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An Improved Histogram Modification Based on Reversible Data Hiding Algorithm

K. Ravindra Reddy[1], K. Siva Chandra[2], P.G.Varna KumarReddy3, T.S.Mahammed Basha4
Assistant professor (ad hoc), ECE Department, JNTUACE, Pulivendula
** Corresponding Author: K. Ravindra Reddy*

ABSTRACT:
In this paper, we propose a improved histogram modification based on reversible data hiding technique. In the proposed algorithm, unlike the conventional reversible techniques, a data embedding level is adaptively adjusted for each pixel with a consideration of the human visual system (HVS) characteristics. To this end, an edge and the just noticeable difference (JND) values are estimated for every pixel, and the estimated values are used to determine the embedding level. The pixel level adjustment can effectively reduce the distortion caused by data embedding. The experimental results and performance comparison with other reversible data hiding algorithms are presented to demonstrate the validity of the proposed algorithm.
Key words: Histogram processing, Human Visual system, just noticeable difference, Data Embedding, Histogram modification

I. INTRODUCTION:

Reversible data embedding, which is often referred to as lossless or invertible data embedding, is a technique that embeds data into an image in a reversible manner. In many applications including art, medical, and military images, this reversibility is a very desirable characteristic, and thus considerable amount of research has been done over the last decade. In the conventional works, extensive efforts have been devoted to increase the embedding capacity without deteriorating the visual quality of the embedded image. A key of reversible data embedding is to find an embedding area in an image by exploiting the redundancy in the image content.

Early reversible algorithm uses lossless data compression to find an extra area that can contain to-be-embedded data. In order to expand the extra space, the recent algorithms reduce the redundancy by performing pixel value prediction and/or utilizing image histogram. The state-of-the-art techniques exhibit high embedding capacity without severely degrading the visual quality of the embedded result.

II. PROPOSED METHOD:

A key of reversible data embedding is to find an embedding area in an image by exploiting the redundancy in the image content. Early reversible algorithm uses lossless data compression to find an extra area that can contain to-be-embedded data. In order to expand the extra space, the recent algorithms reduce the redundancy by performing pixel value prediction and/or utilizing image histogram. The state-of-the-art techniques exhibit high embedding capacity without severely degrading the visual quality of the embedded result.

III. LITERATURE REVIEW:

One common drawback of virtually all current data embedding methods is the fact that the original image is inevitably distorted due to data embedding itself. This distortion typically cannot be removed completely due to quantization, bit-replacement, or truncation at the grayscales 0 and 255. Although the distortion is often quite small and perceptual models are used to minimize its visibility, the distortion may not be acceptable for medical imagery (for legal reasons) or for military images inspected under nonstandard viewing conditions (after enhancement or extreme zoom). In this paper, we introduce a new paradigm for data embedding in images (lossless data embedding) that has the property that the distortion due to embedding can be completely removed from the watermarked image after the embedded data has been extracted. We present lossless embedding methods for the uncompressed formats (BMP, TIFF) and for the JPEG format. We also show how the concept of lossless data embedding can be used as a powerful tool to achieve a variety of nontrivial tasks, including lossless authentication using fragile watermarks, steganalysis of LSB embedding, and distortion-free robust watermarking.

