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A Novel Approach to Reversible Watermarking for Biomedical Imaging, Image Processing and its Qualitative Analysis

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Abstract — Hiding details or redundant information is the most preferred way to reduce data complexity. Watermarking techniques areintroduced to serve the purpose and foundusefulin hiding data or information like numbers, texts and images in digital media formats such as Audio, Video and Image.This paper represents the work carried on one of the fragile watermarking techniques i.e. reversible watermarking.The necessity of improvement in implementation of reversible watermarking technique offers the change in basic algorithm of this technique. The regular criteria in reversible watermarking to calculate threshold value for Prediction Error Expansion (PEE) is adapted with Otsu's method and a levelheaded enhancement in performance measures like PSNR can be seen.

Keywords — Data Hiding, Prediction Error Expansion, Reversible watermarking and Threshold value.

1. INTRODUCTION

Watermark is the visible embedded overlay on a digital photo that may be consisting of text, logo and copyright notice. The main purpose of using a watermark is to identify the desired objects and discourage its unauthorized usage. Even if watermark can't prevent unauthorized usage, it becomes more difficult for someone to claim someone else's photo or art work as their own.Reversible watermarking is a type of data hiding techniquewhere the contents(in digital format) of the host image can be embedded restored after data extraction [2]. In case of two watermarked images theoriginal contents of one image can be extractedand restored digitally. The need of reversible watermarking is theprecise recoveryof the original work image. It is very useful in RemoteSensing, Armed Image processing, Medical Image sharing, Multimedia Archive management and moving object tracking system etc. [1]. Some medical images like fluoroscope featured, vessels knee, X – Rayand MRI are given below.

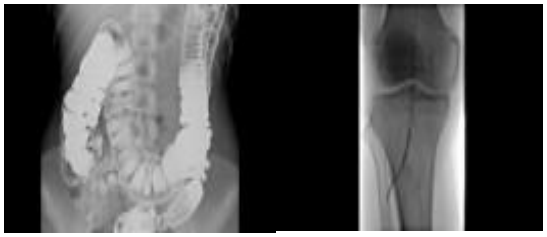

Fig. 1 Fluoroscopy featured and vessels knee

Fig. 2 X-ray and MRI

Based on few properties like Imperceptibility, Capacity, Security, Effectiveness and Data Payload overall efficiency of reversible watermarking can be enhanced. In general the techniques like Histogram Shifting(HS), Difference Expansion(DE), Interpolation technique, Integer transform and prediction Error Expansion(PEE)are used in reversible watermarking [1]. Authenticity of medical images is one of the prominent applications of reversible watermarking. In medical applications it is important to prevent unauthorized manipulation of digital images and to be able to demonstrate credibility and provenance. Reversible watermarking has been widely used to protect the copyright of digital images. The original image that embeds the watermark image is termed a watermarked image. The actual owner can prove his/her ownership for the suspected image by retrieving the watermark from a watermarked image andin turn determines the ownership for the suspected image.

2. LITERATURE SURVEY

Mehmet UtkuCelik et al.'s [3] proposed a novel framework for lossless (invertible) authentication watermarking, which enables less distortion reconstruction of the un-watermarked images upon verification. Its new frame allows authentication of the watermarked images before recovery of the original image. It should be increase the image with compacted file size and payload size. Mehmet UtkuCeliket al.'s [3] used the grayscale, 512*512 pixels image for to calculate the effectiveness, PSNR and payload size, here values are increased. But there is a problem of harms of images. To solve this loss of an image the Tsung-Yuan Liu et al.'s [5] proposed a novel method for generic visible watermarking with a capability of lossless image retrieval. This method can be characterized in two types which are visible and invisible. This technique used the deterministic one-to-one compound mappings of image pixel values for overlaying a variety of visible watermarks of arbitrary sizes on cover images. Result can be gives the efficiency of the proposed approach. This method gives the very less values of PSNR which is 12-14 dB than a novel framework for lossless (invertible) authentication watermarking [3] method. It gives better retrieval of an image. But there is a problem of distortion of images. To achieve the low distortion SitharaFathima et al.'s [6] proposed a transform that introduces lower distortion based on high performance predictor using Median Edge Detection (MED). The prediction error expansion is calculated for embedding patient information in the biomedical image. MED is used to accomplish less distortion. This method does not satisfy the requirement of imperceptibility, capacity and robustness. Then SumalathaLingamgunta et al.'s [7] proposed a 'Reversible Watermarking scheme for Image Authentication' (RWIA) using Integer Wavelet Transform that satisfies the requirements of imperceptibility, capacity, and robustness. SumalathaLingamguntaet al.'s [7] used Wavelet Tree, Histogram Modification and Watermark Embedding and Extraction to detect the different attacks.

