ANALYTICAL APPROACH FOR LOCAL PREDICTION BASED DIFFERENCE EXPANSION REVERSIBLE WATERMARKING

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ABSTRACT

In the digital information age, digital content(audio,image and video) can be easily copied, manipulated and distributed. Copyright protection and content authentication of digital content authentication of digital content has become an urgent problem to content owners and distributors. Reversible Watermarking provided valuable solution to this problem based on its application scenario. Although tremendous progress has been carried out on this visversa in the past years. There still exist a large number of problems in the conventional schemes. In this paper we proposed a reversible watermarking method based on local prediction. The local prediction is general and it applies regardless of the predictor order or the prediction context. For the particular cases of least square predictors with the same context as the median edge detector, gradient-adjusted predictor or the simple rhombus neighborhood, the local prediction-based reversible watermarking clearly outperforms the state-of-the-art schemes based on the classical counterparts. Experimental results are provided.

Keywords: Reversible watermarking, local prediction, least square predictors, state-of-the art schemes.

1. INTRODUCTION

Digital watermarking has grown explosively in the last few years. It embeds an invisible (in some cases, visible) mark (payload) into digital content for the purpose of copyright communication and protection, content authentication, counterfeit deterrence, forensic tracking, connected content, or broadcast monitoring, etc.

From the application point of review, most digital watermarking methods can be divided into two categories: robust watermarking and fragile watermarking. Robust watermarking is mainly aimed at copyright protection. Here “robust” means the embedded watermark should be very resistant to various signal processing operations. On the other hand, fragile watermarking is aimed at content authentication. A fragile watermark will be altered or destroyed when the digital content is modified. As a special subset of fragile watermarking, reversible watermarking, has drawn lots of attention recently. Reversible watermark, (which is also called lossless watermark, invertible watermark, erasable watermark), has an additional advantage such that when watermarked content has been detected to be authentic, one can remove the watermark to retrieve the original, unwatermarked content. Such reversibility to get back unwatermarked content is highly desired in sensitive imagery, such as military data and medical data.

In this paper, we present a reversible watermarking method of digital images. Our method can be applied to digital audio and video as well. Compared with other reversible watermarking methods, our method employs an local prediction based reversible watermarking algorithm. The embedding algorithm starts with a reversible color conversion transform. Reversible watermark is a special subset of fragile watermark. Like all fragile watermarks, it can be used for digital content authentication. But reversible watermark is much more than content authentication. It has an additional advantage that when watermarked content has been detected to be authentic, one can remove the watermark to retrieve the original, unwatermarked content..

II.DIFFERENCE EXPANSION REVERSIBLE WATERMARKING:

A. DIFFERENCE EXPANSION

In the basic reversible watermarking scheme there is the part of DE. Difference Expansion means generating some smalla values to represent the features of the original image.

The basic algorithm of the DE is :

(i). Take two adjacent pixel values to represent

(ii). Find difference and average of taken pixels

(iii).Expand into its binary form and add watermark bit right after MSB to get.

(iv).Reconstruct the image using D, we get the watermarked image.

B.Basic Reversible Watermarking Scheme:

Let $\hat{x}_{i,j}$ be the estimated value of the pixel $x_{i,j}$. The prediction error is

$$e_{i,j} = x_{i,j} - \hat{x}_{i,j} \quad \ldots (1)$$

Let T >0 be the threshold. The threshold controls the distortion introduced by the watermark. Thus, if the prediction error is less than the threshold and no overflow or underflow is generated, the pixel is transformed and a bit of data, b, is embedded. The transformed pixel is:

$$x'_{i,j} = x_{i,j} + e_{i,j} + b \ldots \ldots (2)$$

The embedded pixels are also called carrier pixels (see [12]). The pixels that cannot be embedded because$|e_{i,j}| \geq T$ (the non-carriers) are shifted in order to provide, at detection, a greater prediction error than the one of the embedded pixels. These pixels are modified as follows:

$$x'_{i,j} = \begin{cases} x_{i,j} + T, & \text{if } e_{i,j} \geq T \\ x_{i,j} - (T-1), & \text{if } e_{i,j} \leq -T \end{cases} \quad \ldots \ldots (3)$$

The underflow/overflow cases are solved either by creating a map of underflow/overflow pixels or by using flag bits . Let us suppose that, at detection, one gets the same predicted value for the pixel $x_{i,j}$. The prediction error at detection is

$$e'_{i,j} = x'_{i,j} - \hat{x}_{i,j} \quad \ldots \ldots (4)$$

The discrimination between embedded and translated pixels is provided by the prediction error If

$-2T \leq e'_{i,j} \leq 2T+1$ one has an embedded pixel. For the embedded pixels one has $e'_{i,j}=2e'_{i,j}+b$ and b follows as the LSB of$e'_{i,j}$. The original pixel is immediately recovered as

$$x = \frac{x'_{i,j} + \hat{x}_{i,j} - b}{2} \quad \ldots (5)$$

For the shifted pixels, the original pixel recovery follows by inverting equation (3). As long as at detection one has the same predicted value, the reversibility of the watermarking scheme is ensured. The same predicted value is obtained if the pixels within the prediction context are recovered before the prediction takes place. Let us suppose that the watermarking proceeds in a certain scan order.

