Contemporary Approaches on Reversible Data Hiding Methods: A Comparative Study

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Abstract: Reversible data hiding is an important concept on secret communication not only the hidden data can be subtracted from a covered media but also the cover media can be entirely reconstruct after the extraction steps. In the last decade, self-pixel based, block based and interpolation based methods have been extensively developed by using spatial-frequency domain and any others. In this paper, we present an overview of these methods and their marginal specifications. In addition to these, the purpose of this study is to explain and to classify the various algorithms, inside groups and their studies in the reversible data hiding concept.

Keywords: Reversible methods, Data hiding

1. Introduction

In fact, many studies have been carried out on data hiding so far. Data hiding can be used in order to covert transmission or secret communication and it has three main objectives. The first one is detectability, which is the basic requirement for cover transport and communication. The second is robustness against attacks and the last one is bit rate that is the highest quantity of data that can be transmitted without any corruption [1]. Recently, reversible data hiding is obtaining more and more important. Reversible Data Hiding (RDH) also known as lossless data hiding, not only ensures the extraction of the hidden information, called stego or watermark, but also the complete recovery of the original image as well. Current methods can be approximately classified based on the domain where hiding process is worked: Spatial domain and Frequency domain.

A digital data hiding method can dissemble sensitive information into multimedia for covert communications. The cover media has been distorted by data hiding methods while inserting a watermark. Even though the distortion is generally small and slight to Human Visual System (HVS), the irreversibility is not admissible to some sensitive applications, like image and video. For that reason, the RDH is not only hoped to extract the hidden data but also recover the original host signal as well [2]. As mentioned above, many kinds of methods have been presented in the literature. These methods can be categorised as seen below:

- Block based
  - Histogram
  - Mapping
  - Pixel differencing
  - Authentication
- Pixel based
  - Pixel modification
  - Pixel differencing
  - Arithmetic coding
- Interpolation based
- The others
  - Quantization
  - Others

On the other hand, some of these methods have been used for the authentication and steganalysis, too. These kinds of methods have generally used Support Vector Machine (SVM), LZW, Hidden Markov Model – Neural Network, Fractal coding, GIS-2D vector maps, Pair wise or tamper detection purpose applications.

2. Reversible Data Hiding Methods In The Literature

Several interesting approaches (i.e., reversible histogram modification, shifting data hiding processes using block-based, pixel-based, interpolation-based) have been recently reported in the literature. These approaches offer substantial data hiding capacity for a fixed image quality measure. However, there is considerable margin of improvement as regards the imperceptibility versus capacity trade-off is concerned. Some of the data hiding applications such as those related to integrity control need more capacity [3]. Thus, many researchers present high capacity reversible watermarking approaches based on histogram processing and block selection.

A reversible data hiding algorithm on wavelet based scheme is studied over the last years. These methods perform reversible difference expansion algorithm on the subband generated by wavelet lifting method in order to intercept overflow behaviour. Some limitation is dedicated to the subband coefficients, leadership to that not all the blocks can be hided watermarking [4].

Reversibility is generally brought to the evaluation of the block based or pixel based while applying in data hiding. Many methods have been existed to compute this bases; each method has its own theoretic basis for the same feature it leads to obtain different bases by different methods.

These differences appear because the block based is not about calculable in this condition in many situations. Therefore, the technics close it by application different algorithms in order to guess visibility, stability and bit rate of the reversibility basis. Despite the fact that the applied algorithms differ from each
other, they accept the same basis summed up by the two converts: These are Spatial and Frequency (PL Haar, DCT, and Wavelet) domain.

In the next sub-section, we available and categorize the best common methods & grouped into four classes: block-based, pixel-based, interpolation-based RDH methods and other RDH methods.

2.1. Block-based RDH Methods

In these methods, pixels are represented on a box scale grid and the grid effects interaction with the calculating block modification or shifting. Therefore, other technics have been described to remove the grid box effects. This process is illustrated in the following scheme (Fig. 1).

2.1.1. Histogram

Figure 1. Block-based data hiding system.

While searching on literary texts, it is seen that several important reversible block-based watermarking approaches using histogram processing have been studied. These approaches suggest so important watermarking capacity for a fixed image quality measure. But the imperceptibility versus capacity trade-off is concerned that, there is considerable margin of improvement. Some of the watermarking applications like imperceptibility versus capacity is related to integrity control need high capacity. 2.1.1.1. Shifting

There have been many studies on shifting in the literature. It seems that Hong et al. (2008) are the first reporting a RDH scheme based on histogram-shifting of prediction errors (HSPE), which includes two-stage structures, the prediction stage and the error modification stage employed has been proposed [5].

