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Reduced Pixel Shifting and Improved Histogram Shifting Based Reversible Watermarking for Cartoon Images

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Abstract– **The Hong's modified histogram shifting method is best method of reversible watermarking. But Hong's modified histogram method is not suitable for cartoon images. Our improved backward histogram shifting method overcome drawback of Hong's method. Generally PSNR decreases when embedding capacity increases. But our improved backward histogram shifting method gives more embedding capacity and high PSNR. Hong's method becomes unable to locate minimum point after 255 as generally histogram of cartoon images concentrates at 255 pixel value, which is called as maximum point. Our backward method finds minimum point before maximum point. Our improved backward histogram shifting method shifts required pixel values to left by '1' numbers which is called minimum point. The embedding capacity for cartoon images is maximum because maximum numbers of pixels are available at 255, than any other images. The complexity of our improved histogram shifting backward method is same as that of Hong's modified histogram shifting method as both scans image twice only.**

Index Terms– **Reversible Watermarking, Histogram Shifting, Embedding Capacity, Processing Time, PSNR, Backward Method and Forward Method**

I. INTRODUCTION

THE earliest reference to reversible data embedding we could find is the Barton patent, filed in 1997 [1]. In his invention, the bits to be overlayed will be compressed and added to the bitstring, which will be embedded into the data block. Honsinger et al. [2] utilized a robust spatial additive watermark combined with modulo additions to achieve reversible data embedding, also reconstructed the payload from an embedded image, then subtract the payload from the embedded image to losslessly recover the original image. Goljan et al. [3] proposed a two cycles flipping permutation to assign a watermarking bit in each pixel group.

Celik et al. [4] presented a high capacity, reversible data-embedding algorithm with low distortion by compressing quantization residues. Tian [5] presented a reversible data embedding approach based on expanding the pixel value difference between neighboring pixels, which will not overflow or underflow after expansion. Thodi and Rodrguez [6] exploited the inherent correlation among the neighboring pixels in an image region using a predictor. Xuan et al. [7] embedded data into high-frequency coefficients of integer wavelet transforms with the companding technique, and utilized histogram modification as a preprocessing step to prevent overflow or underflow caused by the modification of wavelet coefficients.

Macq [8] proposes an extension to the patchwork algorithm to achieve reversible data embedding. Fridrich, et al. [9] developed a high capacity reversible data-embedding technique based on embedding message on bits in the status of group of pixels. They also describe two reversible data-embedding techniques for lossy image format JPEG. De Vleeschouwer, et al. [10] proposed a reversible data-embedding algorithm by circular interpretation of bijective transformations. Kalker, et al. [11] provide some theoretical capacity limits of lossless data compression based reversible data embedding and give a practical code construction. Celik, et al. [4], present a high capacity, low distortion reversible data-embedding algorithm by compressing quantization residues. They employ the lossless image compression algorithm CALIC, with quantized values as side-information, to efficiently compress quantization residues to obtain high embedding capacity.

Petitcolas et al. in 1999 [12] have introduced data hiding initially for a copyright protection. Lin and Tsai, 2004 [13], Lin and chen 2000[14] and Zhicheng Ni, Yun-Qing Shi, Nirwan Ansari, and Wei Su, 2006 [15] have introduced copy right protection for which data are embedded. Rich redundancies provided by digital images are very suitable for data embedding because some redundancies are easily replaced by the data bits. To conceal data image into a cover image pixel values are modified. This causes certain distortion in image. This type of image is called watermarked image. Usually the distortion in the data hiding is not reversible; hence we can say that original image cannot be recovered to its original state after watermark is extracted.

On the contrary, a reversible watermarking has the capability to restore original image. Some times, it is very important to have original image. For example a misreading of an **x-** ray picture may cause misdiagnosis of a patient. The techniques in the reversible watermarking can roughly be categorized into five types, namely Difference expansion [5], Histogram shifting [16], Contrast Mapping [17], Integer Wavelet Transform, modulo 256 addition [3], lossless multi resolution transform [8], lossless compression [4], [20], invertible noise adding [4], circular interpretation of bijective transformation [10] etc. All other techniques are explained above. Here we have proposed increased embedding capacity histogram shifting technique. Histogram shifting technique presented by Ni et al. [16], have disadvantage that it has more complexity due to image is scanned three times. A modified histogram shifting is presented by Wien Hong, Tung Shou Chen, Kai Yung Lin, Wen Chin Chiang [16], who reduced complexity and improved quality of image. He presented a restricted payload by the distribution of pixel values. In general as an image histogram with greater peak height, the image should have a greater payload. This drawback is reduced in our proposed method.