L. M. Vargas et al.'s [8] proposed a reversible data hiding algorithm for the capacity problem. It provides good capacity by manipulating the correlation between neighboring pixels. Its application is suitable in medical, cartographic and forensic images because it's possible to recover the original image and what's more the watermarked image is of very good quality so it can be used in some cases not very challenging. Its applications include authentication, reliability control, or inserting metadata.

ChaiyapornPanyindee et al.'s [9] proposed a high performance reversible watermarking technique which involves adaptable predictor and sorting parameter to suit each image and each payload in order get lowest image distortion. There is a problem of more distortion and low efficiency of an image. ChaiyapornPanyindee et al.'s [9] has used PEE technique which having small PE values and harmonious PE sorting parameters will greatly decreases distortion of an image. Genetic algorithm is used to improve all parameters and produces the best results possible. ChaiyapornPanyindee et al.'s [9] used a Gaussian weight function for the predictor as it can be modifying for specific parameter values by changing only two variables. The prediction error rate cannot be used to sort data because hiding data causes sorting errors when the decoder attempts to reinterpret the data. It is used the optimization tool to achieve a different sorting parameters for instead of relying on the prediction error values. It can be produces significant development in an image quality.

C. Vinoth Kumar et al.'s [10] proposed a High Capacity Reversible Data hiding based on histogram shifting for Medical Images which is used to increase the hiding size. It is based on hierarchically separating a cover image into smaller blocks for data embedding using the histogram shifting method. In this method high data hiding size and high stego-image quality are accomplished. But there is a safety problem when data can be transmitted. Rhythm Katira et al.'s [11] proposed a Random Traversing Based Reversible Data Hiding Technique Using PE and LSB for security of transmitting data. Rhythm Katira et al.'s [11] proposed method Steganography and LSB, Knight's tour used. Steganography makes the data invisible by hiding it in the multimedia such as image, audio or video file and thus covers for its existence. Knight's tour isillustrated for increasing the safety of hidden data. To increase the hiding capacity, Rhythm Katira et al.'s [11] has increase the number of bits embedded but it was reduce the feature of image, so the proposed technique has higher hiding capacity and better image quality.

Anoja C.M. et al.'s [12] proposestheContext Based Reversible Watermarking. This is used to increase the graphical quality of the recover images and to increase the embedding capacity with less computational complexity and less distortion. Zahra Pakdaman et al.'s [13] proposed a Reversible Image Watermarking in Hadamard Domain to solve the capacity problem. This method does not requirement any location map, this property authorizations to increase the capacity.

A. Nagurammalet al.'s [14] proposesthe generic visible watermarking with a capability of lossless image recovery for the problem of imperceptibility and robustness of an image. A. Nagurammalet al.'s [14] proposed method, when image can be adapted into HDR image then it can erase image conversion from normal image. A. Nagurammalet al.'s [14] one-to-one compound mappings used that can map image pixel values to those of the desired visible watermarks. The algorithm HDR image can be identifying watermarking system with the requirements of imperceptibility and robustness.

Samira Bouchama et al.'s [15] proposed a Reversible data hiding scheme for the H.264/AVC video codec. This system is established for the embedding capacity and visual quality of images. Samira Bouchamaet al.'s [15] has used DCT based reversible data hiding method for

compacted image to H.264/AVC codec. Here PSNR can be reduced in dB and increases the bitrate in %. It can be improve the tradeoff between the embedding capacity, graphical quality and the bitrate of the watermarked video. To solve the security problem A. Umamageswari et al.'s [16] proposed a JPEG2000 algorithm and Arnold's cat map method (Arnold's Transform) to solve the problem of information security of patient's and increase the authentication for patient information. A. Umamageswariet al.'s [16] used Region of Interest (ROI) in an image and trying to embed data in Region of Non Interest (RONI). It can be improve the information security to maintain in secret, reliability and accessibility of the embedded data. Here, patient's info and syndrome information is embedded into DICOM images.