Data embedding applications could be divided into two groups depending on the relationship between the embedded message and the cover image. The first group is formed by steganographic applications in which the message has no relationship to the cover image and the cover image plays the role of a decoy to mask the very presence of communication. The content of the cover image has no value to the sender or the decoder. In this typical example of a steganographic application for covert communication, the receiver has no interest in the original cover image before the message was embedded. Thus, there is no need for lossless data embedding techniques for such applications. The second group of applications is frequently addressed as digital watermarking. In a typical watermarking application, the message has a close relationship to the cover image. The message supplies additional information about the image, such as image caption, ancillary data about the image origin, author signature, image authentication code, and so forth. While the message increases the practical value of the image, the act of embedding inevitably introduces some amount of distortion. It is highly desirable that this distortion be as small as possible while meeting other requirements, such as minimal robustness and sufficient payload. Models of the human visual system are frequently used to make sure that the distortion due to embedding is imperceptible to the human eye. There are, however, some applications for which any distortion introduced to the image is not acceptable. A good example is medical imagery, where even small modifications are not allowed for obvious legal reasons and a potential risk of a physician misinterpreting an image. As another example, we mention law enforcement and military image analysts who may inspect imagery under special viewing conditions when typical assumptions about distortion visibility do not apply. Those conditions include extreme zoom, iterative filtering and enhancement. Lossless data embedding could also be a convenient method of data embedding for customers who are overly concerned about decreasing the quality of their images by embedding a watermark.

Until recently, almost all data embedding techniques, especially high-capacity data embedding techniques, introduced some amount of distortion into the original image and the distortion was permanent and not reversible. As an example, we can take the simple Least Significant Bit (LSB) embedding in which the LSB plane is irreversibly replaced with the message bits. In this paper, we present a solution to the problem of how to embed a large payload in digital images in a lossless (invertible) manner so that after the payload bits are extracted, the image can be restored to its original form before the embedding started. Even though the distortion is completely invertible, we pay close attention to minimizing the amount of the distortion after embedding. The ability to embed data in an image in a lossless manner without having to expand the image or append the data can be quite useful. Data embedded in a header or a separate file can be easily lost during file format conversion or resaving.

Additional information embedded directly in the image as additional lines or columns may cause visually disturbing artifacts and increases the image file size. In contrast, information that is embedded in the image is not modified by compatible format conversion or resaving, no bandwidth increase is necessary to communicate the additional information, and a better security is obtained because the embedded information is inconspicuous and imperceptible. For increased security, a secret key can protect the embedding process. In addition to these advantages, lossless data embedding enables novel elegant applications, such as lossless fragile authentication and erasable robust watermarking. Applications that would benefit from the newly coined lossless data embedding include the whole spectrum of fragile watermarking, such as authentication watermarks or watermarks protecting the image integrity. A classical authentication watermarking scheme starts with dividing the image or its blocks into two parts—the part that carries the majority of the perceptual information and an “unimportant” part that can be randomized without causing perceptible artifacts. The perceptually important part is then hashed and the hash is inserted into the “unimportant” part. The Wong’s scheme is an example of such a scheme.

In Wong’s technique, the perceptually important part consists of the seven most significant bits, while the unimportant part is formed by the least significant bit-plane. However, this and similar approaches can be reformulated as simply decreasing the information content of the image and inserting or attaching the hash to the modified image as is done in pure cryptographic authentication methods. Thus, the advantage of embedding the hash rather than appending becomes dubious at best. The lossless data embedding enables hash insertion while retaining the information content of the image in its entirety. This is important for customers who are overly concerned with the quality of their images after information has been embedded. Some customers are simply so emotionally attached to their images that no argument about invisibility of the embedding artifacts is convincing enough.

Lossless embedding techniques simply close this issue because the original data can be restored without any loss of information. This is especially useful for military images, such as satellite and reconnaissance images. Actually, the lossless authentication watermarks are currently being incorporated as an integrity protection mechanism into the ISSE guard. Another application that would clearly benefit from the proposed lossless techniques is integrity protection watermark embedded inside the digital camera for imaging hardware used by forensic personnel. Establishing the integrity of evidence throughout the investigation is of paramount importance. Authentication watermarks embedded by a watermarking chip inside the digital camera have been proposed in the past. However, because the authentication process invariably modifies the image, today, the legal problems associated with watermarking prevent the spread of watermarking technology. The removable lossless authentication watermark provides an elegant solution to this sensitive issue.

1. Reversible Data Embedding Using a Difference Expansion by Jun Tian:

Reversible data embedding has drawn lots of interest recently. Being reversible, the original digital content can be completely restored. In this paper, we present a novel reversible data embedding method for digital images. We explore the redundancy in digital images to achieve very high embedding capacity, and keep the distortion low.