The embedding capacity of the basic DE HS scheme is given by the number of pixels that are embedded with equation (2), namely the pixels having the absolute prediction error lower than the threshold. Obviously, the capacity depends on the prediction error, i.e. on the quality of the prediction.

III.LOCAL PREDICTION REVERSIBLE WATERMARKING

An adaptive global predictor estimates all the pixels of the image. Since the statistics of the image change from a region to another, it is very improbable that the predictor will have good performances everywhere. By dividing the image into blocks and by computing a distinct predictor for each block, one expects that the predictor will provide better results. The problem is to select the size of the blocks or, equivalently, the number of blocks. The larger the number of blocks, the better the prediction. The limit is the case when one computes one distinct predictor for each pixel

In order to illustrate the reduction of the prediction error provided by using a distinct predictor for each pixel, a simple example is presented. Let us consider the case of the rhombus context and let us evaluate the mean squared prediction error for local LS prediction computed on a $B \times B$ sliding window. The improvement depends on the image content, namely it is more significant for images with a high content of texture or fine details than for the ones with large uniform areas.

A. Local Prediction

we investigate the computation of a distinct predictor for each pixel. Obviously, the embedding of the predictors coefficients into the image is out of the question. Therefore, instead of computing the predictors on original image blocks, we investigate the computation on blocks containing both original and modified pixels.

Let the pixels be embedded in a raster-scan order, pixel by pixel and row by row, from the upper left corner to the lower right one. Obviously, the decoding proceeds in reverse order, from bottom to top, starting with the last embedded pixel.

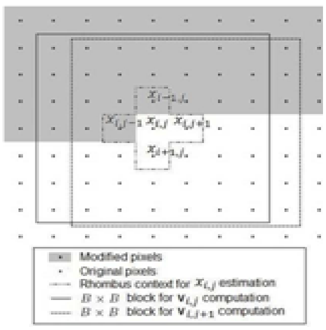

Fig : Blocks Local Predictor computation

Let the pixels be embedded in a raster-scan order, pixel by pixel and row by row, from the upper left corner to the lower right one. Obviously, the decoding proceeds in reverse order, from bottom to top, starting with the last embedded pixel. Let us consider the decoding and letxi,j be the current pixel. Let us take a block of pixels centered onxi,j. If one compares the block taken at detection, before the decoding ofxi,j, with the same block, but taken at embedding, before the embedding of xi,j, it immediately appears that only xi,j is different (Fig. 3). Obviously, since the decoding starts with the last embedded pixel, all the pixels that follow the current pixel in the raster-scan order have already been decoded. The observation that, except the central pixel, the blocks centered on a pixel at embedding are exactly recovered at detection, suggested to us the computation of the predictor for each pixel on aB×Bblock centered on it and the recovery of the same predictor at detection. Thus, instead of considering as in Section II-B, the matrix Xand the vector y for the entire image, one should consider a matrixXi,j and a vector yi,j by taking only the pixels having the prediction context included into the B×Bblock centered on the pixelxi,j.Then the current predictor vi,j is computed (for instance, by using equation (6)) and so on.

$$v = (X'X)^{-1}X'\ y \quad \ldots(6)$$

Obviously, the current pixel cannot be considered in the computation of the current predictor. Meanwhile, the current pixel appears in the prediction context of other pixels of the block. If the prediction context haskpixels, the central pixel takes part in k other prediction equations. There are two solutions

1) The vector corresponding to the central pixel,xi,j,as well as the ones that contain the central pixel (xl,m, with xi,j ∈xl,m) are eliminated fromXi,j and the central pixel as well as the pixelsxl,mare eliminated fromyi,j ;

2) Before the construction ofXi,j andyi,j , the central pixel of the blockxi,j is replaced by an estimate ˜ xi,j computed by using a fixed predictor as the one of equation (7).

$$\tilde{x}_{i,j} = \frac{x_{i-1,j} + x_{i+1,j} + x_{i,j-1} + x_{i,j+1}}{4} \quad \ldots(7)$$

The above equation used for estimation of the central pixels , $\hat{x}_{i,j}$ is not used directly in watermarking no rounding of average to integer values is necessary.

