Reversible Watermarking on Histogram Pixel Based Image Features

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Abstract **- Reversible watermarking is a useful concept to extracts the embedded data, but also recovers the original data. Image processing furnishes a way to analyze and identify an image and to predict the values for the image. Watermarking can be applied to Images, Text, Audio/video, and Software. By using lot of analysis, values predicted for the areas likes medical image processing, Satellite images, and natural images. An important research area for information hiding in modern multimedia technologies like copyright protection, fingerprinting, monitoring and data hiding. In existing system local prediction in difference expansion scheme based on prediction context such as median edge detector(MED),gradient adjusted predictor(GAP),Simplified gradient adjusted predictor(SGAP), and Rhombus are used to predict values, by performance rhombus provides better results. For each image, in order to minimize the prediction error, the coefficients of the predictor are computed, for that the solution is least square (LS) prediction. An alternative approach proposed for predict values from pixel that provides better result is histogram shifting approach. To increasing the embedding capacity the heights of the peak points in the histogram can be raised. Our put forward method improves the embedding capacity upon several images and still maintains the quality of the images.**

Keywords – Reversible watermarking; Histogram shifting; least square prediction; Difference Expansion.

I. INTRODUCTION

Watermarking works in two phases, the embedding phase and the detecting phase. But Reversible watermarking can also able to work in third phase such that extraction phase. Reversible watermarking is used to embed the secret data into the image and to extract the same information from that image whenever required without any distortion [1].Reversible watermarking plays a major role for securing images of sensitive content, like medical or military images, for which any little change may impact their meaning one puts on action. Watermark removal is possible; image is not protected once the watermark is removed. Continuous protection watermarking offers high interest in keeping the watermark in the image such as storage, transmission and also processing of information. The need for reversible technique is lowest distortion with high embedding capacity [1].

Watermark is a technique from reversible data hiding mainly used for authentication of data like image; video and electronic document .watermarking is two types visible and invisible. When watermark that can be perceived to human observer after primary image is embedded into watermark it is visible, if it is not perceived then the embedded image is invisible [2].The extracted image should be free from distortion it is the aim of reversible watermarking. Reversible watermarking based on lossless data compression, Histogram shifting, Difference expansion [10].

Barton [3] developed a reversible data embedding algorithm that is based on data compression. In his method he compressed the data that is to be embedded in an image. Celik [4] developed a low distortion reversible data hiding algorithm that is achieved by compressing some portions of the signal that are easily affected to distortions. Compression of data is embedded into an image; LSB is performing where the compression ratio is poor so it limits the efficiency of lossless compression [5].

Ni, et al [6] introduces Histogram shifting approach. The proposed Histogram is constructed by pixel values and embeds the information using the vacancy between peak points and zero points. The intensity levels of pixels is no more than 1.Hong et al [7] presented value of histogram, prediction scheme provides a way to increase the embedding capacity. Watermarking technique achieves robustness and low computational complexity by using Histogram shifting [8].

Introduced by Tian [9], Difference Expansion calculates the difference of neighboring pixel values and selects some difference values for restoration information, a message authentication code and additional data. Catalin[7], For data insertion simple multiplication by two.DE expands the difference between two adjacent pixels by shifting to the left its binary representation, thus creating a new virtual Least significant bit.LSB is used for data insertion[1]. Pixel pairs difference that does not cause an overflow or underflow to embed the bits of data [8]. If no overflow or underflow appears, add one bit of data to expanded difference. If LSB of difference is set to zero it is substituted by a bit of data.DE goal is to reduce embedding distortion [10].

To gain embedding capacity, embedding bit rate increased from o.5bpp to n-1/n bpp. Each pixel is embedded, advance DE algorithm proposed to increase embedding bit rate to 1bpp[11].To increase embedding bit rate for medical images, use adaptive switching between Histogram shifting and Difference expansion[1].Fast DE-scheme proposed[13].In bit rate changes greater than 1bpp,by DE with Histogram shifting outperforms DE with location map[14].To minimize global distortion select adding and subtracting data bit[18].pixel of flat region embeds 2 bits and pixels of rough region embeds 1 bit by adaptive scheme[19]

MED used in [11], [18], [12] and [20] is a very good predictor, it is also used in JPEG-LS standard 20 composed of lower diagonal neighbors of pixels from right.GAP used in CALIC (context-based, adaptive, lossless image coding) algorithm [21], GAP is more complex than MED.SGAP is simplified version of GAP at lower cost and SGAP outperform based on MED [22].Rhombus context prediction is computed by partial difference equation [23].

II. REVERSIBLE WATERMARKING

Reversible watermarking is classified in to three categories namely 1st for fragile authentication, 2nd for high embedding capacity, and 3rd for semi-fragile authentication. In fragile authentication does not need much data to be embedded in a cover medium, the embedding capacity in this category is not large, normally between 1k to 2k bits. For a typical 512×512 gray scale image, this capacity is equivalent to a data hiding rate from 0.0038 bits per pixel (bpp) to 0.0076 bpp [3].

