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REVERSIBLE DATA HIDING FOR SECURITY APPLICATION

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ABSTRACT

In this topic, a novel reversible that is lossless data hiding (RDH) technique is proposed for digital image. The proposed technique enhances the contrast of host image to its visual quality, instead of keeping it PSNR value high. Enhanced images can be achieved by histogram equalization. The highest two bins in the histogram are found out and selected for data embedding so that histogram equalization can be performed by repeating the same process. For the recovering the original image, the location map is embedded into the host image, together with the message bits and other side information. It is the first algorithm that achieves image contrast enhancement by RDH. The visual quality can be preserved after a considerable amount of message bits have been embedded into the contrast-enhanced images.

There are various types of reversible data hiding and image contrast enhancement. In this technique that is in image contrast enhancement by reversible data hiding algorithm the both embedding a data in an image and enhancing the contrast of the same image can be done simultaneously. The exact data which is embedded in an image can be extracted with better visual quality of an image. This process is even better than three specific MATLAB functions used for image contrast enhancement.

Keywords: Contrast Enhancement, Histogram equalization, Reversible data hiding, Stenography, Visual quality.

I. INTRODUCTION

Reversible data embedding has drawn lots of interest recently. Being reversible, the original digital data from image can be completely restored. Reversible Data Hiding (RDH) has been intensively studied in the field of signal processing. It is also referred as invertible or lossless data hiding, RDH is to embed a piece of information into a host signal to generate the marked image, from which the original signal can be exactly recovered after extracting the embedded data. The technique of RDH is useful in applications where no permanent change is allowed on the host signal or in host image. The hidden data usually can be a string of binary bits (e.g., digital signature), a logo image, identification (ID) number, or any information that is useful [1].The goal of this work is to do the data embedding and contrast enhancement simultaneously. In this algorithm, image contrast enhancement can be achieved by histogram equalization. By modifying the histogram of pixel values, data embedding and contrast enhancement can be performed at the same time.

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In the algorithm firstly, the two peaks (i.e. the highest two bins) in the histogram are found out. The bins between the selected two peaks are unchanged while the outer bins are shifted outward so that each of the two peaks can be split it into two adjacent bins. To increase the embedding capacity, the highest two bins in the modified histogram can be further chosen to split, and so on until satisfactory contrast enhancement effect is achieved. Due to data embedding overflow and underflow problem may occur [2]. To avoid the overflow and underflow due to histogram modification, the bounding pixel values are pre-processed and allocation map is generated to memorize their locations. For the recovery of the original image, the location map is embedded into the original image, together with the message bits and other side information. The visual quality of an image is increased with the higher PSNR value [3].

II. METHODOLOGY

There are two processes in this. The below processes are used for embedding he data and exact recovery of an image. They are as follows,

