An Analysis of the Effectiveness of various Techniques in Reversible Watermarking in the field of Image Processing and Biomedical Imaging

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Abstract— one of the most favored way to lessen data complexity is to conceal details or redundant information. Watermarking is a technique which consists in inserting a robust and imperceptible brand in a host image, in order to defend it against illegal plagiarism. Being reversible, the watermarking information like numbers, texts and images can be embedded digital media formats such as Audio, Video and Image. Fragile watermarking techniques i.e. reversible watermarking is one of the most widely used watermarking techniques. This paper represents the work carried on the need of enhancement in performance of reversible watermarking technique that presents the change in fundamental algorithm of this technique. Prediction Error Expansion (PEE) for computing threshold value is tailored with Otsu's method which enables equable augmentation in performance measures like PSNR. The PSNR values are checked to evaluate the proposed watermarking technique.

***Keywords*:** Data Complexity, Reversible watermarking, Prediction Error Expansion, Fragile watermarking, Threshold value.

I. INTRODUCTION

The significance of digital watermarking techniques has increased over the last few years and is motivated by the need to provide copyright protection to digital works, such as images, audio, and video. Watermarking is the art of imperceptibly embedding image, a logo or a copyright text into a work. The main principle of using a watermark is authentication of the data and to discourage its unauthorized usage. Even if a watermark fails to prevent illegal usage, it becomes more difficult for encroacher to claim or justify his intrusion on other's work. Reversible watermarking is a technique that means after watermark information was embedded into the host data, original data can be restored while watermark information is extracted through a series of processes [1]. Because the reversible watermarking schemes can achieve lossless recovery, they can be widely used in military communication, medical image, and digital forensics fields [2]. Some of the medical images like X – Ray, MRI, vessels knee, are given below.

Fig. 1: X – Ray, MRI, vessels knee, Fluoroscopy and vessels knee

The overall competence of reversible watermarking can be improved based on by few attributes like Imperceptibility, Authenticity, Security, Capacity and Data Payload. The procedures like Difference Expansion (DE), Integer transform, Histogram Shifting (HS), Interpolation techniques, and prediction Error Expansion (PEE) are generally used in reversible watermarking. Authenticity of medical images is one of the high-flying applications of reversible watermarking. In medical applications it is important to prevent unofficial manoeuvring of digital images and to be able to exhibit reliability and provenance as many of the instances will be dealing with life and death issues. A small error may prove to be very expensive and may claim of patients.

Reversible watermarking has been widely used to protect the copyright of digital images. Image authentication techniques protect images from malicious manipulation at every stage of transmission and storage. Reliable image authentication technology must be able to protect an image from the time it was first produced until the final stage of use. The image that is embedded into the original image is termed as watermarked image. The actual owner can prove his/her ownership for the alleged image by reclaiming the watermark from a watermarked image and in turn determines the ownership for the actual image.

II. LITERATURE SURVEY

L. M. Vargas et al.'s [3] put forward a reversible data hiding algorithm for the capacity problem with an aim of reliability control and authentication. It offered good capacity by manipulating the correlation between neighboring pixels. It can be applied in medical, cartographic and forensic images because it‘s possible to recover the original image and mainly the watermarked image is of very good quality so it can be used in some cases not very challenging. Mehmet UtkuCelik et al.'s [4] put forward a novel agenda for lossless authentication watermarking that enables un-watermarked images to show less distortion reconstruction upon verification. Its novel frame allows authentication of the watermarked images before recovery of the original image. It increases the image with compacted file size and payload size with the utilization of the grayscale, 512*512 pixels image to calculate the PSNR and payload size, and its effectiveness. The values are increased. But there is a problem of degrading of images. To solve this Tsung-Yuan Liu et al.'s [5] proposed a new method for generic visible watermarking with a capability of lossless image retrieval. This method can be characterized in two types, visible and invisible. This procedure compound mapped the deterministic one-to-one image pixel values for overlaying a variety of visible watermarks of arbitrary sizes on cover images. This method gives very less values of PSNR which is 12-14 dB than a novel framework for lossless (invertible) authentication watermarking [4] method. It gives better retrieval of an image. But there is a problem of distortion of images.In order to achieve low distortion SitharaFathima et al.'s [6] projected a transform that bring in 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. But the downside being, the inability to satisfy the requirement of imperceptibility, capacity and robustness. 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 by means of Wavelet Tree, Histogram Modification and Watermark Embedding and Extraction to detect the different attacks. ChaiyapornPanyindee et al.'s [8] projected 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. [8] Used PEE technique 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 with Gaussian weight function for the predictor as it can be modify 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 can beused as the optimization tool to achieve different sorting parameters instead of relying on the prediction error values.C.Vinoth Kumar et al.'s [9] proposed a High Capacity Reversible Data hiding based on histogram shifting for Medical Images 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 for transmitting data.