One of the other study about this topic has been presented by Kuo et al. (2008) using the block segmentation technic and a bit to save the change of the chosen lowest point to change the save data method using in Ni et al. (2006) scheme’s due to improve the data hiding capacity [6, 7].

Zeng et al. (2009) also presents a RDH scheme based on the difference histogram due to empty field for data hiding [8]. There are nine basic scan path s outlined, and this means all directional neighbouring pixel differences able to be obtained. In each hiding process, they can be hidden big number of data into the cover media that selecting the best scan path and the effective pixel difference. The results of this study have shown that the cover images can be easily embedded sensitive data at a good average. Furthermore, Fallahpour et al. (2011), suppose a very effective reversible data hiding system which is based on dividing image into tiles and shifting the histograms of each image parts between lowest and highest frequency [9]. After that to increase data hiding capacity the data are put in the largest frequency. The minima (zeros) and maxima (peaks) of the histograms and the image tiles that translocated to embedding the data. It is because of that the values of some pixels are altered. The key requirements of data hiding in medical images are high accuracy, high capacity and reversibility.

Zhang’s work did not exactly get advantage of the pixels in calculating the smoothness of each block and did not consider the pixel correlations in the edge of vicinal blocks because of that reason Hong et al. (2012), has done a new improved version of Zhang’s reversible data hiding method in encrypted images. And the experimental results proposed by Hong et al. (2012) show that the proposed method offers better performance over Zhang’s work [10].

Another histogram shifting RDH method for images testing on high bit depth medical images has been proposed by Huang et al. (2013) [11]. Huang et al. (2013) achieved the high correlation for smooth surface of base structure in medical images. The original image can be recovered in a correct way after the hidden data extraction by an inverse histogram shifting mechanism.

Chen et al. (2013) use a technique to get the mean value for calculating the minimum value of just ostensible difference (JND). The JND is then accustomed to detect the appropriate embedding level to reduce image distortion. [12]. On the other hand, Khan et al. (2014) proposed histogram processing and block selection (RW-HPBS) approach exploits the concept of down sampling for more capacity about control and authentication based applications [3].

Han et al. (2010) stated that the original image can be used for RDH in two steps: At the first step, no over lapping sub-blocks achieved and then, wavelet transform is realized for each block. And, Inter Wave Transform (IWT) is applied to each image sub-blocks. The low-frequency appeared to hide data about sub-band based. The statistical properties of the image selected according to the peak-signal, two threshold parameters adaptive noise ratio watermark image as having a better visual effect (PSNR) [4].

2.1.1.2. Modification

Ni et al. (2006) has recently introduced a histogram-based reversible data hiding technique in which the message is hidden into the histogram bin. Parts of up and zero points are utilized to success low hiding distortion but the hiding capacity becomes low. Similarly, histogram modification technique has been increasingly used in recent times [7, 13].

Chrysochos et al. (2007) also created a new technique called “quasi lossless” is based on the image histogram in which least recurring colours are treated to increment the hiding capacity that reached up to 60%. It is clear that the method raised the stego
image quality while reduced the hiding capacity [14].
The other work (Kumari et al. (2008)) utilizes a pick point of
histogram and increment the height of the peak by transporting
the pixels from the vicinal values to obtain the high embed
capacity. [15].
Lin et al. (2008), in order to hide messages, present a multilevel
reversible data hiding scheme using a multilayer hiding strategy
to obtain more hiding capacity and keep distortion low but that
scheme is based on the difference of histogram modification [16].
Apart from the studies mentioned above Li et al. (2010) introduce
a fingerprint authentication system in order to keep the privacy of
the fingerprint template having “embeddability criterion”, stored
in a database [17].
Yoo et al. (2010) proposed a new RDH algorithm based on
histogram modification of block image and multilayer data hiding
to increment the hiding capacity [18].
In addition, a high capacity reversible image data hiding scheme
based on a generalization of prediction-error expansion (PEE)
and an adaptive embedding strategy has been proposed (Gui et al.,
2014). Its prediction value and complexity measurement are
firstly computed according to its context for each pixel [19].
Haoa et al. (2007) proposed reversible data hiding technique by
symmetrical histogram expansion in the transform domain of
Piecewise Linear Haar (PLHaar) [20]. Moreover, Xuan et al.
(2002, 2004), proposed an algorithm hiding the data and the
overhead data representing the accountancy information into a
middle level bit-plane of the integer wavelet coefficients in high
frequency sub bands [2, 21].
Another paper presents a lossless data hiding method for images
using integer wavelet transform with threshold embedding technique (Xua et al.,
2005). Data are embedded inside the least significant bit plane (LSB) of high frequency CDF integer
wavelet coefficients whose magnitudes are less than a specific predefined threshold. Histogram modification is applied as a pre-
processing to forestall overflow and underflow [22].
Yuan et al. (2010) proposed geometric and a robust different
digital watermarking method for gray level images. Approximation sub-band pixels are categorized into some blocks,
having the same number of intensity levels, therefore the block
histogram is generated. For watermark subtraction, the
watermarked image is decomposed inside the approximation and
details. So that, the pixels in the approximation sub-band are
grouped [23].