3. EXISTING SYSTEM

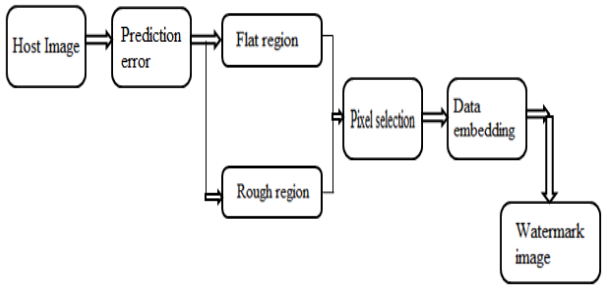

Fig. 1 System Architecture [2]

Above figure shows the system architecture of reversible watermarking. It takes an image input and calculatesits prediction error.Two different methods are used to calculate prediction error i.e. Median Edge Detector (MED) and Gradient Adjusted Prediction (GAP) [2]. As Gradient Adjusted Prediction (GAP) method considers more neighboring pixels than Median Edge Detector,it suffices to the requirement and hence, it is considered for implementation. The resultant image can be partitioned into two regions namely Flat region and Rough region [2]. Next the pixel selection process takes place based on capacity parameter and threshold value. Select smooth pixels for data embedding and ignore the rough ones and compare with prediction error.

3.1 Image Partition Algorithm [2]

Step1:Image Acquisition
Step2: Calculate forward variance (FV)
FV= square root $(0.25\sum(V_k-\bar{V})^2)$
Step3: Image partitioning based on FV.
If FV<threshold value
Then pixel will be considered as a smooth pixel
Else rough pixels.

3.2 Pixel Selection Algorithm [2]

Step 1: According to the capacity, the capacity parameter and threshold value are determinedwhichare further used in select pixels.
Step 2: Select relatively smooth pixels and ignore the rough ones.
Step 3: Compared with prediction error

3.3 Data Embedding Algorithm [2]

Step 1: Read the input image files, get the data matrixes of host and watermark.
Step 2: Calculate the prediction error using the GAP.
Step 3: Calculate the forward variance
FV= square root $(0.25\sum (V_k-\bar{V})^2)$
Step 4: Assume some suitable adaptive embedding threshold.
Step 5: Divide the image pixels by flat region and rough region using the FV.
Step 6: Find out the capacity parameter based on the capacity.
Step 7: Find out the Pixel Selection threshold. For this we required forward variance, backward variance & the gap.
Step 8: Embed the watermark data into the divided selected pixels and export the complete image data matrix.
Step 9: Store the auxiliary information into rows of watermarked image. This auxiliary information is required for extraction.

3.4 Data Extraction Algorithm [2]

It is the reverse process of Data Embedding.
Step 1: Extract the size of the watermark from the head of host image data
Step 2: Calculate the prediction error in each of the pixels. Similar to the embedding process.
Step 3: Divide the image pixels by flat region and rough region
Step 4: Take the pixel selections for the data extraction based on prediction error resulted between a threshold
Step 5: Extract the expanded bytes of watermark data until all bytes are extracted
Step 6: Recover the watermarked image

4. PROPOSED METHODThe adaptation of regular criteria in reversible watermarking to calculate threshold value for Prediction Error Expansion (PEE) with the Otsu's method in order to see a levelheaded enhancement in performance is focus of this research. Otsu's method is an image processing technique, used for calculating a threshold value and further defines the basic criterion for the conversion of a grey scale image into a binary image. By dividing pixels into two regions i. e. flat region and rough region (or smooth pixels and rough pixels), one can minimize the intra-class variance of the data contained within the class.

4.1 Algorithm for Proposed Method

Step 1: Read an Image
Step 2: Calculateadaptive embedding threshold value using greythresh function.
Step 3: Calculate forward variance and backward variance for pixel selects from smooth area.