Watermarking and Reversible watermarking requirements based upon attacks viz. *Low pass filtering attack, Geometric attack,* Forgery *attack,* VQ *attack,* Cropping attack are as follows:

i) Security ii) Imperceptibility iii) Capacity iv) Robustness

The noises which we can be applied are Cropping, Gaussian, Poisson, Salt and Pepper, Rotational, geometric and Multiplicative noise.

The performance of a reversible data-embedding algorithm can be measured by the following.

i) *Payload capacity limit:* It is the maximum amount of information that can be embedded.

ii) *Visual quality:* It is the visual quality after the embedding of image.

iii) *Complexity:* It is the complexity of mathematical equations and hence the algorithm.

II. PROPOSED METHOD

Embedding:

Input: Original 8 bit grayscale image I, with MxN pixels and watermark Iw.

Output: Watermarked image Iw, the peak point a, the minimum point b, length of watermark and the location map L.

Step 1: Scan the image I and construct it's histogram H(x)Є[0, 255]. In this histogram obtain peak point a and less point b which is equal to (a-1).

Step 2: Record the position of pixel values whose values lies between point a and b.

Step 3: Scan the cover image I again. Set counter k for length of watermark.

If counter k is less than length of watermark

(a) If scanned pixel value lies within a and b, decrease it by 1.

(b) If pixel value lies below 'b' and, then don't change that pixel value.

(c) If pixel values lies above 'a' then don't change that pixel value.

(d) Scan the watermark, if scanned value is 0, then decrease pixel value of a by 1. If scanned pixel value of watermark is 1, then do not decrease pixel value.

Step 4: Continue step 3 upto end of watermark. If counter k becomes greater than length of watermark, do not change any value upto end of image scanning completes.

Extraction and Restoration: The extraction and restoration procedure is given below:

Input: Watermarked Image Iw, the peak point a, the minimum point b, the location map L and the length of the watermark Iw.

Output: Original 8 bit grayscale image I and the recovered watermark Iw.

Step 1: scan the image in the same order as in the embedding phase.

Step 2: Set counter k=0, k is used to indicate length of watermark. For k is less than length of watermark, go to step 3 else step 4.

*Step 3: (*a) If image scanned pixel value is 'a' bit 1 is extracted. If the scanned value is a-1, extract 0 bit, increase pixel value by (n-1), and increase counter k=k+1.

(b)If scanned pixel value lies between a and b then add '1' in the scanned pixel value (optional).

(c) (i) If pixel value is greater than 'a' and lesser than 'b' then do not change these values.

Step 4: Continue step 3 upto end of watermark. If counter k becomes greater than length of watermark, do not change any value upto end of image scanning completes.

Step 5: Go to location map L of b+1, and make it b+1.

III. RESULTS AND DISCUSSION

Hong's method do not support cartoon images. Results in Table 1 shows that our method gives around 77.87 dB PSNR for cartoon images. This shows that our improved backward histogram shifting method gives highest PSNR than available existing all methods. The minimum PSNR of our improved histogram backward shifting method is 48.13 dB.

The embedding capacity is 170671 bits, which is highest for cartoon image than any other image with any other method.

Our method shifts '1' pixel while processing. This means our method shifts min number of pixels during processing. As shifting of pixels are minimum, our method is suitable for cartoon images. Hence we get better quality of cartoon image as compared to recent available all methods. Hence our method is fittest to cartoon images.

This result is related to 21x21 size of watermark and cartoon image. As size of watermark changes PSNR, number of shifting of pixels changes and it is depicted in result table.

The complexity of our method is same as that of Hong's method [16], as we also scans image twice. Hence we can say that our reduced pixel shifting and improved histogram shifting method is more superior than Hong's modified histogram shifting method.

IV. CONCLUSION AND FUTURE SCOPE

In this paper we have presented minimum pixel shifting and improved backward histogram shifting method for cartoon images. Our method has highest PSNR than any other existing method. This is depicted in results Table 1.

Generally PSNR and Embedding Capacity are inversely proportional to each other. But our proposed method gives highest PSNR and highest embedding capacity than any other method. As shifting of pixels are reduced in our method, the quality of our method is highest than any other existing method. As shifting of pixels are minimum for cartoon images, quality is best. Hence we can say that our method is fittest for cartoon images.