2.1.3. Colour Histogram
Cetin et al. (2009), presented two new stenographic algorithms
which utilize the same histograms and different histograms. Both
algorithms are used to select the correct pixel values with
focussing on perceptibility and capacity parameters of the cover
media [24].
Thanuja et al. (2009) proposed an algorithm to hide data an into
colour image increasing multiple peaks histogram. The
watermark is hidden in spatial domain in RGB values [1].

2.1.2. Mapping
Mapping is the formation of maps, a transformed data of the
significant status.

2.1.2.1. Look-up Table
Wang et al. (2011) presented a data hiding method by using the
lowest distortion look-up table (LUT) based on data hiding is a
way to embed data inside media content for assorted applications,
such as transaction tracking and database annotation, achieving
nice distortion-robustness performance [25].

2.1.2.2. Location Map
Block responses in different ranges depending on several input
parameters are measured. Data can be hidden to those who are
stable response (State “1”). Those who unstable data is not
hidden (State “0”). These two conditions are stored in a table.
This table is called the location map.
A novel reversible data embedding method has been proposed by
Tian (2003) for digital images and explored the redundancy in images to obtain very high embedding capacity, and provide low
distortion [26].
Jia et al. (2010) proposed a method includes the inverse
embedding method in the second embedding strategy to increase
the hiding capacity and reduce the distortion. [27].

2.1.3. Contrast Mapping
Two adjacent received pixel block (XY). Mutually between X
and Y is calculated absolute difference d and overflow. (XY and
YX). And according to the size of the threshold storage mapping
done is done.
While some studies done on look-up table or reversible but Lu et
al. (2007) combined these studies by contrast mapping technique
contrast mapping technique to create rapid watermarking
embedding method’s the hiding capacity is large. And so the
quality of the covered image create by their method is sensitive
[28].

2.1.3. Authentication
Shi et al. (2004), categorize algorithms in three categories: fragile
authentication; embedding capacity; and semi-fragile
authentication. The mechanisms, merits, drawbacks and
applications of these algorithms are analysed in their study [29].
Lee et al. (2006) present a late reversible image authentication
technique. That technique is based on watermarking in which
whether the image is authentic or not after the hidden data has
been extracted. Comparing with other lossless data hiding
algorithm that method uses histogram characteristics of the
difference image and modified pixel values lightly to embedding
more data [30].
Ni et al. (2008) first notice that this method has endured from the
tedious salt/pepper noise reason by using modulo-256 addition to
prevent underflow and overflow [31].
Based on histogram modification, a reversible data hiding scheme
is presented by Tai et al. exploiting a binary tree structure to
detach the problem of transmission pairs of peak points [32].
While keeping the distortion low distribution of pixel differences is
used to achieve extended hiding capacity and in addition espouse a histogram shifting technique to forestall
underflow/overflow.

2.1.4. Pixel Differencing
Because of the high degree of colours uniformity, some valuable
results with cartoon images having considered previously
inappropriate for data hiding technique named “quasi Lossless”
and based on histogram showed very good are proposed by Saleh
et al., too [33, 34].
Ellinas (2009), presents a new reversible watermarking method
embedding the remains of the right frames to the observant
frames of the left sequence, reduces the total capacity and
keeping its content visible while reducing the size of a
stereoscopic image sequence [35].
Moreover, Zeng et al.’s scheme (2009) is based on the difference
histogram shifting to backup field for data hiding. Nine basic
scan way are defined, and these appliances all directional
neighbouring pixel distinction can be achieved. Because of the
case that the grayscale values of adjacent pixels are close to each
other, all the directional neighbouring pixel distinction histogram
includes a big number of points with same values.
Indeed, the right ones are slightly distorted while the left frames can be exactly recovered as the residuals are not hidden intact.