To achieve high capacity Tian [9] introduce reversible data embedding algorithm. In the algorithm, two techniques are employed, i.e., difference expansion and generalized least significant bit embedding, to achieve a very high embedding capacity, while keep the distortion low. Content-based authentication makes more sense than representation based authentication. This is because of semi-fragile authentication, because it allows some incidental modification, in compression within a reasonable extent, while the fragile authentication, does not allow any alteration in compression.

III. REVERSIBLE WATERMARKING BASED ON LOCAL PREDICTION

All pixels of the image are judged by adaptive global predictor. Since the numerical facts about the image collected and arranged, systematically they change from one region to another, so it is not possible that the predictor will have good performance everywhere, better solution for this problem is dividing the image into blocks and computing the predictor for each block it provides better results. For good prediction, the rule is larger the number of blocks better the prediction. Let us consider rhombus context and evaluate mean square prediction error. Local LS prediction computed on B×B sliding window, B={8,12,16}.There are six standard 512×512 test images, Lena, Mandrill, Jet plane, Barbara, Tiffany and Boat (see Fig.1)

From four prediction context MED, GAP, SGAP and Rhombus. By performance level rhombus provide good results for images. It also provides quality of the images by reducing the PSNR (Peak signal noise ratio) values. So rhombus is taken as best result by using local prediction with a basic difference expansion scheme

Fig.1 Test images: Lena, Mandrill, and Jet plane, Barbara, Tiffany and Boat

In reversible watermarking by considering larger the number of block better the prediction, predicted pixel is embedded or shifted. If predictor computed on original block, pixels are modified, at embedding stage it cannot be recovered at detection. The solution for such block, co-efficient of predictor is computed as additional information, it is available at detection. This solution limits the smaller the number of block better the prediction.

In Rhombus prediction [23] error is calculated by

$$X_{m,n} = \frac{X_{m-1,n} + X_{m+1,n} + X_{m,n-1} + X_{m,n+1}}{4} \quad (1)$$

Block size is examined first, the result of block sizes on grey level set varying from 7×7 to 25×25 have been analyzed. The Optimal block size depends on test images. Thus one gets 13×13 for Lena, 12×12 for Jet plane, 17×17 for mandrill, 11×11 for Barbara, 12×12 for Tiffany and 9×9 for Boat. For rhombus 12×12 is a good compromise of block size obtained from Histogram shifting with threshold and flag bits [10]. Block sizes depend on test images, for fixed block size 12×12 rhombus loss is less than 0.15. Maximum loss in Mandrill is 0.12dB, by improvement loss is less than 0.1dB in central pixel, and so jet plane reaches

0.25dB. The current pixel estimation is given in equation (1). Least square predictor is used to minimize the sum of the squares of the prediction error [10].

IV. LOCAL PREDICTION BASED ON PREDICTION CONTEXT

The selected block sizes for prediction context are as follows, 8×8 for MED, 13×13 for GAP and 10×10 for SGAP, size of the optimal block is correlated with size of the prediction context. MED context contains smallest neighborhood, with smallest sliding block of 3 pixels, while GAP context of 7 pixels it contains largest block sizes. For SGAP and rhombus, 4 pixels are considered, optimal block sizes for SGAP is 10×10 and for rhombus context it is 12×12.SGAP context pixels are closer to each other than rhombus, as a result variation between context pixels of SGAP is lower than the neighborhood of rhombus[24].

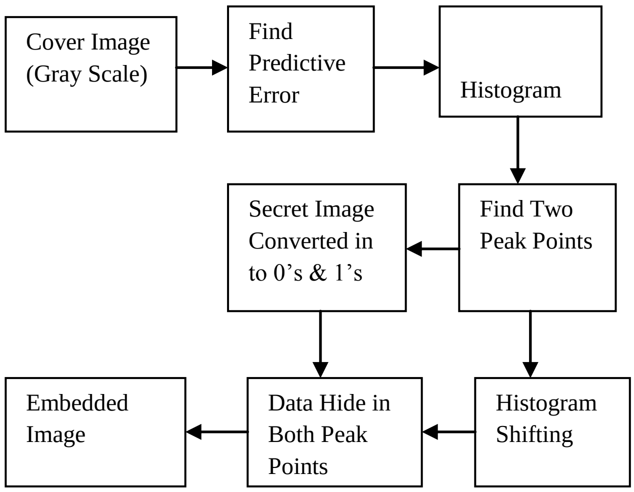
In MED context, it consists of 3 pixels($X_{m+1,n}$, $X_{m,n+1}$ and $X_{m+1,n+1}$),the Gap context consists of 7 pixels($X_{m+1,n}$, $X_{m,n+1}$, $X_{m+1,n-1}$, $X_{m+1,n+1}$, $X_{m+2,n}$, $X_{m,n+2}$ and $X_{m+2,n-1}$) ,and SGAP context consists of 4 pixels($X_{m+1,n}$, $X_{m,n+1}$, $X_{m+1,n-1}$ and $X_{m+1,n+1}$)[10]. For particular predictor size of the block is adjusted, for entire set of images block size is selected. Local prediction for GAP context based on test images of Barbara and Tiffany outperforms the rhombus at high capacity greater than 0.65dB. For Tiffany SGAP outperforms better than GAP, to achieve high capacity at rhombus context. To achieve high capacity the average PSNR is 0.5dB for Barbara and 0.27dB for tiffany [16].

