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Invertible Data Embedding By Histogram Modification and Contrast Enhancement

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Abstract: *The main aim is to enhance the contrast of a host image by Reversible data hiding algorithm and to improve its visual quality. The highest two bins in the histogram are selected for data embedding so that histogram equalization can be performed by repeating the process. The Reversible data hiding algorithm is used for better preserving the visual quality of contrast enhanced image with increased efficiency. Further, the evaluation result shows that the visual quality can be preserved and also it can be applied to medical and satellite images for better visibility.*

Keywords: Data embedding,PSNR,Hiding Capacity

INTRODUCTION

An image is a array, or matrix, of s pixels (picture elements) arranged in columns and rows. Digital image processing is the use of computer computations to perform image processing on digital images. The 2D continuous image is divided into rows and columns. The image can also be a function other variables including depth, color, and time.[1]The input image is first divided into groups based on the optional key. Then RS vector is calculated for each group using flipping function. The RS vector is then compressed and the groups are flipped. Then message bits are included in the flipped groups. This is the resulting Stego image. While extracting the data the Stego image is first divided into groups based on the same optional key. Then RS vector is calculated for each group using the flipping function. The RS vector is then decompressed and the groups are unflipped. Then message bits are obtained from the unflipped groups. Finally the original image is restored. [2]

An image given in the form of a, photograph or ray is first digitized and stored as a matrix of 0,1 digits in computer memory. This digitized image can be displayed on a high-resolution television monitor. For display, the image is stored in a fast-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display. However, the world is in stable motion: stare at something for long enough and it will change in some way. Even a large solid, like a building or a mountain, will change its appearance depending on the time of day (day or night); or various shadows falling upon it. We are concerned with single images. Although image processing can deal with changing scenes, for our purposes, an image is a single picture which represents something. It may be a picture of a person, of people or animals, or of an outdoor scene, or a microphotograph of an electronic component, or the result of imaging. Even if the picture is not immediately recognizable, it will not be just a random blur.

DIGITIZER

Digitizing or digitization is the representation of an object, image, sound, document or a signal (usually an analog signal) by a discrete set of its points or samples. Digital information exists as one of two digits. These are known as bits. An image is digitized to convert it to a form which can be stored in computer's memory or on some form of storage media such as a hard disk. This digitization procedure can be done by a scanner, or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations.

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Vidicon camer
Photosensitive solid- state arrays.

THE IMAGE PROCESSING SYSTEM

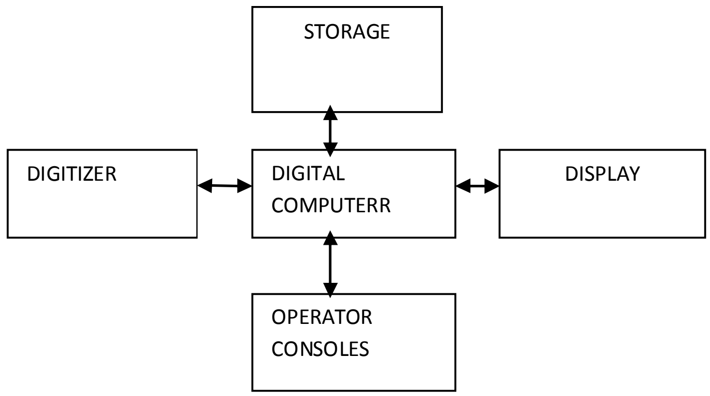

Fig .Block diagram of Image processing system

DIGITAL COMPUTER

A computer is an electronic device that accepts raw data, processes it according to a set of instructions and required to produce the desired result. Mathematical processing of the digitized image such as convolution, averaging, addition, subtraction, etc. are done by the computer.

MASS STORAGE

Mass storage devices used in desktop and most server computers typically have their data organized in a file system. The secondary storage devices normally used are floppy disks, CD ROMs etc.

OPERATOR CONSOLE

The operator console consists of equipment and arrangements for verification of results and for alterations in the software as and when require. The operator is also capable of checking for any errors and for the entry of requisite data.

DISPLAY

Popular display devices produce spots (display elements) for each pixel

- Cathode ray tubes (CRTs).
- Liquid crystal displays (LCDs).
- Printers.