2.2. Pixel Based

The second sub-section about RDH is the pixel-based methods. In these methods the pixels are represented on only arithmetic pixel process and the effects interplayed with the computing modification or shifting (Fig. 2).

The basic inconvenience of all the irreversible data hiding methods have some permanent distortion. Li (2005) interferences to rescue original signal after the signal passing the authentication operations were made just a few years ago. Some ordinary matters now may be resolved, for example salt/pepper artefacts due to intensity wrap around and low hiding capacity [36]. A reversible data hiding scheme based on difference modification was presented by Tai et al. (2009). They profit by a binary tree structure to solve the problem of communicating pairs of highest points [36]. Whereas keeping the distortion low, they use dispersion of pixel differences to achieve large hiding capacity and in addition espouse a histogram shifting technique to forestall underflow and overflow.

2.2.3. Arithmetic Coding

Celik et al. (2002) follow some steps to use reversible data hiding method. At first, the method permits the certain rescue of the original host signal into subtraction of the embedded information using arithmetic coding technique. And then, a prediction-based provisory entropy coder uses static parts as side-information and increases the compression efficiency without losing data embedding capacity [37, 38].

2.3. Interpolation Based

Yalman et al. (2010) also offer a reversible data hiding technique called is based on Neighbour Mean Interpolation (NMI) method that utilizes the R–weighted Coding Method (RCM) [39].

Yalman and Akar (2014) propose a high Capacity reversible data hiding method called HCRHide based on the Neighbour Mean.
Interger divides some elements of $\mathcal{S}_i$. The $\mathcal{S}_i$andered to embed data while other bins are shifted to ensure reversibility. The results of that method have approved high performance of the proposed method over the existing reversible data hiding methods.

2.4. Others

2.4.1. Quantization:

2.4.1.1. VQ (Vector Quantization)

Vector quantization (VQ) is a basic quantization technique. It allows the modelling of probability density functions by the distribution of prototype vectors. This method is based on Side-Match Vector Quantization (SMVQ) and Search Order Coding (SOC). An index compression and reversible data hiding method was proposed by Chang et al. (2013). The secret data are hide inside the converted index table of a cover media in that proposed method [41].

2.4.1.2. SMVQ (Side-Matched Vector Quantization)

A reversible data hiding method hiding embedding data into a transformed media and holds lossless reinstatement of vector quantization (VQ) indices has lately been presented by Lee et al. (2010). The side-matched VQ scheme modifies the VQ compressed image to lead a transformed media, so that, to obtain very high embedding capacity and a low bit rate [42]. Wang et al. (2014) proposed a novel reversible data hiding scheme that can embed high capacity of secret bits and recover image after data extraction [42].

2.4.1.3. JPEG Q (JPEG Quantization)

Wang et al. (2013) presented a new high capacity reversible data hiding method based on altering the quantization table with be quantized discrete cosine transformation (DCT) coefficients for JPEG compressed images. An integer divides some elements of the quantization table while the same integer multiplies and an adjustment value to make free place for embedding the data adds the corresponding quantized DCT coefficients [43].

2.4.2. Others

2.4.2.1. PEE, histogram modification

Gu et al. (2014) present a high capacity reversible image data hiding scheme which is based on a generalization of prediction-error expansion (PEE) and adapted embedding strategy [19]. After the prediction-error histogram is generated, high frequency bins are expanded to embed data while other bins are shifted to ensure the reversibility. Traditional PEE as embedding, after prediction error histogram is created. Extended to embed high-frequency bins, the other boxes are shifted to ensure reversibility.

2.4.2.2. Steganalys SVM

Lou et al. (2013) presented a technique called the interpolation error based reversible data hiding which unites difference expansion and histogram shifting techniques to hide secret data inside interpolation error histograms from a cover image with high weight and low distortion they also propose an active stage analysis scheme analysing and modelling histogram abnormality in the interpolation error domain of subsample images with the general Gaussian distribution features, besides, estimated parameters of GGD trains vector machine (SVM) classifier and histogram differencing in the interpolation-error domain of subsample images with the Gaussian distribution properties [44].