Rhythm Katira et al.'s [10] proposed a Random Traversing Based Reversible Data Hiding Technique Using PE and LSB for security of transmitting data. 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 is illustrated for increasing the safety of hidden data. To increase the hiding capacity, the number of bits were embedded were increased.Anoja C.M. et al.'s [11] put forward the Context 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 [12] proposed a Reversible Image Watermarking in Hadamard Domain to solve the capacity problem. This method does not require any location map.A. Naguramma al.'s [13] put forward the generic visible watermarking with a capability of lossless image recovery for the problem of imperceptibility and robustness of an image when image can be adapted into HDR image then it can erase image conversion from normal image with 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 [14] proposed a Reversible data hiding scheme for the H.264/AVC video codec. This system established for the embedding capacity and visual quality of images by using DCT based reversible data hiding method for compacted image to H.264/AVC codec. Here PSNR can be reduced in dB and it increases the bitrates in %. It can improve the trade-off between the embedding capacity, graphical quality and the bitrates of the watermarked video.To resolve the security problem A. Umamageswari et al.'s [15] 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 using 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, reliability and accessibility of the embedded data. Here, patient's info and syndrome information is embedded into DICOM images.

III. EXISTING SYSTEM

Above figure below shows the system architecture of reversible watermarking. It takes an image input and calculates its prediction error. Two different methods are used to calculate prediction error i.e. Median Edge Detector (MED) and Gradient Adjusted Prediction (GAP) [3]. As Gradient Adjusted Prediction (GAP) method considers more neighbouring 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 [3]. Next the pixel selection process takes place based on capacity parameter and threshold value. It selects smooth pixels for data embedding and ignores the rough ones and compares with prediction error.

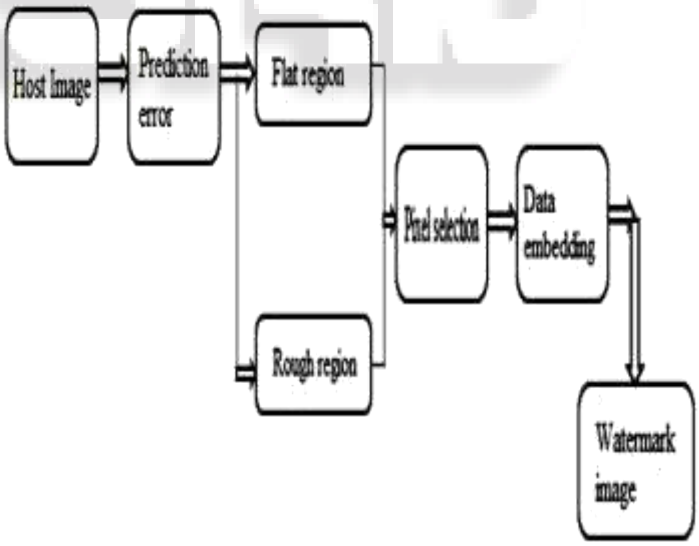

Figure 2: System Architecture

A. Image Partition Algorithm

Step1: Image Acquisition

Step2: Calculate forward variance (FV) FV= square root $(0.25\sum(V_K\text{-}V^{-})^2)$

Step3: Image partitioning based on FV. If FV<threshold value then pixel will be considered as a smooth pixel Else rough pixels.