V. LOCAL PREDICTION BASED ON HISTOGRAM SHIFTING

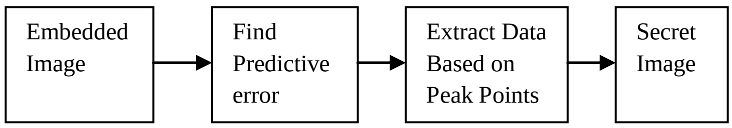
A. *System architecture*

Instead of considering single pixel, Histogram shifting technique taking difference of two adjacent pixels (i.e.) pixel pair, to increase data hiding capacity. Because of strong correlation of adjacent pixel value, many peak points exist around the zero value bin and many points exist were move away from the zero bin. Also, Histogram technique is used to prevent overflow and underflow. The luminance values of peak and zero points, each is represented by 8 bit, are treated as side information. For altered data hiding the range of luminance values would be treated. If the embedding bit of binary data is 1, the luminance value is increased by 1, if embedding bit is 0 the luminance value will be decreased by 1.

EMBEDDING PROCESS



EXTRACTION PROCESS



B. *COVER IMAGE*

Watermarking imperceptibly embeds data into a cover media, so that messages can be delivered secretly. Digital images are often used as carriers to deliver such messages. A cover image is an image that is used to carry data, and a secret image.

The histogram plots the number of pixels based on predictive error values in the image (vertical axis) with a particular brightness value (horizontal axis). Algorithms in the digital editor allow the user to visually adjust the brightness value of each pixel and to dynamically display the results as adjustments are made. Improvements in picture brightness and contrast can thus be obtained.

C. *EMBEDDING*

Histogram of input image is generated and is shifted from both ends to prevent overflow and underflow. This occurs by expanding the difference of adjacent pixels. Let us explain Histogram shifting concept by taking the histogram of cover image in fig.2.

Histogram of cover image is to prevent overflow and underflow that shift the histogram from both sides by units where L is the level. Imagine four is the value of level taken, and then H will be shifted by 2^4 units (i.e) 16 units from both sides as shown in fig.3

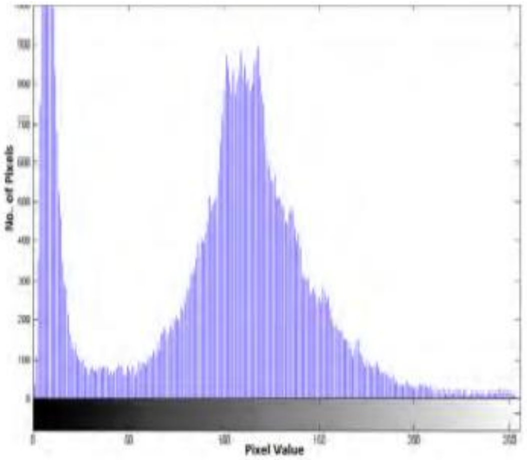


Fig.2 Original Histogram

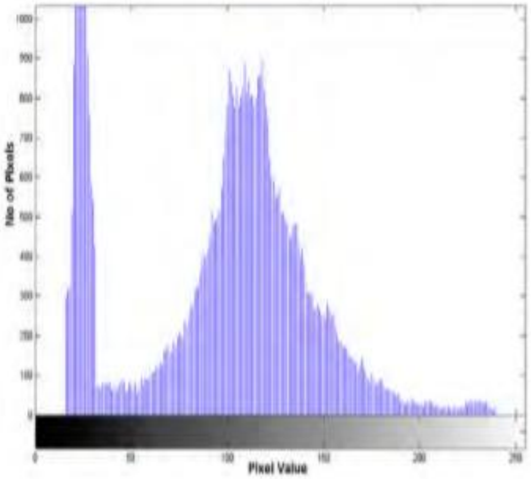


Fig.3 Shifted Histogram

D. EXTRACTION

At last predictive error values are calculated for embedded image. Then plot the Histogram based on predictive error values in the image; it is a plot of frequency occurrence of pixels along horizontal and vertical axis. Then shift the values to convert binary sequence to get secret image.

VI. CONCLUSION

The proposed use of Reversible watermarking based on prediction error histogram shifting technique. The Least significant bit is used for data insertion because of lossless compression, substitution is applied on LSB where the compression ratio is poor this limits the efficiency of Reversible watermarking. In proposed method efficiency is overcome by Histogram shifting, cover image is embedded with two secret image without lossless compression. An embedded image is passed to the user with any source like email, socket communication, bluetooth, by this way user can extract the data with copyright protection from reversible watermarking. The proposed method avoids overflow/underflow, and achieves high embedding capacity with low distortion

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