Spots may be binary (e.g., monochrome LCD), achromatic (e.g.,so-called black-and-white, actually grayscale for intensity), pseudo color or false colors (e.g., for intensity or hyper spectral data), or true color (color data displayed as such).

IMAGE PROCESSING FUNDAMENTAL

PIXEL

In order for any digital computer processing to be carried out on an image, it must first be stored within the computing machine in a suitable form that can be manipulated by a computer program. The most practical way of doing this is to divide the image up into a collection of discrete components (and usually small) cells,which are known as *pixels*. Most commonly, the image is divided up into a rectangular grid of pixels, so that each pixel is itself a small rectangle. After this has been done, each pixel is given a value that represents the color of that pixel. It is assumed that the entire pixel is the same color, and so any colour variation that did exist within the area of the pixel before the image was lost. However, if the area of each pixel is very small, then the discrete nature of the image is often not visible to the human eye.

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Pixel shapes and formations can be used, most notably the hexagonal grid, in which each pixel is a small hexagon. Has some advantages in image processing, including the fact that pixel connectivity is less ambiguously defined than with a squarical grid, but hexagonal grids are not widely used.

PIXEL CONNECTIVITY

The notation of pixel connectivity describes a relation between two or more pixels. For two pixels to be connected they have to fulfill certain criteria on the pixel brightness and spatial adjacency. First, in order of 2 pixels to be connected, their pixel values must both be from the same set of values V. A pixel p is connected to a pixel q if p is *4*-connected to q or if p is *4*-connected to a third pixel which itself is connected to q. Or, in other words, two pixels q and p are connected if there is a path from p and q on which each pixel is *4*-connected to the next one. A package of pixels in an image which are all connected to each other is called a component. Finding all connected components in an image and marking each of them with a differentiable label is called connected component labeling.

RGB

The **RGB color model** in which red, green and blue light are mixed together in various ways to reproduce a broad array of colors. RGB uses additive color adding and is the basic color model used in television or any other medium that projects color with light. It is the basic RGB model used in computers and for web graphics, but it cannot be used for print production.
The secondary colors of basic model – cyan, magenta, and yellow – are formed by mixing two of the primary colors (**red, green** or **blue**) and excluding the third color.

IMAGE TYPES

There are several ways of encoding the information in an image.

- Binary image
- Grayscale image
- Indexed image
- True color or RGB image

BINARY IMAGE

Each pixel is just blackor white. Since there are only two possible values for each pixel (0, 1), we only need one bitper pixel.

GRAYSCALE IMAGE

Each pixel is a shade of gray, normally from 0 (black) to 255(white). This range means that each pixel can be represented by eight bits, or exactly one byte.

INDEXED IMAGE

An indexed image consists of an array and a color map matrix. The pixel values in the array are direct indices into a color map. By convention, this documentation uses the variable name X to refer to the array and map to refer to the color map.

TRUE COLOR OR RGB IMAGE

Each pixel has a particular color; that color is described by the amount of red, green and blue in it. If each of these components has a range 0–255, this gives a total of 2563 different possible colors. Such an image is a "stack" of three matrices; representing the red, green and blue values for each pixel. This means that for every pixel there correspond 3 values.

METHODOLOGY

IMAGE CONTRAST ENHANCEMENT

CONTRAST ENHANCEMENT:

Contrast defines the difference between lowest and highest intensity level. Higher the value of contrast means more difference between lowest and highest intensity level. Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. It is important to keep in mind that enhancement is a very subjective area of image processing. Improvement in quality of these degraded images can be achieved by using application of enhancement techniques.

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HISTOGRAM PROCESSING:

Image contrast enhancement employs a partitioning operation over the input histogram to chop it into few histograms so that they have no dominating component in them. Then each sub-histogram goes through the and is allowed to occupy a specified gray level range in the enhanced output image. Thus, a better overall contrast enhancement is acquired by dhe with controlled dynamic range of gray levels and eliminating the possibility of the low histogram components.
The discrete function h(rk)=nk , where rk is the kth gray level in the range of [0, L-1] and nk is the number of pixels having gray level rk.In an image of low contrast, the image has grey levels concentrated in a short band.Define the grey level histogram of an image *h(i)* where :

h(*i*)=number of pixels with grey level = *i*

NORMALIZED HISTOGRAM

It is p(rk)=nk/n, for k=0,1,…,L-1 and p(rk) can be considered to give an estimate of the probability of occurrence of ray level rk.Each of the two peaks in the histogram is split into two adjacent bins with the similar or same altitude because the numbers of 0s and 1s in the message bits are required to be almost equal. To increase the hiding rate, the highest two bins in the modified histogram are further chosen to be split to all pixels counted in the histogram. The same can be repeated by splitting each of the two peaks into two adjacent bins with the similar heights to achieve the histogram equalization effect.