The first solution is simple, but does not consider the pixels close to the current pixel as sample data for the computation of the current predictor. The second solution eliminates this drawback, even if instead of the true central pixel value we use an estimate.

B. Proposed Scheme

The Proposed scheme consists of a basic reversible watermarking scheme for the local prediction, In raster scan order ,the image pixels has been processed which is started from the upper left corner. The proceedings for each pixel $x_{i,j}$ are as follows :

1). Following or using the local LS prediction scheme or the fixed predictor , we are computing the pixel $x_{i,j}$ as

- The pixel $x_{i,j}$ which is centered for the block $B \times B$ is extracted :
- Having the block which is extracted is replaced with the pixel $\tilde{x}_{i,j}$
- Scanning the block by creating $X_{i,j}$ and $y_{i,j}$
- By solving $y_{i,j} = X_{i,j} v_{i,j}$ the local predictor $v_{i,j}$ is computed
- Compute $\hat{x}_{i,j}$.

2). Compute the prediction error $e_{i,j}$.

3). If $|e_{i,j}| < T$ compute $x'_{i,j}$ with eq (2) or otherwise with eq(3).

4). If $x'_{i,j} \in [0, T-1]\ U[255-T, 255]$, replace $x_{i,j}\ by\ x'_{i,j}$ if $x'_{i,j} \in [0,255]$.

5). Do not replace $x_{i,j}$ if $x'_{i,j} \nexists [0,255]$ and if the flag bit b=0 insert it to the next embeddable pixel.

The detection proceeds pixel by pixel and row by row starting with the last marked pixel,according to pixel position. It should be noticed that the proposed local prediction scheme applies regardless of the size or the shape of the context.

IV.SIMULATION RESULTS :

In this section, experimental results of the proposed local prediction based reversible watermarking scheme are presented. The classical test videos are used for the test. The videos are provided in Audi Video Interleaved Format and the logo images are provided in Portable Network Graphics format. Our experiment on the test videos Fig 6.1 show that the size of the block should be adjusted for each particular predictor. As expected, the proposed approach gives very good result for these contexts as well. As for the rhombus case, the local predictor based schemes appear to significantly outperform both the corresponding global prediction based schemes and the DE-HS schemes. The ranking between the performances of the reversible watermarking schemes based on local prediction is similar to the one of the schemes based on the classical counterparts.

In the below figures we are giving the experimental results for the proposed schemes extension. In the proposed scheme they just recover images for the gray level images only. But now we are approaching this for the AVI format videos. Let us observe the Figure (a) ,this is the input video which we have taken for the simulation. It must be in the format of AVI. And the video doesn't contain any visible or invisible logos or watermarking. Now we are applying a watermark for the input video, the watermark which we are applying it can be a text, logo, image .etc. The logo must in the format of PNG. The logo which we are taking is shown in fig (b). After applying the logo to the video we get the watermarked video as shown in fig (c).The difference between the original video and the watermarked video is RGB. The RGB value for the input video is 255x255 and for the watermarked video is 360x640. After that we are removing the logo by using local prediction based rhombus context. It divides the video in to blocks and applies the local prediction based difference expansion and removes the logo from the watermarked video, which is shown in fig (d). And finally we get the recovered video by using the proposed scheme, it just adjusting the pixels for recovering the loss of the logo dismissal

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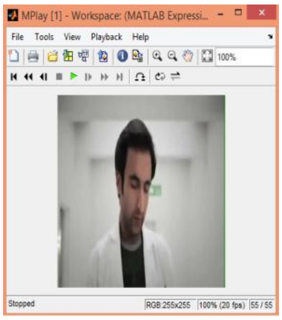

Fig (a) : Original video

Fig (b) : Original Logo

Fig (c) : Water marked video

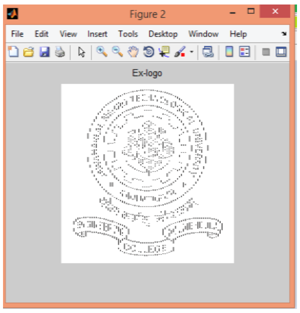

Fig (d) : Ex-Logo

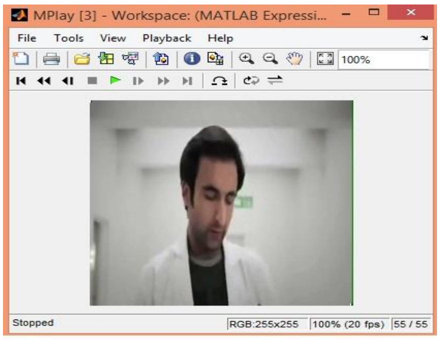

Fig (e) : Recovered video

Table : Comparing MSE & PSNR values for the Different video samples

Video name	MSE	PSNR	nb	Br
1	0.2156	0.261	5088	0.0782
2	0.6297	2.0088	34273	0.5271
3	0.2211	0.2713	6088	0.6820
4	0.3650	4.3766	17097	0.2629

We checked the proposed algorithm to the different videos, by taking different types of logos. i.e, text,symbol and image formats. And we calculate Mean square error, PSNR, nb and br.