2.1 DATA EMBEDDING PROCESS

2.2 EXTRACTION AND RECOVERY PROCESS

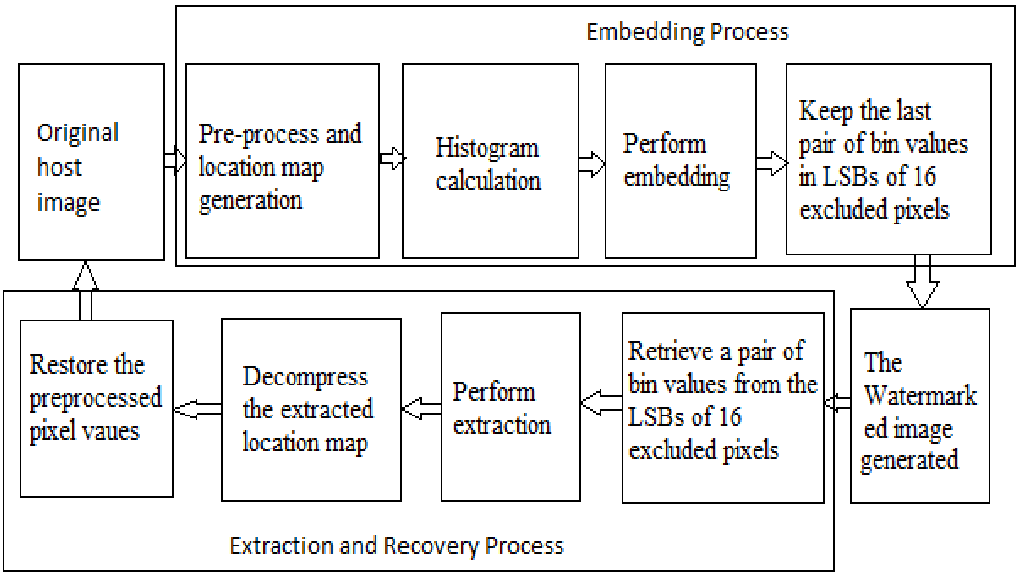

Figure 1: Block diagram for proposed work

2.1 DATA EMBEDDING PROCESS

The data embedding process contains various blocks. Data embedding is nothing but to embed the piece of information or message in an image. There are various types of embedding the data in an image.

The original image is pre-processed first and location map is generated then the histogram is calculated and embedding of data is performed. Using data embedding process the watermarked image is generated.

2.1.1 Pre Process And Location Map Generation

Determine clip limit from the normalized value if necessary, pad the image before splitting it into regions. Process each contextual region thus producing gray level mappings: Extract a single image region, make a histogram for this region using the specified number of bins, clip the histogram using clip limit, create a mapping (transformation function) for this region.

The pixels in the range of [0, L-1] and [256-L, 255] are processed as mentioned in the above section. The location map is generated and the location of those pixels are recorded and compressed by the JBIG2 standard to reduce its length [8]. The location map contains the location information of all the selected expandable pixels values. We create a one-bit bitmap as the location map, with its size equal to the numbers of pairs of pixel values. For example, if we use the horizontal pairing through all pixels, the location map will have the same height as the image, and half the width. Here histogram shifting technique is presented to embed a location maps for capacity control. The location map is also used to reverse the process and get the knowledge of the highest peak points In order to achieve lossless data embedding, a location map is employed to record the shifted pixel pairs. The location map is then compressed by lossless or reversible compression method and concatenated with message to be superimposed on the host signal. For restoring the host image again location map is required [14] .

To avoid the overflows and underflows due to histogram modification, the pixel values are pre-processed and a location map is generated to memorize their locations. Overflow is the condition the value exceeds above 255. Underflow is the condition that the gray value falls below 0 at the gray. The location map is embedded into the host image, together with the message bits and other side information to recover the original image.

2.1.2 Histogram Modification

Data embedding is done by histogram modification. The histogram in image processing is the operation by which the occurrence of each intensity value in the image is show. The histogram is a graph showing the number of pixels in an image showing different intensity value found in that image. There are 256 different possible intensities for an 8-bit grayscale image, and so the histogram of such image will graphically display 256 numbers showing the distribution of each pixel amongst those grayscale values. Histogram equalization is the technique in which the dynamic range of the histogram of an image is increased. HE assigns the intensity values of each pixel in the input image such that the output image contains a uniform or same distribution of intensities. It improves contrast of image and the goal of HE is to obtain a uniform histogram. This technique can be used on a whole image or just on a single part of an image. This method usually increases the contrast of many different images, especially when the usable data of the image is represented by close contrast values. Through this adjustment in image, the intensities can be better distributed on the histogram obtained. This allows the lower local contrast to gain a higher contrast without affecting the global contrast of original image. Histogram equalization accomplishes this by spreading out the most frequent intensity values. The method of HE is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, this method can lead to views structure of bone in x-ray images, and to better detail in photographs that are over or under-exposed. There are various methods of histogram modification. Here the pixels for histogram are modified [7].

