Quantum Pulse:
Journal of AI, Data Science & Systems Engineering
ISSN: XXXX-XXXX | Volume 1 Issue I July - December 2025 | Inaugural Edition | QP05

REVERSIBLE IMAGE DATA HIDING WITH CONTRAST ENHANCEMENT

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ABSTRACT: A novel approach to digital image processing is described in this research as reversible data hiding (RDH). Keeping the PSNR number high isn't given much weight in the proposed strategy. Conversely, it enhances the visual appeal of a primary image by drawing more attention to the contrasts between its constituent layers. The two largest histogram bins can hold data. It becomes more simpler to apply the approach to equalize the histogram repeatedly in this way. There is additional data in the host image in addition to the message bits. Thanks to this, we can get the original photo back to its original state. Both sets of images prove that the strategy is effective. Using reversible data hiding (RDH) technology to enhance contrast appears to be a first. Even after adding several message bits to images to make them more readable, the study found that the images maintained their visual integrity. When compared to three other popular MATLAB methods, this one significantly boosts image contrast.

Keywords: RDH, MATLAB, Image, Histogram.

1. INTRODUCTION

An extensive study of RDH has been carried out by signal processing experts. Reversible data hiding, or RDH, adds data to a host signal to make a marked signal. This makes it possible to get the inserted data out and then get back to the original signal. RDH is helpful in tricky situations where the host signal can't be damaged permanently. The most common algorithms in the books are designed to add watermarks to digital images or hide data.

The image quality and concealment rate shown are used to judge how well the RDH method works. When the concealment rate goes up often, it often changes the visual material, which is called a trade-off. When the peak PSNR of the picture histogram changes, it makes distortion embedding less possible. Current methods use surrounding pixel correlations to handle prediction errors that are spread out and stop data hiding distortion. A picture named by a prediction error-based method has a high PSNR, but the quality of the image is lower because of embedding distortion. When compared to better picture quality in low light, high PSNR is not as important. When looking closely at medical or satellite pictures, contrast enhancement is a must. Even though the PSNR is low, the enhanced image has more information. We don't know of any RDH method that improves the contrast of the host picture. The goal of this study is to come up with an RDH method that improves contrast instead of just keeping the PSNR high.

Histogram normalization can make contrast better. The method changes the pixel value histogram to add more information and make the contrast better.

Find the two highest points, or peaks, of the graph. The bins next to each peak are made bigger, but the bins in the middle of the peaks stay the same. To increase embedding capacity, the two highest bins of the new histogram can be split into smaller groups. This can be done over and over until the desired contrast enhancement effect is reached. You can fix histograms that are too full or too empty by preprocessing the values of the border pixels and making a location map to show where they are. The message bits, position map, and other data needed to reconstruct the original picture are in the host image. This makes it possible to get back whole photos and extract info that hasn't been processed. There were two sets of pictures used to show how well the plan worked. As far as we know, this is the first picture contrast enhancement method based on RDH. The test results show that adding a lot of message bits to images that have been contrast-enhanced is a better way to keep the quality of the pictures than using three MATLAB methods for image contrast enhancement.

OBJECTIVES

The objectives of "Reversible image data hiding with contrast enhancement" are

- To attain complete reversibility, significantly enhance image clarity, segregate data, and reduce noise.
- To know that we are aware they can access the internet.
- To verify RDH ensures secure data transmission through an unreadable third-party technique.

2. SYSTEM DEVELOPMENNT

Reversible and lossless data embedding can be employed to incorporate payloads into digital images. Data embedding is inadvisable as it may compromise image quality. Reversible data integration following data extraction enhances both the appearance and functionality of the system. Reversible data embedding enables the encryption of data within digital images, ensuring that it is accessible solely to authorized users. Here are several criteria to evaluate the apparent reversibility of a data-embedding method:

- Data embedding capacity limit
- Visual quality
- Complexity

Reversible data embedding is preferable as it preserves the integrity of the data without alteration. The knowledge that an entity possesses can alter it in several manners. In confidential medical and military data, even a minor alteration in pixel value can result in significant issues. All information is significant in this context. Due to the significant resemblance between the implanted and original images, reversible data implantation can be covertly utilized for communication with others. Two techniques can be employed to conceal substantial quantities of data:

Method of reversible data hiding

Method for concealing irreversible data

The message signal and original cover are preserved as components of the data concealment technique. This approach acquires the touch signal discreetly. This explains the prevalence of concealing data in a reversible manner.