In this way, data embedding and contrast enhancement are simultaneously performed. Given that the pair number of the histogram peaks to be split is , the added by while the pixels from to 255 are subtracted by in the pre-process (noting L is a positive integer). A location map is generated by assigning 1s to the altered to pixels, and 0s to the others. The location 23 map can be pre-computed and reduced to be firstly embedded into the host image. The value of, the size of the compressed location map, and the previous peak values, incontrary, are embedded with the last two peaks to be split, whose values are stored in the LSBs of the 16 pixels. In the extraction process, the last split peak values are retrieved and the data embedded with them are extracted. After restoring the histogram, the data embedded with the previously split peaks can also be extracted by processing them pair by pair. At last, the location map is obtained from the extracted data to identify the pixel values modified in the image.

REVERSIBLE DATA HIDING USING *HISTOGRAM SHIFTING*

REVERSIBLE DATA HIDING

Reversible Data Hiding (RDH) has been concentrated on a study of Signal processing. The Lossless Data Hiding techniques hide data in a received signal (i.e., an image) which can able to extract the original signal and also with embedded data. It needs two important provisions for data hiding techniques are capacity of embedding should be large and with low distortion. In digital images there are many proposed algorithms to embed invisible data. This method divides the image into pairs of pixels and uses each legitimate pair for hiding one bit of information. So that the capacity is at best 0.5b/pixels. However a compressed location map also needs 0.5b/pixels. To estimate the secret rate and the smudged image quality are the two important metrics watermark within the host signal whileretaining the characteristic of the host untainted.

A technique to embed watermark in the JPEG compressed encrypted images. The algorithm is simple to implement as it is directly performed on the compressed-encrypted domain. it does not require decrypting or partial decompression of the content.. The homomorphism properties of the crypto are exploited, which allows us to detect the watermark after decryption and control the image quality as well. We analyze the relation between payload capacity and quality of the image for different resolutions[5]

NEED FOR REVERSIBLE DATA HIDING:

Reversibility gives the ability to retrieve the exact original input data after extraction process. This is a technique to embed additional message into some distortion not acceptable cover media, such as military or medical images, with a reversible manner so that the original cover content can be restored well after extraction of the hidden message. Reversibility can be used. The lossless embedding highers the size of the original image and lossy embedding process cannot be applied to medical field. Recently, reversible data embedding technique has attracted many attentions. It is also called lossless data hiding

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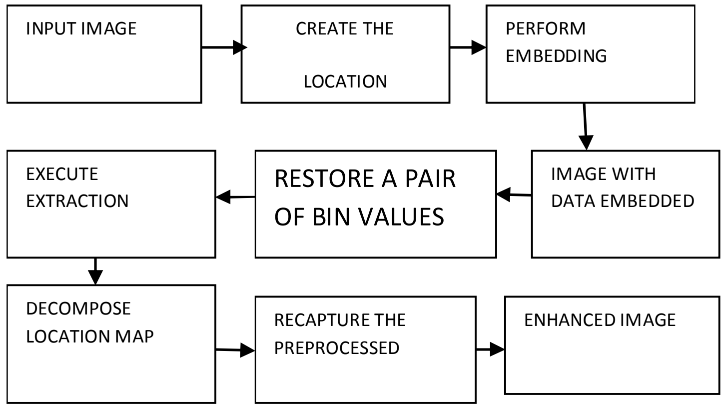

Fig. Block Diagram of RDH Algorithm

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KEY PARAMETERS OF REVERSIBLE DATA HIDING

