TEST Engineering & Management

January – February 2020
ISSN: 0193-4120 Page No. 13323 - 13327

Reversible Methods Used To Improve the Embedding of High Quality Images

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Article Info
Volume 82
Page Number: 13323 - 13327
Publication Issue:
January-February 2020

Article History
Article Received: *18 May 2019*
Revised: *14 July 2019*
Accepted: *22 December 2019*
Publication: *24 February 2020*

Abstract

The reversible watermarking gains popularity in the fields of health, military and law. In this paper, the methods of reversible watermarking associated with various applications like error resiliency, embedding capacity and coding efficiency is considered as a major factor for surveying. The main objective of paper is to provide an extensible survey of state-of-the-art methods in reversible watermarking on several applications in image processing domain. This paper reflects latest progress of reversible watermarking in researches and specifies the key issues to improve the work in future. Finally, improvements are presented on reversible watermarking in order to probe into newer areas of research in image processing field.

Keywords; *Reversible Data Embedding, Data Encoding, Multimedia, Capacity and Quality*

I. INTRODUCTION

Reversible watermarking technique gains increased attention of researchers in past years, since it is been an interesting field in many application areas. The basic block diagram of watermarking technique with reversible flow scheme is provided in Figure 1.

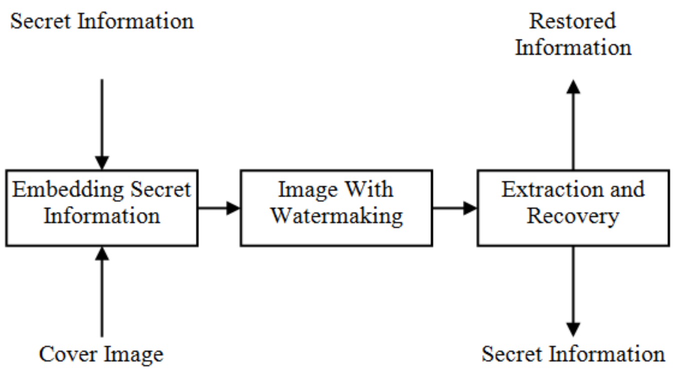

Figure 1: Watermarking technique with Reversible Flow

Hiding data could be classified into reversible or irreversible one. In an irreversible data hiding, the data is been hidden in such a manner that during recovery the losses predicted is more. Reversible data hiding or lossless data hiding techniques is considered to be lossless one, since extraction or recovery provides lossless embedded data. The primary element while considering or choosing embedding technique is its low degradation in its digital content's quality. The secondary element for embedding a hidden file is the reversibility option i.e. it is difficult for a user to restore the original file or removing the embedded data after authentication. This reversible option is considered to be the secondary option while considering a high recoverable original content in case of sensitive data like medical, law and military applications. So, choosing reversible data embedding technique could be regarded as a more appropriate technique for

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embedding hidden data over a multimedia file or digital content.

Reversible data embedding consists of three major schemes: Spatial domain: This domain helps in embedding the reverse code and the secret code. Frequency Domain: This domain uses discrete cosine transform (DCT) or discrete Fourier transforms (DFT) or discrete wavelet transforms (DWT) for pre-processing the original data content. This is done to convert the spatial domain content to frequency domain content, before the embedding operation. During embedding scheme, frequency domain helps in mixing the secret data into frequency coefficients and followed by this is the inverse operation from frequency domain.

II. TECHNIQUES ON WATERMARKING

Fridrich, et al. (2002) [1], suggested an reversible data embedding scheme, in which the embedded information over JPEG pixels in lossy image format is handled here. De Vleeschouwer, et al. (2003) [2], proposed bijective transformation with circular interpretation. Kalker, et al. (2002) [3], provided the limits of theoretical capacity over compressed lossless data and the practical construction of codes.