Our improved histogram shifting method significantly increases PSNR (Fig. 1), embedding capacity and reduces shifting of pixels. The complexity of our method is same as that of Hong's modified histogram shifting method, as our method also scans image twice. Handling of distortion still remains a difficult task. More robust system will also significantly lead the area. Secure reversible watermarking with any attack may be a dream and a challenging field in near future.

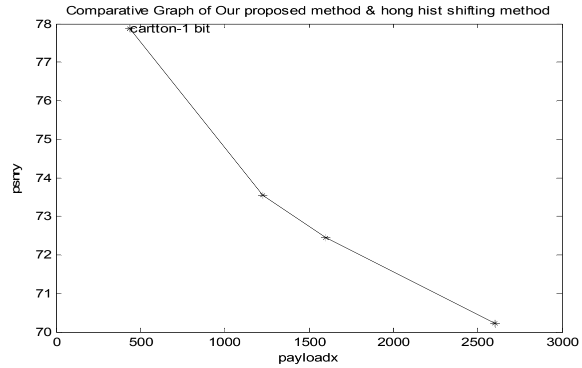

Fig. 1: Above comparative graph shows PSNR Vs payload for Cartoon image

Table 1: Following table shows result of our improved histogram backward shifting method with different payload, PSNR, No. of shifted pixels and Max embedding capacity for cartoon images

		Logo size 21x21=441			Logo size 35x35=1225			Logo size 70x70=4900		
Image	Method	Max emb Ca -pacity	PSN R (dB)	Shifted Pixel	Max emb Capacity	PSNR (dB)	Shifted Pixel	Max emb Capacity	PSNR (dB)	Shifted Pixel
Cartoo	B/w(1val)	170671	77.87	1	170671	73.54	11	170671	67.26	44

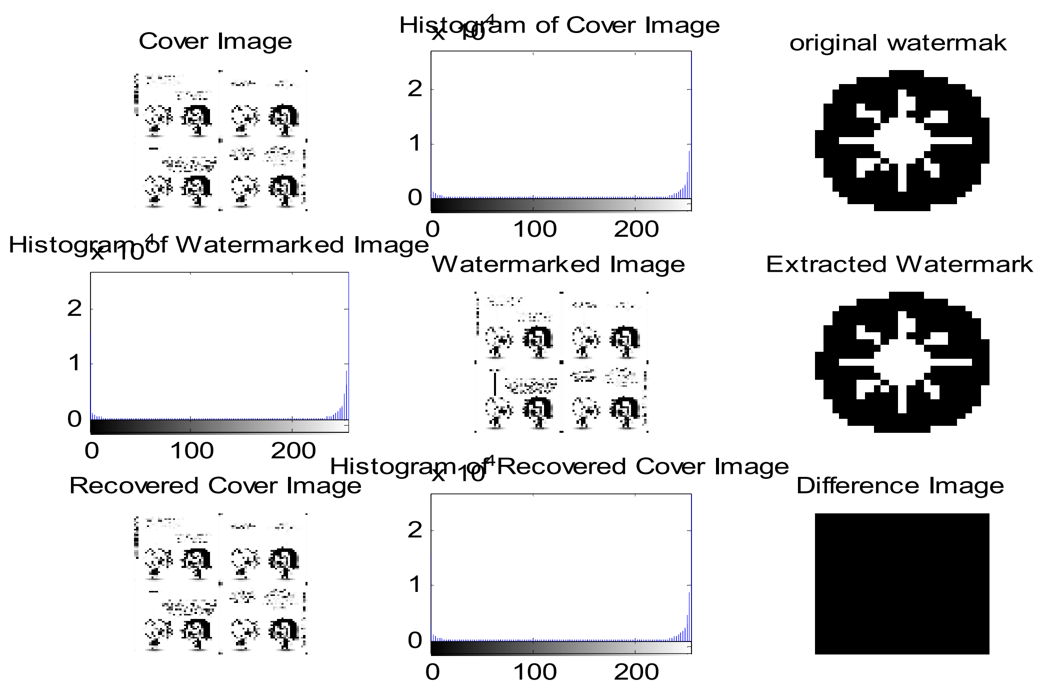

Fig. 2: The Above Fig. 1 shows: (a) cover image (b) Histogram (c) Original watermark (d) Histogram of original watermark (e) Watermarked image (f) Extracted Watermark (g) Recovered image (h) Histogram of recovered image (i)Difference between original and recovered image, for cartoon image

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