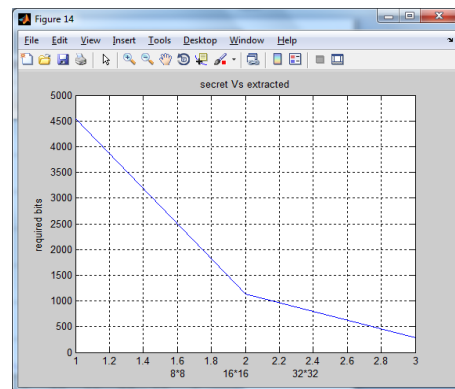
**Figure 6. Graph Showing Secret
vs. Extracted (RMSE)**

**Figure 7. Graph Showing Secret
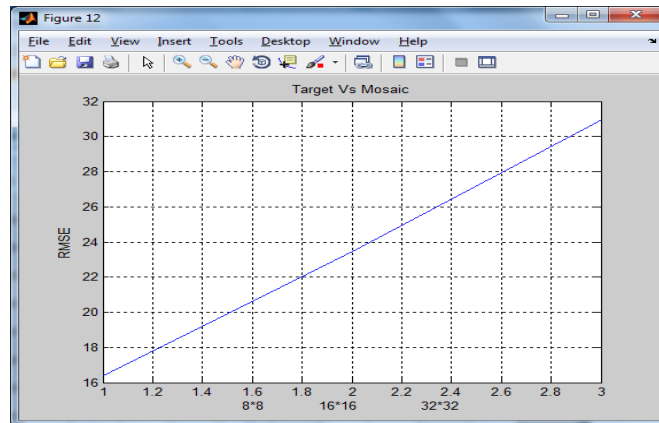vs. Extracted (Required bits)**

Figure 8. Graph Showing Target vs Mosaic (RMSE)

This Method has been applied to various sizes like 8*8, 16*16, 32*32 and their outputs are shown below.
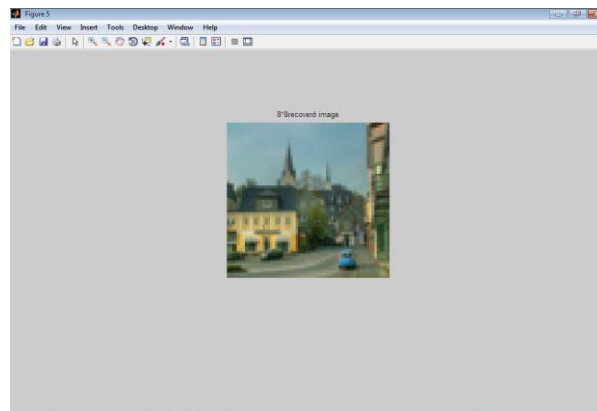

Figure 9. Recovered Image of Size 8*8 Block
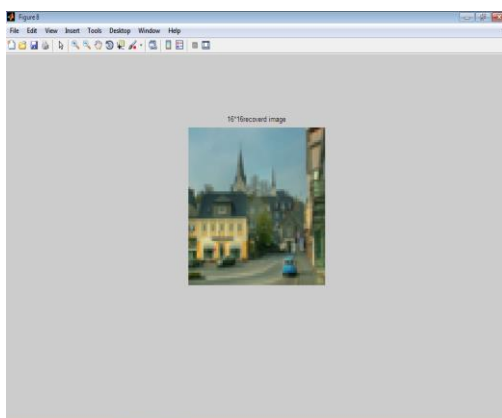

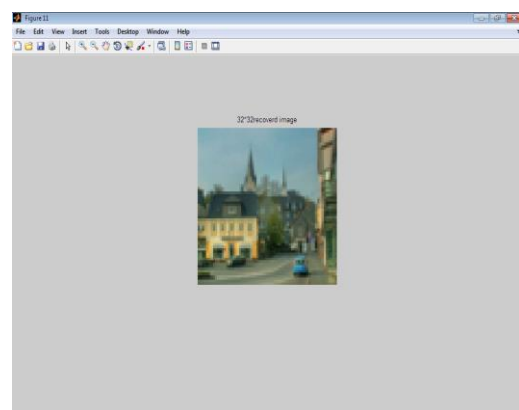**Figure 10. Recovered Image of
Size 16*16 block**

**Figure 11.Recovered image of
Size 32*32 block**

By using these we have tabulated different parameters like RMSE, PSNR, run time, required bits are shown in Table 1.

Table 1. Various Measured Parameters for Different Sizes of Image Blocks

Parameters	8*8	16*16	32*32
Root Mean Square Error (Target vs. Secret)	16.39	23.94	30.93
Root Mean Square Error (Secret vs. Extracted)	0.81	0.71	1.04
Required Bits	4544	1136	284
Peak Signal to Noise Ratio (dB)	50.01	51.18	47.82
Run Time (seconds)	48	22	12

6. Conclusion

Hiding the data in digital images has been area of interest in the digital image processing domain. Although so much work has been carried out in the literature to resolve the issues like increasing the data capacity, creating the secret image alike of target image but most of the works fails to meet the practical requirements. This paper presents an approach where mosaic image generation has done by dividing the secret image into fragments and transforming their respective colour characteristics into corresponding blocks of the target image. Usage of the Pixel colour transformations helps to yield the lossless recovered image based on the untransformed colour space values. Generation of the key plays an important role to recover the data from the secret image in lossless manner. Finally the same approach can be performed on videos also which helps to eliminate the flickering artifact to achieve the lossless data recovery in motion related videos. The experimental results shows good robust behavior against all incidental and accidental attacks and compare to the conventional algorithms performance evaluation has been increased in a significant way.

7. Future Scope

The proposed method has been written on the digital images, in this work images are used as media to hide the secret image by using the an approach where mosaic image generation has done by dividing the secret image into fragments and transforming their respective colour characteristics into corresponding blocks of the target image. Usage of the Pixel colour transformations helps to yield the lossless recovered image based on the untransformed colour space values. So in extension work we did the same algorithm on the digital videos. The approach towards videos is totally different from the images, so algorithm on videos is the future expansion for our contribution.

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