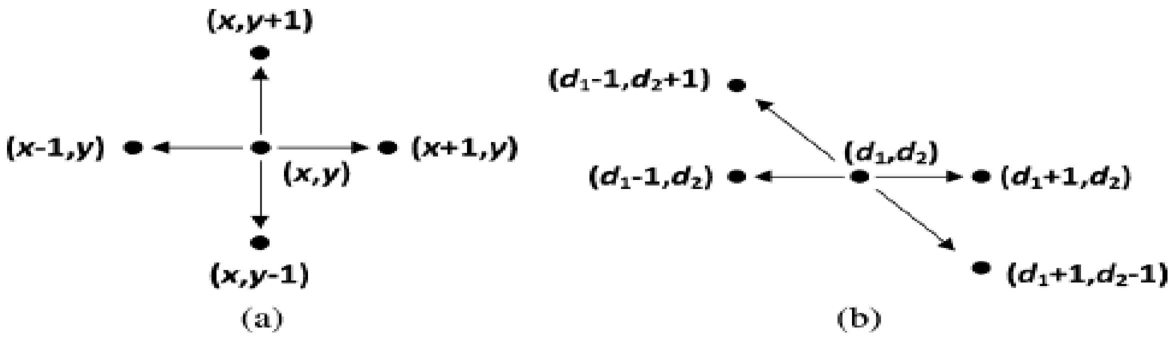

Figure Error! No text of specified style in document.**: MODIFICATION OF HISTOGRAM**

2.1.3 Perform Embedding

The algorithm can be used for both gray level image and colour image. Given an 8-bit gray-level image I, the histogram of image can be calculated by counting the pixels with a gray-level value j for j $\in$ {0, 1, … , 254, 255}. We use h_I (j) to denote the image histogram so that h_I (j) represents the number of pixels with a value j. Suppose I consists of N different pixel values. Then there are N number of nonempty bins in h_I, from which the two peaks (i.e. the highest two bins from histogram) are chosen and the corresponding smaller and bigger values are denoted by I_S and I_R, respectively. For a pixel counted in h_I with value i, data embedding is performed by,

$$i' = \begin{cases} i-1 & for & i < I_s \\ I_s - b_k & for & i = I_s \\ i & for & I_S < i < I_R \\ I_R + b_k & for & i = I_R \\ i+1 & for & i > I_R \end{cases} \qquad (1)$$

Where i' is the modified pixel value, and b_k is the k-th message bit (0 or 1) which is to be hidden. By applying Eq. (1) to every pixel counted in h_I, totally $h_I(I_S)+h_I(I_R)$ binary values are embedded. Given that there is no bounding value (0 or 255) in I, there will be N+2 bins present in the modified histogram. That is, the bins between the two peaks are unchanged while the outer one pixels are shifted outward so that each of the peaks can be split into two adjacent bins (i.e. I_S-1 and I_S, I_R and I_R+1, respectively).

2.1.4 Water Marked Image

After embedding the data in a host image we get the watermarked image. Watermarking technique can be classified into two different types. In the first type the watermark from image is visible i.e. different text can be inserted and are visible. The second technique is used for applying watermarks to the images, videos, which are invisible. This invisible technique is called as digital watermarking technique. The digital watermarking technique can be used in many applications, like for providing copyright protection or secured data to the films, videos, etc. The digital watermarking technique is a more secured one as the watermark from image is not visible, so if the intruder views the content of the image he will not be aware of the watermark which is present in the image. So if the intruder modifies the image it will be known to the receiver after receiving the image. The receiver after receiving the image will see that the watermark from image has been changed and will be aware that the image has been modified [15].

The watermarking process is usually irreversible degradation of the original medium. Although this degradation is slight but it may not be acceptable to some applications, such as military uses, medical uses. However, these applications may tolerate the addition of noise if the watermark from can be removed after decoding. After this removal the original medium without any reference to information beyond what is available in the watermarked medium itself is restored. The amount of tolerance to the watermark from image varies from one application to another application. Although some applications require high signal-to-noise ratio (SNR), many others accept low SNR

The last 16 pixels from histogram is excluded as we have to extract the embedded data from the image. To form the marked image the lastly split peak values are replace the LSBs of 16 extended pixels. Reversible watermarks are used to restore the original cover content from image completely after the extraction of watermark. The watermarked image is further used for extraction and recovery of an image.

2.2 EXTRACTION AND RECOVERY PROCESS

In extraction and recovery process the exacted embedded data and the original image is recovered. The extraction and recovery process contains various blocks. For exact recovery of an image the watermarked image is used. The watermarked image is pre-processed first and embedded data is extracted. The 16 excluded bins are considered and then extraction process is carried. The image obtained after extraction of data is contrast enhanced image with higher visual quality.