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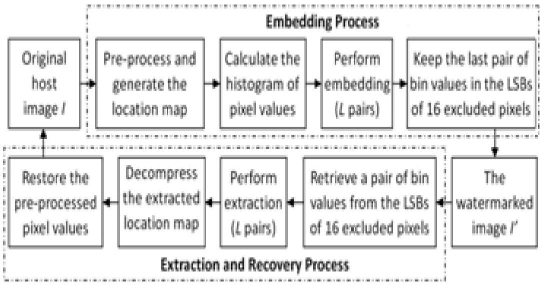

Fig. 1. The suggested RDH algorithm

Matlab's pixel value matrix process for any image is:

I <256x256 uint8>

	1	2	3	4	5	6	7	8	9	10
1	171	160	147	138	121	109	93	81	70	
2	82	73	67	64	65	72	79	90	103	
3	104	112	126	143	163	179	193	201	204	
4	205	210	209	203	193	184	170	153	133	
5	135	123	108	93	80	77	74	73	73	
6	72	81	92	103	116	131	149	162	173	
7	150	187	198	208	217	224	227	223	200	
8	165	215	209	199	182	160	149	135	111	
9	91	118	94	86	77	70	71	77	85	
10	83	85	104	112	129	142	156	166	177	
11	115	146	193	194	194	191	177	175	164	
12	127	130	150	129	118	106	91	86	81	
13	122	89	78	72	70	71	73	72	75	
14	131	103	77	74	67	63	59	53	44	
15	81	59	41	34	27	21	18	15	14	
16	21	19	18	17	17	18	17	17	17	

Fig2.Imagine yourself as a matrix.

Total no. of pixels in image = no. of rows * no.of columns= 256 *256
= 65536 pixels
Intensity value is calculated from the following gray scale. Where, 0 = Black, 2:

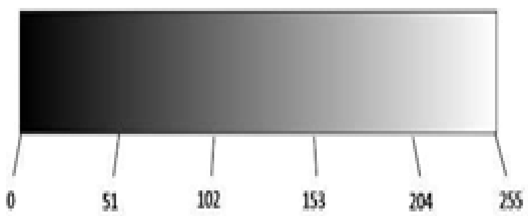

Fig 3.The grayscale scale

3. DATAEMBEDDING BY HISTOGRAM MODIFICATION

Utilizing the same technique to color photographs is as straightforward as using it to monochromatic images. Utilize the value j = 0 to generate the histogram of an 8-bit grayscale image with values ranging from j = 0 to 255. To display the histogram of the image, hI(j) represents the quantity of pixels with value j. Consider N numbers representing pixels. The subsequent step involves selecting the two greatest peaks (bins) from the N nonempty bins in hI. The fundamental value for IS is 0, while the value for IR is 1. For count i frames, the information is embedded.

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

Histograms display the frequency of image intensity. It displays the number of pixels for each intensity.