Tian, (2003) [4] used grayscale images to embed data and for color images, each combination of color component has to coded separately or it has to decorrelated. After decorrelating the color components based on its dependency among the image blocks. Then the components are embedded to maintain high embedded capacity using reversible data embedded algorithm. The DE technique cancels the effect of compressing the image and creates an extra storage space. A maximum embedded capacity could be achieved using linear prediction and entropy coding with increased complexity.

Shinfeng D. Lin et al. (2007) [5] used error resilient algorithm for embedding the reversible data into cover data. This method uses Difference Expansion (DE) method over intra frames. The error resilient algorithm concentrates mainly on H.264 intra frame than B and P frames due to temporal compression in a Group of Pictures. This method provides a better coding efficiency and compression ratio. Adding more techniques into H.264 intra frame will increase the dependency on the neighborhood blocks. If an error occurs in a dependent block, prominently the error will propagate in a wide spread manner. Traditional techniques like Error resilient encoding and concealment, mostly degrades the image quality and if no error occurs; these techniques gets degraded to a vast extent.

The conventional embedding methods are not interchangeable and restricted by either the media or domain. If the method is applied in spatial domain, frequency domain is not applicable and vice versa. Image in frequency domain are not applicable with the audio in frequency domain. Thus re-designing is required to change the domain for embedding. Moreover, for any digital signal it is important to have a universal embedding scheme due to increase in standards and formats. The above universal watermarking scheme is addressed by Stankovic et al. (2010) [6] and propose an embedding unified approach in time domain for audio and in frequency domain for images. This method is cannot be considered as complete interchangeable one due to its inefficiency in compressing the bit-streams of audio and image. Shih and Wu, (2003) [7] proposed hybrid technique that embed data over the frequency and spatial domain in an image.

The advantage is that the digital signal could be treated over bitstream that embeds directly the data in spatial or frequency domain in an interchangeable pattern. Mobassari et al. (2010) [8] proposed a technique that eliminates partial decoding to embed data over bitstream domain. In JPEG bitstream, Huffman coder is used for embedding. Yet, this bitstream is not applicable over compressed image domain using Arithmetic encoder or audio bitstream or text bitstream or other digital contents.

S.P. Maity et al. (2013) suggested an algorithm for the watermarking spread spectrum using genetic algorithm in M-band wavelet domain. Initially, the process is carried out with single bit and then repeated over multiple set of watermark embedding [9]. Jagadeesh et al. (2014) proposed content protection using Fuzzy logic watermarking in DCT domain [10]. Botta et al. (2016) proposed a fragile watermarking technique with Karhunen–Loève transform. This flexible and easily extendable technique is carried out both in compressed and uncompressed file. Genetic algorithm is carried out to find optimum pixel modification using inverse transforms over high quality images [11]. An adaptive reversible watermarking for multiple watermarks using Bi-directional Associative Memory Neural Networks and Fuzzy Inference System.

N. Yuvaraj and P. Vivekanandan (2016) divided regions and used M-Ary modulation for embedding watermarks. Further, Region of interest is extracted using Fuzzy C-means segmentation for better segmentation in mid-band DCT coefficient [12]. N. Yuvaraj and P. Vivekanandan (2016) proposed technique IRW-Med companding function that reduces embedding distortion. Integer Wavelet Transform (IWT) is also used to achieve reversibility. Further, in order to avoid overflow or underflow problem histogram processing is used. To make optimal selection of wavelet coefficient, genetic programming is used [12].

M Sivaram et al. (2012) proposed affine invariant image watermarking technique to provide resistance over geometric distortions. This method uses Harris–Laplace detector based on probability density profile [13]. A blind watermarking to increase the security of embedding without host image. To improve the reduced computational complexity than SVD, QR decomposition is used [14].

Yuvaraj et al., (2013) proposed a technique that embeds the secret data into MPEG – 4 video similar to the compression in [15]. The inter code and intra coded frames are needed to be included in embedding the video. This is followed by encoding with a suitable encoder like DCT, VQ etc. Followed by this is the prediction process and this method provides a better quality scheme for MPEG-4 video. The MPEG-4 compression includes the sequence formation in I-frame, P-frame, B-frame. In MPEG-4 compression, I-frames or key frames are considered for reconstructing the compressed video. Multiple feedbacks are used in predictive coding by encoder for improving the coding performance. The luminance component is preferred for embedding the data into I-frame. Pixel modification has been done over the selected channel possessing 2D histogram. The main aim is to achieve best data hiding scheme with the characteristic of six design rules in embedding scheme.