Reversible data embedding, which is also called lossless data embedding, embeds invisible data (which is called a payload) into a digital image in a reversible fashion. As a basic requirement, the quality degradation on the image after data embedding should be low. An intriguing feature of reversible data embedding is the reversibility, that is, one can remove the embedded data to restore the original image. From the information hiding point of view, reversible data embedding hides some information in a digital image in such a way that an authorized party could decode the hidden information and also restore the image to its original, pristine state. The performance of a reversible data-embedding algorithm can be measured by the following.

i) Payload capacity limit: what is the maximal amount of information can be embedded?
ii) Visual quality: how is the visual quality on the embedded image?
iii) Complexity: what is the algorithm complexity?

The motivation of reversible data embedding is distortion-free data embedding. Though imperceptible, embedding some data will inevitably change the original content. Even a very slight change in pixel values may not be desirable, especially in sensitive imagery, such as military data and medical data. In such a scenario, every bit of information is important. Any change will affect the intelligence of the image, and the access to the original, raw data is always required. From the application point of view, reversible data embedding can be used as an information carrier. Since the difference between the embedded image and original image is almost imperceptible from human eyes, reversible data embedding could be thought as a covert communication channel. By embedding its message authentication code, reversible data embedding provides a true self authentication scheme, without the use of metadata

This method can be applied to digital audio and video as well. We calculate the differences of neighboring pixel values, and select some difference values for the difference expansion (DE). The original content restoration information, a message authentication code, and additional data (which could be any data, such as date/time information, auxiliary data, etc.) will all be embedded into the difference values. In this, consider grayscale images only. For color images, there are several options. One can decorrelate the dependence among different color components by a reversible color conversion transform, and then reversibly embed the data in the decorrelated components. Or one can reversibly embed each color component individually. Please note that reversible data embedding is a fragile technique. When the embedded image is manipulated and/or lossy compressed, the decoder will find out it is not authentic and thus there will be no original content restoration.

IV. IMAGE PROCESSING:

Digital Image Processing (DIP) involves the modification of digital data for improving the image qualities with the aid of computer. The processing helps in maximizing clarity, sharpness and details of features of interest towards information extraction and further analysis. This form of remote sensing actually began in 1960s with a limited number of researchers analyzing airborne multispectral scanner data and digitized aerial photographs. However, the launch of Landsat-1, in 1972, that digital image data became widely available for land remote sensing applications. At that time not only the theory and practice of digital image processing was in its infancy but t h e cost of digital computers was very high and their computational efficiency was far below by present standards. Today, access to low cost and efficient computer hardware and software is commonplace and the source o f digital image data are many and varied. Digital image processing is a broad subject and often involves procedures which can be mathematically complex, but central idea behind digital image processing is quite simple. The digital image is fed into a computer an d computer is programmed to manipulate these data using an equation, or series of equations and then store the results of the computation for each pixel (picture element). These results form a new digital image that may be displayed or recorded in pictorial format or may itself be further manipulated by additional computer programs. The possible forms o f the digital image manipulation are literally infinite. The raw digital data when viewed on the display will make it difficult to distinguish fine features

V. HISTOGRAM:

The histogram of digital image with gray levels in the range [0 , L-1] is a discrete function p(rk) = nk / n, where rk is the kth gray level, nk is the number of pixels in the image with that gray level, n is the total number of pixels in the image, and k = 0,1,2,……………..,L-1. The histogram p(rk) of an image gives an estimate of the probability of occurrence of gray level rk. A plot of this function for all values of k provides a global description of an image. For example, fig. 1 shows the four basic types of Histograms of an image. The histogram has shown in fig 1 (a) shows that the gray levels are concentrated towards the dark end of the gray scale range. Thus this histogram corresponds to an image with overall dark characteristics. Just the opposite is true in fig 1 (b). the histogram shown in the fig 1 (c) has a narrow shape, thus it corresponds to an image having low contrast. Finally, 1 (d) shows a histogram with significant spread, corresponding to an image with high contrast.