Fig4.Originalimage

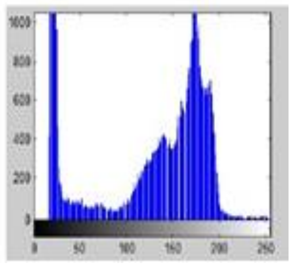

Fig5.Histogram

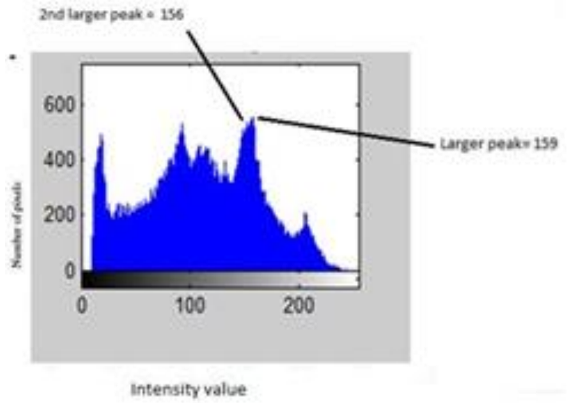

Fig6.Histogram

A more pronounced IR peak exists. The trigger IR is 159, and the IS is 156. This is the tallest summit extant.

where i represents the modified pixel value and bk is the kth bit of the confidential message (0 or 1). Equation (1) demonstrates that each hI pixel can be represented by either hI(IS) or hI(IR). This modified histogram will consist of N+2 segments due to the absence of a boundary number. Preparation is essential. By relocating the outer bins, we may divide each peak into two adjacent bins, designated as IS-1 and IS, and IR and

IR+1. The bins remain consistent between the two peaks. To scan images in Matlab, adhere to the following procedures:

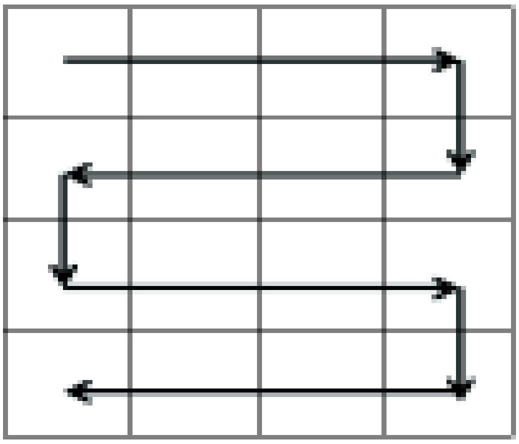

Fig7.Scan in reverse order

The data from IR and Peak Is will be consolidated. The quantity of IS and IR pairs required to retrieve the stored information. Enhance the capacity for embedding. Simply search for the phrase "image security."

To obtain embedded information, you must provide peak numbers. If you prefer not to, refrain from include those 16 photographs in the histogram. The least significant bits (LSBs) of binary codes are concealed within pixels. The 16 vacant low-level bits (LSBs) are substituted by 8 bits of information retrieval (IR) and information storage (IS) for each pixel containing data subsequent to the application of Eq. (1). Upon determining the image's peak values and histogram, the recorded data can be retrieved by eliminating the 16 pixels.

$$b'_k = \begin{cases} 1, & \text{if } i' = I_S - 1 \\ 0, & \text{if } i' = I_S \\ 0, & \text{if } i' = I_R \end{cases} \quad (2)$$

$$i = \begin{cases} i' + 1, & \text{for } i' < I_S - 1 \\ I_S, & \text{for } i' = I_S - 1 \text{ or } i' = I_S \\ I_R, & \text{for } i' = I_R \text{ or } i' = I_R + 1 \\ i' - 1, & \text{for } i' > I_R + 1 \end{cases} . \quad (3)$$

Subsequently, the IS-1, IS, IR, and IR+1 values are incorporated into each pixel inside the histogram.

bK denotes the kth binary number extracted from image I. The procedures for both extraction and rectification are identical. Considering the formula. Follow these steps to revert all histogram points to their original values:

We utilize the retrieved binary integers to restore the original least significant bits (LSBs) of the 16 missing pixels. Restore the removed pixels to revert the image to its original state.

Pre-Process for Complete Recovery

The approach is applicable solely when the hI pixel values range from 1 to 254. The histogram may shift above or below the line, depending on the pixel values surrounding it, which can be either 0 or 255. The histogram will be processed prior to any modifications, hence this will not occur. The number 0 transforms into 1, while the number 255 converts to 254. Overflow or underflow is impossible since each pixel can only shift by one or one and a half positions. To revert to the original pixels that remain unaltered, we create a location map identical in dimensions to the original image, assigning a value of 1 to each modified pixel and a value of 0 to each unchanged pixel. This comprises the sixteen absent pixels. Maps derived from concealed binary data can be utilized. Utilizing the data from the extracted labeled image, one may identify the pixels that altered between extraction and recovery. The entire image can be recreated by altering the values of these pixels.