2.4.2.3. LZW

A high capacity data-hiding LZW (HCDH LZW) method has been proposed by Chen et al. (2010) which embeds data in LZW compression codes reversibly by towing the symbol length. The hiding scheme makes the capacity maximum for the number of symbols applicable to hide secrets [45]. Wang et al. (2013) propose a high-performance, data-hiding Lempel Ziv Welch (HPDH LZW) scheme. Embedding data in LZW compression codes by modifying the value of the compression codes, which the value of the LZW code each of them remains unchanged. The LZW dictionary size according to the data will be hidden [46].

2.4.2.4. HMM-NN

An uncompressed a watermarking method’s on Hidden Markov Model (HMM) and Artificial Neural Network (ANN) has been presented by Elbasi (2007). This method separates the video sequences into Group of Pictures (GOP). Parts of the binary watermark may be put in each GOP with a selected data hiding algorithm. This embedding method is a common addition algorithm in minimum and peak frequencies in different transformation domains [47].

2.4.2.5. Fractal Coding

Fractal compression is a lossy compression method based on fractals. Mozaffari et al. (2013) proposes to select non-neighbour sets to decrease the effects of noise and therefore reduce bit error rate. These non-neighbour sets are selected by finding the most similar pairs as performed in the encoding phase of fractal image compression [48].

2.4.2.6. GIS-Vector Maps

Wang et al. (2014) embedded high capacity of secret bits and recover image after data extraction. This method depends on the topically adaptive coding method (LAC) and side-match vector quantization (SMVQ) [49].

2.4.2.7. Tamper detection

Tamper detection are called to the methods used for finding unauthorized changes made. A method has been proposed for data hiding with pair-wise logical computation (PWLC) by Tsai et al. (2005). The method can achieve the utilities of reversible hidden data subtraction and lossless reinstatement of original image without that utilizing any information from the original image. The mission of tampering detection be able to successful [50].

According to the general features of the methods described and table 1 is formed.

Figure 4. Lena, Baboon, Airplane, Boat, Pepper.
Table 1. Summary of Reversible Data Hiding Methods.
VQ Vector Quantization, SMVQ: Side-Match Vector Quantization, PEE: Prediction-Error Expansion, LZW: Hiding Lempel-Ziv-Welch, SVM: Support Vector Machine, HMM – NN: Hidden Markov Model – Neural Network, GIS: Geographic Information System

| Transform | Spatial | Frequency (Wavelet) |
|-----------|---------|---------------------|
| Block Based | Shifting | Hong et al. (2008) [5], Kuo et al. (2008) [6], Ni et al. (2006) [7], Zeng et al. (2009) [8], Fallahpour et al. (2011) [9], Hong et al. (2012) [10], Huang et al. (2013) [11], Chen et al. (2013) [12], Khan et al. (2014) [3] | Han et al. (2010) [4] |
| Histogram | Modification | Ni et al. (2004) [13], Ni et al. (2006) [7], Chrysochos et al. (2007) [14], Kumari et al. (2008) [15], Lin et al. (2008) [16], Li et al. (2010) [17], Yoo et al. (2010) [18], Gui et al. (2014) [19] | Xuan et al. (2002) [21], Xuan et al. (2004) [2], Xua et al. (2005) [22], Haoa et al. (2007) [20], Yuan et al. (2010) [23] |
| Colour Histogram | | Cetin et al. (2009) [24], Thanuja et al. (2009) [1] |
| Mapping | Look-Up Table | Wang et al. (2011) [25] |
| Location Map | Tian (2003) [26], Jia et al. (2010) [27] |
| Contrast Mapping | Lu at al. (2009) [28] |
| Authentication | | Shi et al. (2004) [29], Lee et al. (2006) [30], Ni et al. (2008) [31], Tai et al. (2009) [32] |
| Pixel Differencing | Saleh et al. (2007) [33], Saleh et al. (2007) [34], Ellinas (2009) [35], Zeng et al. (2009) [8] |
| Pixel Based | Pixel Modification | Chang at al. (2007) [36], |
| Pixel Differencing | Tai et al. (2009) [32] |
| Arithmetic Coding | Celik et al. (2002) [37], Celik et al. (2005) [38] |
| Interpolation Based | R-Weighting | Yalman et al. (2010) [39], Yalman and Akar (2014) [40] |
| Quantization | VQ | Chang et al. (2013) [41] |
| SMVQ | Lee et al. (2010) [42], Wang et al. (2014) [43] |
| PEE-histogram modification | Gui et al. (2014) [19] |
| Steganalysis SVM | Lou et al. (2013) [44] |
| LZW | Chen et al. (2010) [45], Wang et al. (2013) [46] |
| HMM - NN | Elbasi (2007) [47] |
| Others | Fractal coding | Mozaffari et al. (2013) [48] |
| GIS- 2D vector maps | Wang et al. (2014) [49] |
| Pair wise or Tamper detection | Tsai et al. (2005) [50] |
Table 2. Lena’s PSNR and Capacity values.