V. CONCLUSION :

In this paper we present a reversible watermarking method based on the local prediction. For each pixel, the least square predictor centered on pixel is computed..The scheme is designed to allow the recovery of the same predictor at the detection, without any additional information. The existing method analyzes this for the gray scale level images but in the extension method we are applying this process for the videos.The local prediction based reversible watermarking was analyzed for the case of the recovering the input video without any additional information by removing the watermarking from the watermarked video. The results have been obtained by using the local prediction with the basic difference expansion scheme with simple threshold control, histogram shifting and flag bits. With a carefully designed location map, the watermarked video quality superb. The authenticator can remove the reversible watermark and retrieve an video, which is exactly the same as original, unwatermarked video,pixel by pixel.

REFERENCES :

[1] J. Tian, "Reversible data embedding using a difference expansion," IEEE Trans. Circuits Syst. Video Technol., vol. 13, no. 8, pp. 890–896, Aug. 2003.

[2] A. M. Alattar, "Reversible watermark using the difference expansion of a generalized integer

transform,"IEEE Trans. Image Process., vol. 13, no. 8, pp. 1147–1156, Aug. 2004.

[3] L. Kamstra and H. J. A. M. Heijmans, "Reversible data embedding into images using wavelet techniques and sorting," IEEE Trans. Image Process., vol. 14, no. 12, pp. 2082–2090, Dec. 2005

[4] C. C. Lin, W. L. Tai, and C. C. Chang, "Multilevel reversible data hiding based on histogram modification of difference images,"Pattern Recognit., vol. 41, no. 12, pp. 3582–3591, 2008.

[5] P. Tsai, Y.-C. Hu, and H.-L. Yeh, "Reversible image hiding scheme using predictive coding and histogram shifting,"Signal Process., vol. 89, no. 6, pp. 1129–1143, 2009.

[6] L. Luo, Z. Chen, M. Chen, X. Zeng, and Z. Xiong, "Reversible image watermarking using interpolation technique,"IEEE Trans. Inf., Forensics Security, vol. 5, no. 1, pp. 187–193, Mar. 2010.

[7] W. Hong, T.-S. Chen, and C.-W. Shiu, "Reversible data hiding for high quality images using modification of prediction errors,J. Syst. Softw., vol. 82, no. 11, pp. 1833–1842, 2009.

[8] C. Wang, X. Li, and B. Yang, "Efficient reversible image watermarking by using dynamical prediction-error expansion," inProc. 17th ICIP, 2010, pp. 3673–3676

[9] D. M. Thodi and J. J. Rodriguez, "Expansion embedding techniques for reversible watermarking," IEEE Trans. Image Process., vol. 16, no. 3, pp. 721–729, Mar. 2007.

[10] G. Coatrieux, W. Pan, N. Cuppens-Boulahia, F. Cuppens, and C. Roux, "Reversible watermarking based on invariant image classification and dynamic histogram shifting,"IEEE Trans. Inf., Forensics Security,vol.8, no. 1, pp. 111–120, Jan. 2013.

[11] D. Coltuc and J.-M. Chassery, "Very fast watermarking by reversible contrast mapping," IEEE Signal Process. Lett., vol. 15, no. 4, pp. 255–258, Apr. 2007.

[12] A. Tudoroiu and D. Coltuc, "Local map versus histogram shifting for prediction error expansion reversible watermarking," inProc. ISSCS, 2013, pp. 1–4.

[13] M. Goljan, J. Fridrich, and R. Du, "Distortion-free data embedding for images," Inf. Hiding, vol. 2137, pp. 27–41, Apr. 2001.

[14] M. U. Celik, G. Sharma, A. M. Tekalp, and E. Saber, "Lossless generalized LSB data embedding,"IEEE Trans. Imag. Process., vol. 14, no. 2, pp. 253–266, Feb. 2005.

[15]Z. Ni, Y. Q. Shi, N. Ansari, and W. Su, "Reversible data hiding," IEEE Trans. Circuits Syst. Video Technol., vol. 16, no. 3, pp. 354–362, Mar. 2006.