B. Pixel Selection Algorithm

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

C. Data Embedding Algorithm

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 $(0.25\sum (V_K\text{-}V^-)^2)$
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.

D. Data Extraction Algorithm

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 thresholds.
Step 5: Extract the expanded bytes of watermark data until all bytes are extracted
Step 6: Recover the watermarked image

IV. PROPOSED METHOD

The Otsu‘s method in reversible watermarking is proposed to calculate threshold value for Prediction Error Expansion (PEE) to see a level-headed enhancement in performance. Otsu‘s method for calculating a threshold value is implemented and it 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.

A. Algorithm for Proposed Method

Step 1: Read an Image.
Step 2: Calculate adaptive embedding threshold value using grey thresh 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.
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 the pixels, 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 threshold values.
Step 13: Extract the expanded bytes of watermark data by following the reverse flow as that of Watermarking.
Step 14: Improve the watermarked image.

V. EXPERIMENTAL RESULTS

For the experimental purpose, MRI images are taken as input. Fig. 3 (a) shows the original image. For watermarking we take Fig. 3 (b) as watermark image. Forward variance and backward variance are computed for image partitioning in order to divide image pixels into rough pixels and smooth pixels.

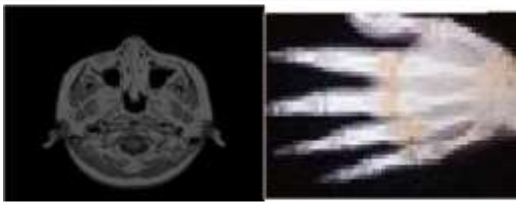

Fig. 3(a): Original image. Fig. 3(b): Watermark image

For gradient adjusted prediction (GAP) subtract the backward variance from the forward variance and it gives the predicted image as well as prediction error Figure 3(c) shows the image partition image, GAP image and prediction image from left to right.

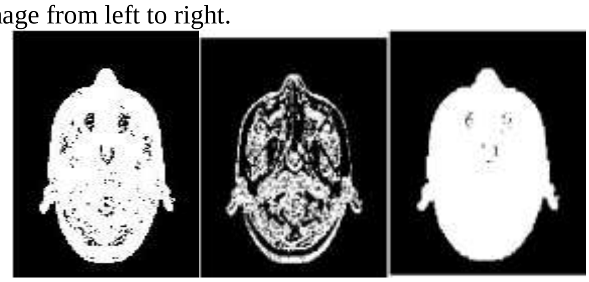

Fig. 3(c): Image Partition, GAP and Prediction

After embedding the watermark image with original image, we get watermarked image, it is shown in Fig. 3 (d) watermarked image. We can extract the watermark image from the watermarked image at the receiving end; result shown in Fig. 3 (e) Extracted image

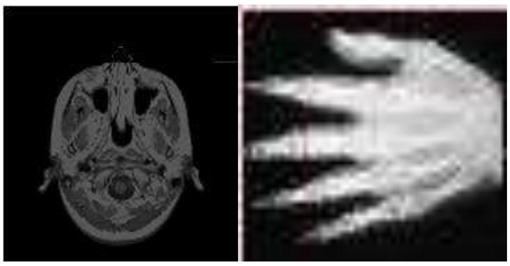

Fig.3 (d): Watermarked Image. Fig.3 (e): Extracted Image

Method	Entropy	MSE	PSNR value
PEE (Existing Method)	9.3212	30030	15.6999
Proposed Method	11.4658	31976	20.103

Table I Results of Entropy, MSE and PSNR

VI. CONCLUSION

A novel reversible watermarking scheme has a special feature that the original digital content can be completely restored. This feature is suitable for some important media, such as medical and military images, because these kinds of media do not allow any losses.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. By fixing the criterion for calculating threshold with minimum impairment of original contents, embedding and extraction of data/ Information can be performed proficiently.

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