| Lena                  | PSNR (dB) | Capacity (bit) |
|-----------------------|-----------|----------------|
| Thanuja et al. [1]*   | 44.47     | 1080033        |
| Yalman et al. [39] ** | 39.56     | 385089         |
| Gui et al. [19]       | 35.39     | 262144         |
| Chang et al. [36]     | 45.11     | 262144         |
| Tian et al. [26]      | 29.43     | 260018         |
| Chang et al. [41]     | 31.22     | 257687         |
| Yalman et al. [40] ** | 38.23     | 200802         |
| Khan et al. [3]       | 52.38     | 183500         |
| Jia et al. [27]       | 55.40     | 163840         |
| Wang et al. [43]      | 31.70     | 86507          |
| Hong et al. [5]       | 48.93     | 86178          |
| You et al. [18]       | 48.78     | 73301          |
| Wang et al. [46]      | 35.71     | 65536          |
| Lin et al. [16]       | 48.67     | 65349          |
| Chen et al. [12]      | 48.62     | 53424          |
| Lu et al. [28]        | 41.17     | 52628          |
| Shi et al. [29]       | 44.20     | 39321          |
| Zeng et al. [8]       | 30.12     | 28147          |
| Lee et al. [30]       | 52.21     | 26990          |
| Xuan et al. [2] *     | 48.20     | 26214          |
| Xuan et al. [21] *    | 36.64     | 23040          |
| Kumari et al. [15]    | 61.79     | 22596          |
| Tai et al. [32]       | 48.32     | 22377          |
| Haos et al. [20] *    | 35.56     | 18403          |
| Celik et al. [38]     | 38.00     | 9347           |
| Celik et al. [37]     | 38.00     | 9325           |
| Kuo et al. [6]        | 48.20     | 8835           |
| Ni et al. [7]         | 48.20     | 5460           |
| Han et al. [4] *      | 45.59     | 4495           |
| Ni et al. [31]        | 40.20     | 792            |
| Chrysochos et al. [14]** | 53.10 | 300            |

Lena image resolution is 512×512 pixels and 8 bit.
* Wavelet Transform used
** Lena image resolution is 512×512 pixels and 24 bit.

3. Experimental Comparison Results

The quality of stego images is generally measured to formulas of Peak Signal to Noise Ratio (PSNR) determined by the following expression:

$$PSNR = 10 \times \log_{10} \left( \frac{255^2}{MSE} \right)$$

Mean Square Error (MSE) is the difference of the stego image compared to the host image.

Success of the algorithms was restrained terms of capacity (bit) and PSNR and with each of the available methods.

Many different images have been used on every article for experimental results. Stated that the success of the method with the values of PSNR. In those papers, they used well-known images, lena, baboon, airplane, boat and pepper (Fig. 3).

Table 2 displays PSNR values and payload values of the images that are used in common. These values are given in comparison with the capacity values and by year of publication of the article.

30.12 dB is the smallest value obtained for Lena. 61.79 dB is the smallest value obtained for Lena [3, 13]. Tian (2003) draws attention to the biggest embed capacity is 84066 bits. Xuan (2002), Xuan (2004), Hao (2007) and Han (2010)’s studies shows that there are studies using wavelet transform. Compared to the work done in the time domain has a slightly smaller value. These values have a slightly smaller value when compared with the impact studies. This study examined, it is seen that acceptable embed capacity and a low PSNR values with better endurance.

4. Conclusions

It can be concluded that in most reversible data hiding methods and techniques applications block-based, self-pixel based and others groups provide a good tool for the characterization and segmentation.

The reversibility and robustness are discontinuous, complex, and fragmented, hence the methods analysis can be applied in this bases. While compared to classic transform methods, the importance, significance and useful of this bases is the way of how the non-regularities to be assumed.

While analysing all the experimental results, it can be easily seen that the number of Wavelet transform methods are less as compared with the Payload, but more effective than spatial transform. Finally, all comparisons shows that, researchers should study on frequency transform for developing a reversible data hiding method.

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