III. SUMMARY

The above mentioned schemes leads to a discussion in maintaining the trade-off between payload and visual capacity. Many techniques proposed as of now concentrated mostly on promising coding approaches, however, they failed in error resilience. So, there exists a trade-off between these two parameters. The methods specified have very less numerical integration and differential techniques, usage of quality controlled algorithms are absent. The technique proposed earlier concentrates mostly on quality controlled approaches and usage of such control system could enhance the processing quality and capability.

The results of various methods are discussed in Table.1. Here, we consider the PSNR values and embedding capacity of different techniques used in reversible data hiding. The results of various techniques proves its efficiency in embedding the codes into image and hence to analyze the results of various techniques, the results are tabulated.

Table.1. PSNR, Embedded Capacity of various methods

Embedding	PSNR
SHA-1 &1024 bits RSA	PSNR (dB) = 35 - 55
Location map	PSNR (dB) = 36 – 45

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Wavelet and DCT	PSNR (dB) = 34.86, 35.48
Search order coding	PSNR (dB) = 21.5 – 31.5
Difference Expansion algorithm	33.12dB, 34.57dB, 35.05dB
Difference expansion	PSNR = 35.45 dB
Discrete wavelet transform	39.20 dB
Dimensional arrays	Lena - 33.50 Pepper - 33.04 Baboon - 30.75
Sweldens' lifting scheme with Difference expansion	27.5 - 70 dB
Difference Expansion	16.47 - 44.20
Sliding Window	30 - 41
Predetermined threshold Value	42 - 47
Hierarchically structured with multi-layer algorithm	16.09 - 44.20
Prediction-based lossless image compression	16.47
Block base Single Parameter	~30 - 60
Inverse S-scan Order	> 50dB
Walsh Hadamard matrix	~37 - 62
Autoregression	> 50 dB for 0.01 bpp
Reference pixel and block selection	Lena & Airplane > 50, Baboon > 48.5
Improved Zhang's method	59.916 dB
Block Classification	35-50
Probabilistic and homomorphic properties	40.3/36.3
Rhombus relationships	48.13 dB

IV.CONCLUSIONS

This paper provides insights of entire reversible data embedded schemes in general and DCT scheme in particular. After looking through the varying range of literatures in terms of historical perspective, we have expounded the relationships of various method with reversible data embedded scheme is learnt. Also, we have described major methods used as supplementary schemes in enhancing the reversible data embedded schemes. Also, we found certain gaps in the previous researches associated with the reversible watermarking schemes. We also have discussed the problems associated with coding, error resilience and payload capacity. The suggestion related to demands, non-usage of techniques an inadequate approaches of reversible data embedded scheme experimental approach are over-specified. Thus this paper should kindle the researches to improve the quality of research in reversible data embedded scheme in terms of its quality and payload capacity.

V. DIRECTIONS FOR FUTURE WORK

From the conventional work, it is could explored that the reversible watermarking techniques are considered fragile and works perfectly for content authentication.

Generally, watermarking technique fails to identify the tampered regions, in case of modifications in the watermark. This could lead to a promising area of research in watermarking.

The watermarking technique has less scope on Fourier series domain and future work can provide significant improvements in reversible watermarking.

The use of benchmarking technique is not available in case of reversible watermarking technique, hence, the use of benchmarks should be used to improve the work further.

Security is other major concern in the field of reversible watermarking and possible future directions are required to improve the security in reversible watermarking technique.

Finally, the improvements can be made on several applications of reversible watermarking and that include: encoding bitstreams, Golomb-Rice code, sliding window and histogram processing.

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Published by: The Mattingley Publishing Co., Inc.

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