Reversible watermarking is a feasible concept due to the fact that the original media usually has a strong spatial or temporary efficiency. Reversibility is guaranteed if enough free space can be found or created to embed the appropriate transform domain by suitable techniques and methods. There are some key parameters are taken care of while trying to increase the embedding capacity at the cost of image quality. A few important ones are briefed below. [3] A joint watermark protocol for the MPML-DRM-A using Chinese remainder theorem. The proposed scheme ensures that only two watermark signals are embedded into the content compared to the embedding of multiple watermark signals into the content with the naive approach. The proposed watermarking protocol involves the entities: an owner levels of distributors a consumer, and a license server. We generate the joint watermark information as the (CRT) solution of a set of congruence's corresponding to each party in the distribution chain. The watermark signal is generated from this joint watermark information using a watermark generation algorithm and then embedded into robust embedding algorithm. The watermark signal is detected using the corresponding watermark detection algorithm. [4] The paper is our response to the call for proposal of the JPEG Security (JPSEC) Working Group. The schemes are very computationally efficient. The schemes are also very secure since they protect 99.15% of the information of an image. Furthermore the schemes are standard compliant which guarantee the inheritance of many nice properties of the un-protected code-streams that have been well built and studied. a JPEG2000 code-stream is structured as a main header followed by a sequence of tile-streams. The code-information should be complete enough stream is terminated by a two-byte marker, EOC (end of code-stream).[6]

FIDELITY

Fidelity is a definition of how far the extracted image resembles the original image in all means. It is an important criterion in bio medical image processing, since even the slightest visual difference cannot be tolerated. A reversible data embedding ensure that there is a perfect balance between quantity of data embedded and the image quality. Fidelity is a term that is concerned with the human visual representation of an image. Fidelity between two pictures are said to be high if the human visual system is not able to detect any visible changes in the modified image.

EFFICIENCY

Efficiency in reversible data embedding depends on the amount of patient information that can be cast into the cover image calculated in bits per pixels (bpp) without affecting the visual quality of the cover image measured in terms of the PSNR.

SECURITY

Security is yet another key factor which deals with the type of encryption and decryption schemes involved in the embedding and extraction procedures, their simplicity in implementation and their strength against hackers. Use of a strong key, number of rounds of encryption is some of the main factors which affect the security of the system. It is a key factor since the patient record in the Hospital storage system should not be tampered with or destroyed on any account.

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PAYLOAD

Data payload refers to the number of bits a watermark system embeds within a unit of time or within a unit of cover signal. A data embedding scheme that embeds N bits into the cover signal is referred to as an embedded. The required data payload may differ greatly for each application. Copy protection or control applications may require only a few bits of information while broadcast monitoring may require rates three times larger than the previous case, or in case of forensic applications the necessary tobe-embedded to prevent any modification of the content. In medical data management, there cannot be any compromise on the payload content as it has the entire patient information, the doctor‘s diagnosis and subsequent treatment information which cannot be selectively ignore.

PREPROCESSING

In order to reversibly retrieve the original image, a problem must be considered, i.e., overflow and underflow problem (for simplicity, overflow is used to represent either overflow or underflow in the rest of this paper). Therefore, a location map is created to record the locations of pixels which will exceed the permitted value range, gray scale image, after watermark embedding.

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern "window", which slides entry by entry, over the entire signal. For one dimension signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such , more complex window patterns are possible (such as "box" or "cross" patterns).The median is simple to define: it is just the middle value after all the entries in the window are sorted numerically.

LOCATION MAP

It is performed by modifying the histogram of pixel values. Firstly, the two peaks in the histogram are found out. The bins between the peaks are not changed while the outer bins are shifted outward so that each of the two peaks can be split into two adjacent bins. To increase the embedding capacity, the highest two bins in the modified histogram can be further to be split, and so on until satisfactory contrast enhancement effect is achieved. To avoid the overflows and underflows due to histogram changes, the bounding pixel values are pre-processed and a location map is generated to memorize their locations. For the recovery of the input image, the location map is embedded into the host image, together with the message bits and other side information. So blind data extraction and complete recovery of the input image are accesed. The proposed algorithm was applied to two set of images.

HISTOGRAM SHIFTING

Algorithm for embedding:

1) *Pre-process:* The pixels in the range of (0002C255) are processed excluding the first 16 pixels in the bottom row. A location map is generated.
2) Histogram is calculated without counting the first 16 pixels in the bottom row
3) Embedding: The highest two bins in the histogram are split for data embedding. Then the two peaks in the modified histogram are split, and so on until pairs are split. The location map is embedded before the message bits.
4) The finally split peak values are used to replace the LSBs of the 16 excluded pixels to form the marked image.

