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Reversible Image Watermarking Based on Histogram Shifting Technique: Review

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Abstract: Digital watermarking is a kind of data hiding technology. It is a way of embedding information (i.e., watermark) in multimedia data (image, audio or video), such that the embedded watermark can be later retrieved from the watermarked data for the purpose of content protection or authentication. Among different kinds of digital watermarking schemes, reversible watermarking has become a research hotspot recently. For about ten years, several reversible watermarking schemes have been proposed for protecting images of sensitive content, like medical or military images, for which any modification may impact their interpretation. These methods allow the user to restore exactly the original image from its watermarked version by removing the watermark. Thus it becomes possible to update the watermark content, as for example security attributes (e.g., one digital signature or some authenticity codes), at any time without adding new image distortions.

Keywords: Digital watermarking, reversible watermarking, digital signature, authenticity codes.

I. INTRODUCTION

Over the past few years, the enormous increase in the use of digital content has increased the issues such as online data vulnerability and copyrights violation. One of the prominent solutions is the watermarking of the digital content. However, watermarking can cause damage to the sensitive information present in the cover work, and thus at the receiving end, the exact recovery of cover work may not be possible. Reversible watermarking, also known as lossless watermarking, allows full extraction of the embedded information along with the complete restoration of the cover work. Reversible watermarking can thus be considered as a special case of watermarking.

During the last decade, reversible watermarking has found a huge surge of experimentation in its domain as there is a huge need to recover the original image after extracting the watermark arises in various applications such as lawenforcement, medical and military image system, it is crucial to restore the original image without any distortions.Encoding an identifying code into digitized music, video, picture or other file is known as a digital watermark. The main purpose to embed code into digital signal is to trace ownership or protect privacy.

If the reversibility property relaxes constraints of invisibility, it may also introduce discontinuity in data protection. In fact, the image is not protected once the watermark is removed. So, even though watermark removal is possible, its imperceptibility has to be guaranteed as most applications have a high interest in keeping the watermark in the image as long as possible, taking advantage of the continuous protection watermarking offers in the storage, transmission and also processing of the information. This is the reason why, there is still a need for reversible techniques that introduce the lowest distortion possible with high embedding capacity.

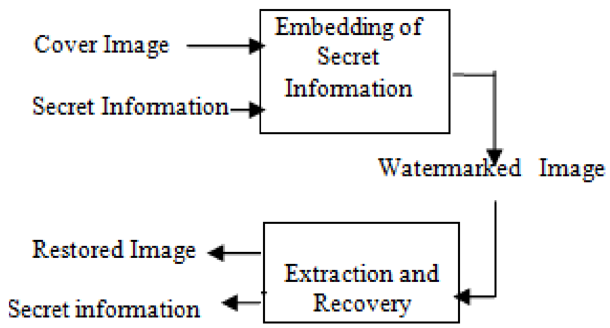

Figure 1: Basic Reversible Image Watermarking Scheme [1]

A general framework representing reversible image watermarking is illustrated in Figure 1. The sender embeds the secret informationto a cover imagein a manner that the receiver could extract the embedded message and also recover the cover image. The difference between watermarked image and cover imageis the distortion caused by the hiding process. Note that although the recovery phase guarantees the complete recovery of the original host image, it is still desired that the distortion caused by data hiding should be as small as possible.Reversible watermarking schemes can be divided into three categories: reversible watermarking based on lossless compression, reversible watermarking based on difference expansion and reversible watermarking based on histogram shifting.

II. LITERATURE REVIEW

Since the introduction of the concept of reversible watermarking in the Barton patent, several methods have been proposed. Many researchers have carried out research in the field of histogram modification based reversible watermarking.