Step 4: If adaptive embedding threshold> FV
Then selects smooth pixels else rough pixels.
Step 5: According to adaptive embedding threshold smooth pixels are compared with prediction error.
Step 6: Try to calculate the capacity parameter based on the capacity.
Step 7: Find out the Pixel Selection threshold i.e. Tps.
Step 8: Embed the watermark data into the separated selected smooth pixels. And transfer the complete image data matrix.
Step 9: Extract the size of the watermark from the original image data
Step 10: Calculate the prediction error in each of thepixels,similar to embedding process.
Step 11: Split the image pixels into flat region and rough region
Step 12: Take the pixel selections for the data extraction based on prediction error resulted between adaptive embedding thresholdvalue.
Step 13: Extract the expanded bytes of watermark data by following the reverse flow as that of Watermarking
Step 14: Improve the watermarked image

5. EXPERIMENTAL RESULTS

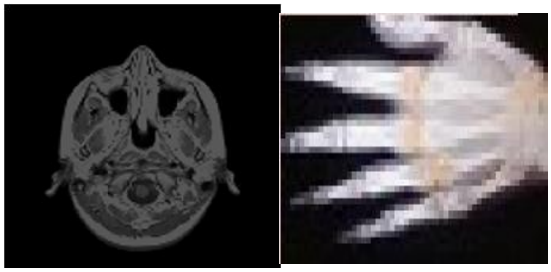

Fig. 2 (a) Original ImageFig. 2 (b) Watermark Image

Fig. 2 (c) Image Partition

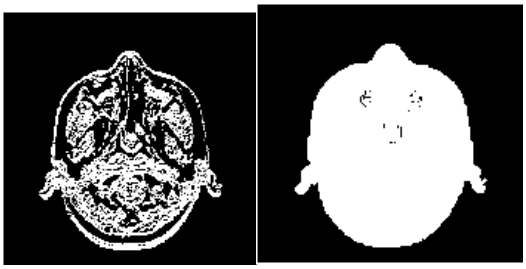

Fig. 2 (d) GAP Fig. 2 (e) Prediction

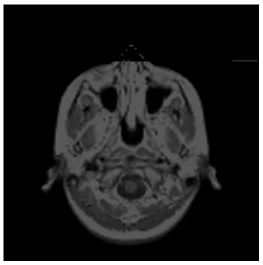

Fig. 2 (f) Watermarked Image

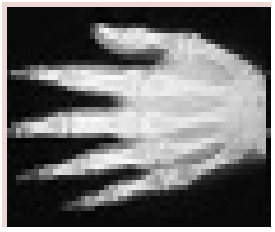

Fig. 2 (g) Extracted Image

For the experimental purpose, MRI imagesare taken as input; Fig. 2 (a) shows the original image. For watermarking we take Fig. 2 (b) as watermark image. Forward variance and backward varianceare computed for image partitioning in order to divide image pixels into rough pixels and smooth pixels. Fig. 2 (c) shows the image partition image. For gradient adjusted prediction (GAP) subtract the backward variance from the forward variance and it gives the predicted image as well as prediction error. Fig. 2 (d) shows the GAP image and Fig. 2 (e) shows the prediction image.After embedding the watermark image with original image, we get watermarked image, it is shown in Fig. 2 (f) watermarked image. Wecan extract the watermark image from the watermarked image at the receiving end; result shown in Fig. 2 (g) Extracted image.

Table (1)

Method	PSNR Value	Entropy	MSE
PEE (Existing Method)	15.7999	9.3754	30032
Proposed Method	20.0743	11.3859	31936

6. CONCLUSION

Reversible watermarking is a renowned technique in Image processing, it has deep roots and connections with fields like Information hiding, Biomedical Imaging, Remote Sensing etc.In reversible watermarking the use

of Otsu's method to find threshold value inhibits elementary characteristics of pixel selection as rough pixel and smooth pixel. Capacity Parameter directs the embedding of a certain amount of information with digital media formats.Apparently, Data/ Information embedding and extraction can be performed proficiently by fixing the criterion for calculating threshold with minimum impairment of original contents.

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