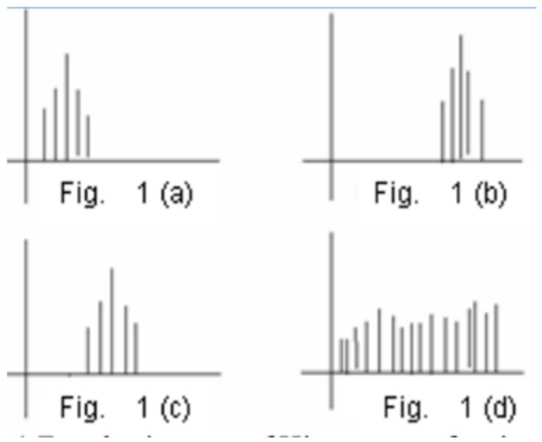


Fig. 1 (a) Fig. 1 (b) Fig. 1 (c) Fig. 1 (d)

1) Histogram Modification:

Histogram equalization and histogram specification have been widely used to enhance information in a gray scale image, with histogram specification having the advantages of allowing the output histogram to be specified as compared to the histogram equalization which attempts to produce an output histogram that is uniform. Unfortunately, expanding histogram techniques to color images is not straightforward. Since humans are sensitive to chromatic changes, care must be taken to ensure that incorrect colors are not produced. Additionally, expanding the 1-D histogram used in gray level histogram techniques to a joint histogram (usually of three variables representing the primary colors of red, green and blue) can yield specified histograms which have no physical meaning hence making it difficult to determine the set of histograms required for the desired enhancement. Method of gray level histogram specification is extended to colour images by performing histogram specification on intensity, saturation and hue components. These methods take into account the relationship between the intensity and saturation components while yield specified histograms that produce natural looking results. How does one can judge a scanned picture? More basically, what are the criteria by which one judges the quality of a scan? Conceptually simple factors such as focus and frame alignment is immediately obvious from viewing the monitor and is easily adjustable through simple controls or manual adjustment. Other factors such as color and tonal balance are much more difficult to evaluate by looking at scanned image on the monitor. A full-frame scan on a scanner with a default resolution of 1350 dots per inch will generate approximately 6 million bytes. At a resolution of 2700 dpi, the file will contain over 24 million bytes. An Image Histogram is the way of making quantitative sense of this mass of data.

It is possible to adjust the level of histogram equalization to achieve natural looking enhanced images. The modified histogram is a weighted average of the input histogram and the uniform histogram, as given in

$$\tilde{\mathbf{h}} = \frac{\mathbf{h_i} + \lambda \mathbf{u}}{1+\lambda} = \left(\frac{1}{1+\lambda}\right)\mathbf{h_i} + \left(\frac{\lambda}{1+\lambda}\right)\mathbf{u}$$

The contribution of the input histogram in the modified histogram is

$$\kappa^{*} = 1/(1+\lambda)$$

But, a direct modification on the input histogram may generate spikes in the modified histogram h ~ for some of the images, especially for a low contrast images. The spikes will add to the noise, creating the visual artifacts in the image and affecting the PSNR of the enhanced image. One solution over this is to change the way a histogram is computed, which is proposed in the next section.