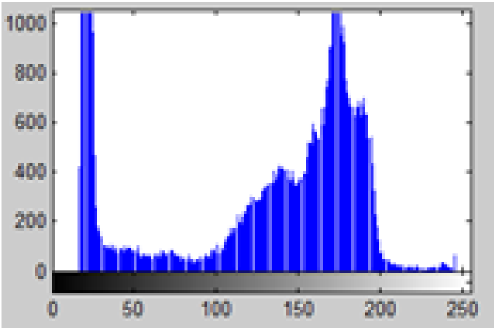

Fig8. Histogram that has been rearranged

The primary advantage of adjusting the histogram is the elimination of overflow and underflow. When incorporating grayscale or negative watermarks into images, ensure that there is no underflow or overflow. The existing system is ineffective, resulting in overflow, underflow, and distortions.

Contrast Enhancement

Contrast enhancement modifies the pixel colors to utilize a greater range of the image's bins. The contrast can be enhanced by modifying the pixel value graph. To separate the two peaks into nearby bins, we can select the two largest histogram bins, exclude the bins between the peaks, and reposition the outer bins further apart. This approach enhances contrast while also incorporating additional information. The top two bins of the histogram should contain additional sections to enhance readability and facilitate data accumulation. A replica of the original image is created by embedding the message bits, position map, and additional data into the cover image.

Histogram equalization enhances contrast by modifying image intensities through the addition or subtraction of data from IR and Is. The additional two peaks observed are designated as IR.+1 and Is 1. Data integration and contrast enhancement are not distinct processes.

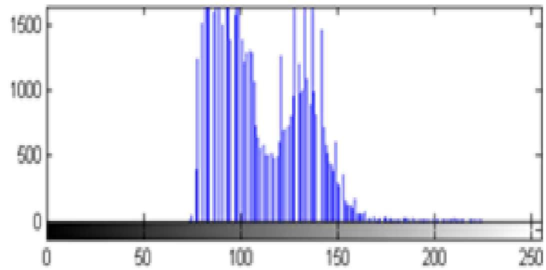

Fig9.The first histogram

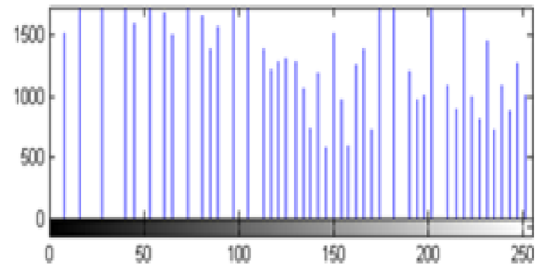

Fig.10Histogram with Equivalents

Due to the requirement for the message bits to contain nearly equal quantities of 0s and 1s, the histogram's two peaks are divided into adjacent groups that exhibit comparable or identical heights. To enhance the concealment rate, the equation divides the two largest bins of the adjusted histogram. Each individual point on the chart. Segment each peak into two adjacent bins of equal height. This will render the histogram more uniform. Data integration and contrast enhancement are not distinct processes. During pre-processing, L varies from 0 to L-1 for each pixel value range and from 256-L to 255 for each pixel value range. L is a positive integer. Creating a position map is straightforward by assigning 1s to altered pixels and 0s to unchanged pixels.

Prior to incorporating the location map into the host image, it can be assessed and resized. They consist of L, representing the dimensions of the compact location map, along with the values of the two preceding peaks and the two subsequent peaks that require division. Equation (2) is employed to obtain the final split peak values and their corresponding data. The provided expression can be utilized to rectify and reconstruct the histogram. Pairwise processing can be employed to extract data from distinct peaks. The retrieved data is utilized to create the position map, illustrating the alterations in pixel values during pre-processing.