Initially, Vleeschouwer et al. [2] presented circular interpretation based reversible watermarking. In their approach, image is divided into several blocks of neighboring pixels. Then, each block is split into two zones, and corresponding histograms are calculated. A bin is shifted in accordance with the value of corresponding watermark bit. If the bit is '1', shift the lowest bin to the highest one, and downgrade other bins. And if the bit is '0', then upgrade each bin and shift the highest bin to the lowest bin. Later, Vleeschouwer et al.[2] improved their work by introducing bijective transformation [3]. The high distortion caused by the shift of lowest and highest bin is handled by allowing at most two shifts. This method that fulfills all quality and functionalityrequirements of lossless watermarking.Additionally, the visual quality of the watermarked images does not suffer from the classic "salt-and-pepper" artifact.

In 2006, Ni et al. [4] developed a novel reversible watermarking approach based on image histogram modification. Before embedding, a pair of peak and zero points is selected from the histogram of the cover image. Only pixels with values between peak and zero points undergo modification during embedding process. However, the embedding capacity is restricted to the number of pixels present in the peak point in a histogram of the cover image.

To increase the embedding capacity of histogram based reversible watermarking techniques, different algorithms are reported.

Lin et al. [5] presented a multilevel reversible watermarking approach that utilizes the histogram of difference image for data embedding. The difference image is generated by taking the difference of two adjacent pixels of the cover image. The cover image is divided into a number of non-overlapping blocks, and then the difference block corresponding to each image block is generated. For data embedding, histogram modification method is applied to each difference block. But this technique suffers from large amount of overhead data i.e. storing the peak value information for each block.

In another work, Ni et al. [6] extensively investigated the Vleeschouwer et al. approach [3]. They concluded that this technique uses modulo-256 addition to tackle overflow and underflow problems, which causes salt and pepper noise. Ni et al. [6] thus proposed an approach, which does not suffer from salt and pepper noise.This paper identifying a robust statistical quantity based on thepatchwork theory and employing it to embed data, differentiatingthe bit-embedding process based on the pixel group's distributioncharacteristics, and using error correction codes and permutation scheme. Gao et al.[7] then highlighted the shortcomings of Ni et al.'s approach [6] and improved it.

Tsai et al. [8] proposed a subtly different approach. The difference between a basic pixel and every other pixel in the block is used rather than the difference of adjacent pixels. However, the prediction method used in [8] is less accurate, and the need for keeping the values of the basic unchanged pixels reduces the embedding capacity of the scheme. Kim et al. [9] proposed a novel method that exploits the spatial correlation between sub-sampled images. A reference sub-sampled image is first selected from several sub-sampled images, and then differences between reference and other sub-sampled images are generated. Embedding is then performed by modifying the difference histogram.

Kamran et al. [10] improved the work reported by Gao et al. [7] by proposing the embedding of correct message bit only. Due to this improvement, BCH coding and permutation scheme is not required which increases thewatermark embedding capacity. Kamran et al. [10] also reported a novel approach which utilizes the concept of down sampling for performance improvement. Down sampling provides two sub-sampled versions of the cover image i.e., reference and data hiding. Then the blocks are generated by using these two sub-sampled versions. Embedding is carried out in the blocks through histogram modification. Further, to make the technique a blind one, Kamran et al [10] embedded the location map (LM) in the watermarked image.

Some robust semi-blind reversible watermarking techniques employing statistical quantity histogram are also introduced. An et al. [11] presented a semi-blind robust reversible watermarking scheme, which utilizes statistical quantity histogram shifting for embedding, and the extraction procedure is modeled as a classification problem in integer wavelet domain.

III. CONCLUSION

In this paper, we have provided an introduction the reversible watermarking schemes. Reversible watermarking schemes can be divided into three categories, reversible watermarking based on lossless compression, difference expansion and histogram shifting. This paper provides basic mechanism of reversible watermarking and by reviewing some fundamental papers in this area, momentarily discussed development and advantages of different reversible watermarking techniques based on histogram shifting.Histogram shifting based techniques reduces the size of auxiliary data and is either semi-fragile or robust.

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