Algorithm for Extraction and Recovery Process:

1) The LSBs of the 16 excluded pixels are retrieved.
2) The data embedded with the last two split peaks are extracted, the length of the compressed location map, the original LSBs of 16 excluded pixels, and the previously split peak values are known.
3) The recovery operations are carried out by processing all pixels except the 16 excluded ones.
4) The compressed location map is obtained from the extracted binary values and decompressed to the original size.
5) With the decompressed map, those pixels modified in preprocess are identified.
6) A pixel value is subtracted by if it is less than 128, or increased by otherwise. At last, the original image is recovered.

Calculation of PSNR Value:

1)MSE = t1/(row*col);

2)maxval = sum(max(clean));

3)PSNR = 10*log10(maxval/MSE);

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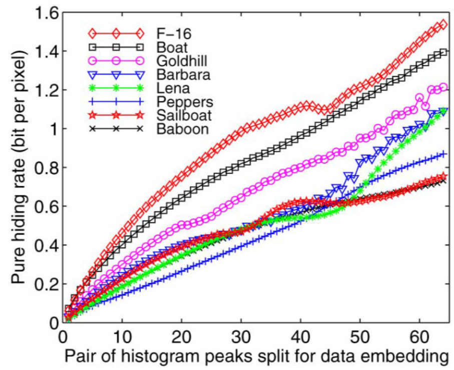
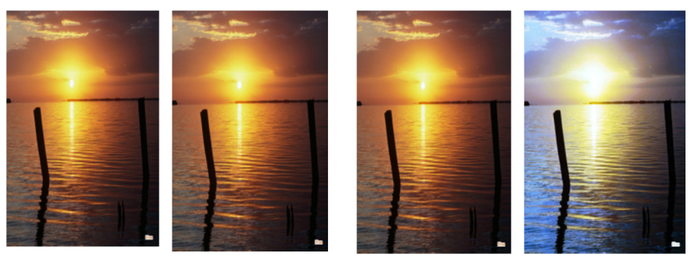


Fig. Pair of Histogram vs Hiding Rate

Matlab is a program that was specifically designed to simplify the implementation of numerical linear algebra routines. It has grown into something much bigger, and it is used to implement numerical algorithms for a wide range of uses. The language used is very similar to standard linear algebra notation, but there are a few extensions that will cause you some problems at first. The input color image is given below By using Reversible Data HidingAlgorithm, Data is embedded in the image.Data is recovered from image but contrast is needed so that the entire image is completely recovered.



(a (b (c) (d)

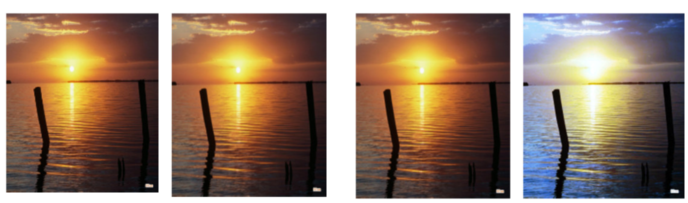


Fig. This is a combination of original image and enhanced image with the high PSNR (a) Original image (b) After applying filter (c) Preprocessed image (d) Enhanced image

Fig. This is a combination of original image and enhanced image with the Low PSNR (a) Original image (b) After applying filter (c) Preprocessed image (d) Enhanced image

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Table-I

COVER IMAGE	HIDING CAPACITY IN BITS	PSNR (in Decibel)
Sunset	319455	44.95
Blue hill	621669	48.51
Water lilly	315420	44.58
Boat	398344	28.01

Table-II

METHODS	PSNR	MSE	BPP
Difference Expection	18.62	652.56	9.314
Sorting and Prediction	15.49	689.66	5.417
Histogram Shifting	25.3362	642.377	4.8828

CONCLUSION

The algorithm which is used to embed the given data in a image using histogram shifting. The data is embedded into the image by shifting and replacing the bit planes with the values of the data. The embedded data is retrived from the image along with the original image. This algorithm shows high performance compared to the other algorithms such as Difference explansion algorithm. The Bits per Plane value of the proposed algorithm is high compared to the previous algorithm used.

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