4. PROCEDURE OF THE PROPOSED ALGORITHM

Figure 1 illustrates the operation of the approach. To ensure effective data integration, the following stages must be executed: The sixteen pixels at the commencement of the bottom row are processed differently, while the pixels ranging from 0 to 1 minus L are processed uniformly. A JBIG2-compressed map indicates the locations where these images were captured. The initial sixteen pixels in the bottom row are discarded when generating the photo histogram.

The equation separates the two greatest histogram points for each pixel during data embedding. Subsequently, we bisected the new histogram at its two apexes. We continue this process until all L pairings have been divided. Following the compact position map bit stream, the message bits are presented subsequently. The final two peaks requiring division are the least significant bits (LSBs) from the sixteen excluded pixels, the length of the compressed location map (L), and the preceding peak values.

The section's maximum values are utilized to populate the least significant bits (LSBs) of the 16 absent pixels to create the desired image. Below are the steps required to extract data from the source image:

Examining the leftmost segments of the sixteen absent pixels reveals the final two bifurcated peaks.

We utilize equation (2) to extract data from the final two split peaks to ensure that the length of the compressed location map, L, corresponds to the original 16-bit least significant bits (LSBs).

It is acknowledged that certain photos are absent and certain peak figures have previously been fragmented. Subsequently, Eq. acquires all the pixels, excluding the 16 that were omitted from the restoration process. The extraction and recovery processes are repeated until all split peaks are identified. This is executed to retrieve the saved data. Binary numbers are extracted and subsequently compressed to create the compressed position map. The modified and processed pixels are displayed on the decompressed map. We subtract L from each pixel value below 128 and add it to each pixel value over 128. This criterion must be fulfilled with absolute certainty, so the maximum permissible L number is 64. The image will be restored by rewriting the least significant bits (LSBs) of the 16 pixels that were deleted.

5. CONCLUSION

The ECE-Reversible Picture Data Hiding with Contrast Enhancement study indicates that this method effectively enhances both image quality and data security. This technique enhances visibility and safeguards privacy by incorporating private information into the image and darkening it. The algorithm is ideal for delicate jobs such as medical imaging, digital forensics, and military surveillance due to its ability to reverse

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changes. It can precisely reconstruct the original image following data extraction. Ultimately, ECE-Reversible Image Data Hiding is an expedient, secure, and lossless method for transmitting enhanced images across the internet.

REFERENCES

1. Kede Ma.Weiming Zhang, Xianfeng Zhao, Nenghai Yu, Fenghua Li, " Reversible Data Hiding in Images by Reserving Room Before Encryption",IEEE Transon Information Forensics and security, Vol.8,No.3,March2013
2. Wen Chung Kuo, Po Yu Lai, LihChyau Wuu, "Adaptive Reversible Data Hiding Based on Histogram", 10th International Conference on Intelligent Systems Design and Application,l'IEEE2010(2002) The IEEE website.[Online].Available:http://www.ieee.org/
3. Kuo-MingHung, Wen-KaiSu, Ting-Wen Chen, Li-Ming Chen, "Reversible Data Hiding Base on VQ and Half toning Technique", M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, "High International Conference on Microelectronics, Communication and RenewableEnergy(ICMiCR-2013).
4. Jose, R.; Abraham, G, "A separable reversible data hiding in encrypted image with improved performance", Emerging Research Areas and 2013 International Conference on Microelectronics, Communications and Renewable Energy(AICERA/ICMiCR),2013 Annual International Conferencel'IEEE2013.
5. Siddharth Malik, Anjali Sardana, Jaya, "A Keyless Approach to Image Encryption", 2012 international conference on Communication systemsandNetwork Technologiesl'2012 IEEE
6. Yi-Hui Chen, Ci-Wei lan and ChiaoChih Huang, " A verifiable Visual Cryptography Scheme", Fifth International Conference and EvolutionaryComputingl'IEEE2011