2.2.1 Retrieve Of Bin Values

The LSBs of 16 excluded pixels are retrieved so that values of last to peaks which are split are known. Then the L pairs of extraction are performed. To get the exact value of two selected highest bins the last 16 bins from the histogram is excluded. These excluded pixels are required for extraction on the embedded message bits.

2.2.2 Perform Extraction

For extraction the equation (2) is used. The peak values I_S and I_R should be provided to embedded data. The least significant bits (LSB) of excluded pixels are collected and included in the binary values to be hidden. After applying Eq. (1) to each pixel h_I counted in for data embedding process, the values I_S of I_R and (each with 8 bits) are used for replacing the LSBs of the 16 excluded pixels by bitwise operation. To extract the embedded data, the peak values need to be retrieved and the histogram of the watermarked image I' is calculated excluding the 16 pixels aforementioned. Then the following operation is performed on any pixel counted in the histogram and with the value of $I_S - 1, I_{S,}$ I_R or $I_R + 1$.

$$b'_k = \begin{cases} 1, & if \quad i' = I_S - 1 \\ 0, & if \quad i' = I_s \\ 0, & if \quad i' = I_R \\ 1, & if \quad i' = I_R + 1 \end{cases} \tag{2}$$

Where b'_k is the k-th binary value which is to be extracted from the marked image I'. The extraction operations are performed same as that of the embedding operations.

2.2.3 Decompress The Extracted Location Map

The original image is compressed while location maps. The location maps which are compressed is obtained from extracted message or binary values or decompressed to original size of an image. For complete recovery, the location map with same size as original image is generated by assigning 1 to the modified pixel and 0 to the unchanged one.

2.2.4 Restoring The Pixel Values:

The modified pixels in pre-process are identified with the help of decompressed maps. Among them, a pixel value is subtracted by if it is less than 128, or increased by otherwise. In the data extraction and recovery process, location maps can be obtained from the data extracted from the marked image so that the pixels modified in the pre-computed process can be identified. The recovery operation is carried out by processing all pixels expected the 16 excluded pixels with equation (3). The recovery process and data extraction is repeated until all the split peaks are restored and embedded with them are extracted. By extracting data and restoring the original values of those pixels accordingly, the original image can be recovered back from the marked image. According to equation (1), the following operation is performed on every single pixel counted in the histogram to recover its original value,

$$i = \begin{cases} i'+1, & for \quad i' < I_S - 1 \\ I_S, & for \quad i' = I_S - 1, \; or \quad i' = I_S \\ I_R, & for \quad i' = I_R, \; or \quad i' = I_R + 1 \\ i'-1 & for \quad i' > I_R + 1 \end{cases} \tag{3}$$

For reversible data hiding algorithm, it is required that all the pixels counted histogram image are within {0, 1, … , 254, 255}, overflow and underflow will be caused by histogram shifting. Pixel modification cannot be done if the pixel gets saturated, that is if overflow of pixel or underflow of pixel occurs. Hence to avoid overflow and underflow, the histogram needs to be pre-processed before the histogram modification operations are done. Specifically, the pixel values of 0 are modified to 1 and values of 255 are modified to 254, respectively. Therefore, no overflow or underflow will be caused because the possible change of each pixel value is +1 and -1. To get the pre-processed pixels, a location map of the same size as the original image is obtained by assigning 1 to the location of a modified pixel, and 0 to the unchanged pixels. The location map can be pre computed and included into the binary values to be hidden. The pixels modified in the pre-computed process can be identified after extraction of data from the marked image. By extracting data and restoring the original values of those pixels accordingly, the original image can be completely recovered from the marked image.

III. CONCLUSION

The contrast enhancement property can be proposed with new reversible data hiding algorithm. Basically, the two peaks or highest two bins in the histogram s selected for embedding the data in a host image so that histogram equalization can be performed simultaneously by repeating the process. To overcome the overflow and underflow, histogram shifting is done. Image contrast can be enhanced by splitting a number of histogram peaks pair by pair. Compared with the special MATLAB functions, the visual quality of the contrast-enhanced images generated by this algorithm is better preserved. By this algorithm the original image can be exactly recovered without any additional information. Hence this technique makes the image contrast enhancement reversible.

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