2) Global Histogram Modification:

We call representatives of all images of the form, where is a strictly increasing function. The question is, which representative of is the best for our purposes? That will depend, of course, in what our purposes are. We have seen above which is the function we have to select if we want to normalize the contrast making the distribution function of uniform. In addition, it was shown in that when equalizing an image.

$$E(v) = \frac{|\Omega|}{2(b-a)} \int_{\Omega} \left(v(x) - \frac{b-a}{2} \right)^2 dx - \frac{1}{4} \int_{\Omega} \int_{\Omega} |v(x) - v(z)| \, dx \, dz.$$

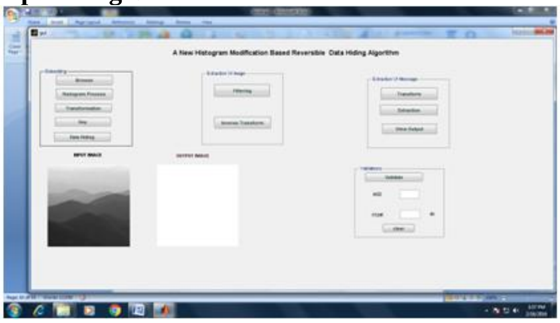
VI. NEW HISTOGRAM:

To deal with histogram spikes in a simple way, one can change the way a histogram is computed. Histogram spikes are created because of a large number of pixels that have the same gray-level and these pixels almost always come from smooth areas in the input image when they create artifacts/noise in the enhanced image. Hence, histogram computation can be modified so as to take pixels that have some level of contrast with their neighbors into account, which will solve the histogram spike problem at the very beginning .Performing histogram equalization on h ~ rather than h will enhance the contrast but not the noise, since the former will only utilize the dynamic range for pixels that have some level of contrast with their neighbors. Nothing that the histogram modification methods presented in the previous section also aim to increase contrast but not the noise visibility, they must modify the histogram in such a way that the modified histogram resembles p [i | C] rather than p[i] . One can simply obtain p[i | C] by counting only those pixels that have contrast, rather than solving complex optimization problems, which in essence corresponds to dealing with histogram spikes resulting from smooth area (noncontract) pixels after computing the histogram in the conventional way Various enhancement schemes are used for enhancing an image which includes gray scale manipulation, filtering and Histogram Equalization (HE). Histogram equalization is one of the well known image enhancement technique. It became a popular technique for contrast enhancement because this method is simple and effective. In the latter case, preserving the input brightness of the image is required to avoid the generation of non-existing artifacts in the output image. Although these methods preserve the input brightness on the output image with a significant contrast enhancement, they may produce images with do not look as natural as the input ones. The basic idea of HE method is to re-map the gray levels of an image. HE tends to introduce some annoying artifacts and unnatural enhancement. To overcome these drawbacks different brightness preserving techniques are used which are covered in the literature survey.Subjective parameters are visual quality and computation time and objective parameters are Peak signal to-noise ratio (PSNR), Mean squared error (MSE), Normalized Absolute Error (NAE), Normalized Correlation, Error Color and Composite Peak Signal to Noise Ratio (CPSNR)

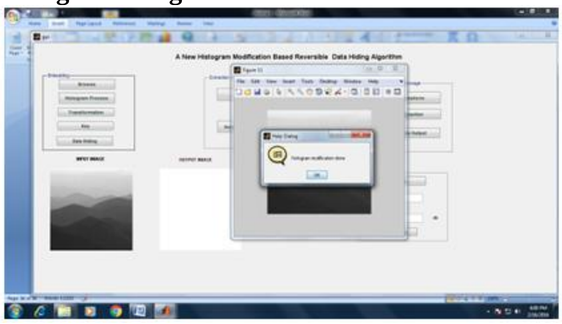
VII. SIMULATION RESULTS

Initial image:

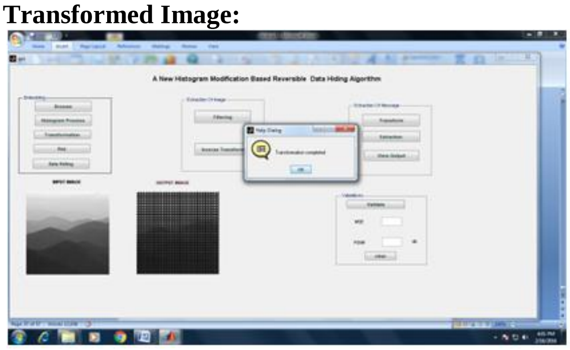
Input image:



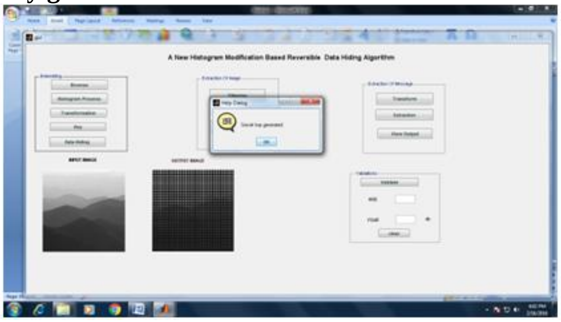
Histogram Image:



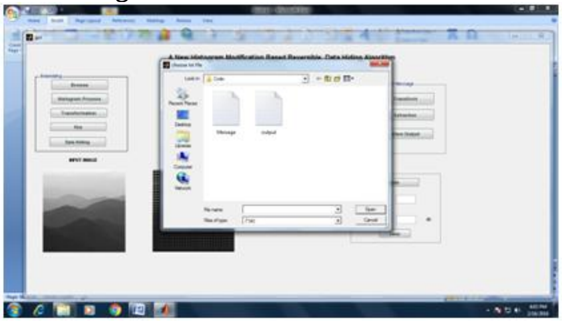
Transformed Image:



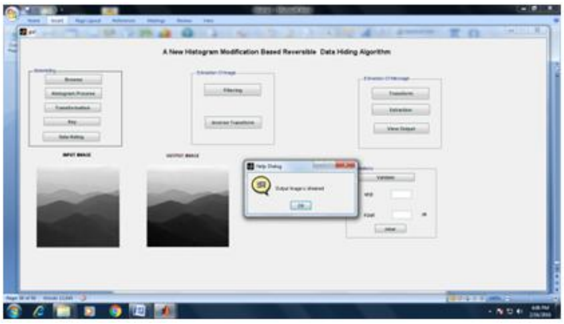
Key generation:



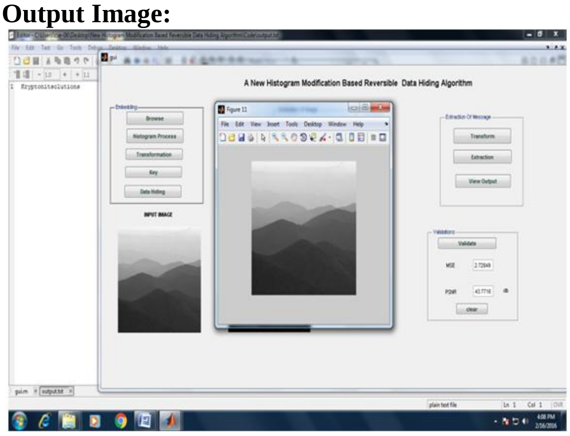
DataHiding:



InverseTransformation:



Output Image:



VIII. ADVANTAGES:

- Accuracy of the process is very high when compared to the previous procedures.
- The quality of the color image is also increased.
- This proposed algorithm can be extended to reversible data embedding in a video and during embedding process the quality of the image can also be enhanced.

IX. APPLICATIONS:

- Secure medical image data system
- Law enforcement
- E-government
- Image authentication
- Military

X. CONCLUSION:

A data embedding level is adaptively adjusted for each pixel with a consideration of the human visual system (HVS) characteristics. To this end, an edge and the just noticeable difference (JND) values are estimated for every pixel, and the estimated values are used to determine the embedding level. This pixel level adjustment can effectively reduce the distortion caused by data embedding. The experimental results and performance comparison with other reversible data hiding algorithms are presented to demonstrate the validity of the proposed algorithm.

XI. FUTURE SCOPE:

In future, we will extend this system considering audio or video files as the cover. In this paper only digital image is considered as cover.

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