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Irreversible Compression

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ABSTRACT

The purpose of this paper is to explore the irreversible compression and the use of irreversible compression in our daily uses. The degree of research on the use of irreversible compression in daily uses like to transfer files,images,,data from one place to another is still in its infancy.In this paper we are also exploring the research conducted on the use of irreversible compression in digital diagnostic radiology and we are examining the use of various compression ratios on image quality and observer performance on several detection tasks such as identifying structures and lesion detection, on files ,data,,images,chest, CT, skeletal, angiography, mammography, MRI, Nuclear Medicine, ultrasound, and teleradiology images. In general, the results of these studies show that image types in digital radiology are different based on their mode of generation, as well as their spatial and contrast resolution determined by their matrix size/pixel size, and bit depth respectively. Furthermore, there are several forms of irreversible compression algorithms, and they are not all equal in terms of performance. Some types of images such as digitized chest images, CT, MRI and Ultrasound images have different "compression tolerance" and therefore a single compression ratio cannot be assigned to a modality, even for a given organ system The survey of several radiology professional and related organizations reveals that no professional practice standards exist for the use of irreversible compression. In this paper, we also try to introduce PPM and JPEG algorithm how we can use this to reduce the Psychovisual Redundancy.

Keywords: *Psychovisual Redundancy, Characteristics of the Digital Image*

I. INTRODUCTION

Digital compression refers to using one or more of many software and/or hardware techniques to reduce information by removing irreversible data and redundancy. Thus we would store the data in the compact form. In a process called decompression, we later decode the information and fills in a representation of the data that was removed during compression". Data Compression is the art or science of representing information in a compact form means to reduce the redundancy or irreversible data which is occurring in data. Data Redundancy is the central issue of Data Compression. In the data there may be 3 types of redundancy Coding Redundancy, Interpixel Redundancy and Psychiovisual Redundancy. Data Compression can be divided into 2 categories:

1. Irreversible Compression (Lossy Compression)
2. Reversible Compressions (LossLess Compression)

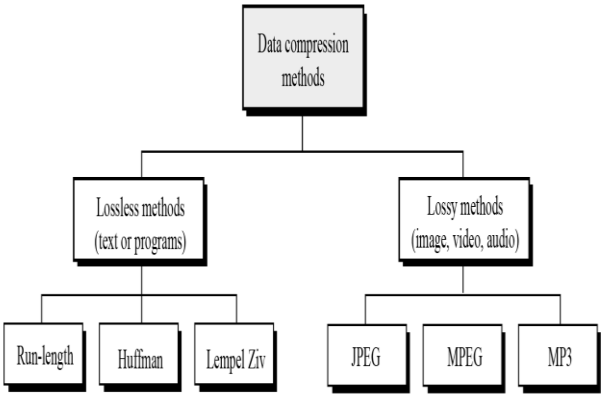

Figure1: Data compression and its types

In the Irreversible Compression, we can't reconstruct the original data after Compression. While in the Reversible Compression we can reconstruct the original data after Compression.

We want to reduce the transfer speed as well as want to store the data in minimum storage. Now-a-Days new technology is coming into existence besides this irreversible compression demand is increasing whether

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we have to sent data from 1 place to another or want to store data Specially in digital Radiography where we deal with inter-pixel redundancy, coding redundancy and phychiovisual redundancy. In the image irreversible compression we will concentrate on hychiovisual redundancy So in digital radiography, we use JPEG in which we Phychiovisual redundancy methodology used.

The purpose of this paper is to explore the research conducted to evaluate the use of irreversible compression and how we will use irreversible compression in digital diagnostic medical imaging.

1. To assess the degree of research conducted to evaluate the effect of irreversible compression
2. To determine whether a consensus of opinion exists among those who have evaluated the effect of irreversible compression
3. How we use JPEG in Image Compression

II. DEFINITION OF TERMS

- *Original image:* "A medical image f (x,y) in digital form, where f is a non-negative integer function and x and y can be 0 to 255, 0 to 511, 0 to 1023 and 0 to 2047"
- *Compressed image file:* "A 1-D array of encoded information derived from the original…. image by an image compression technique"
- *Reconstructed image* from a compressed image file: "A 2-D rectangular array f (x,y)… the technique used for reconstruction (or decoding) depends o the method of compression (encoding). In the case of error-free (or reversible or lossless) compression, the reconstructed image is identical to the original image, whereas in irreversible or lossy image compression, the reconstructed image loses some information of the original image"
- *Compression ratio:* "The compression ratio between the original image and the compressed image file is the ratio between *Compression ratio=(original image/compressed image)*
- *Digital Image Quality:* This can be described by three parameters; spatial resolution, density resolution, and the signal-to-noise ratio (SNR). Only the first two are relevant to this Paper.

  - *Spatial resolution* refers to the ability of the imaging system to image fine detail (sharpness) .In spatial resolution we directly work on pixels of a image.
  - *density resolution* is the ability of the imaging system to image differences in tissue contrast

Both spatial resolution and density resolution are related to the number of pixels and the range of pixels used to represent an object (patient) respectively.

Irreversible Compression In the irreversible Compression if we have compressed the data, we can't reconstruct the original data. In the irreversible compression we deal with physciovisual redundancy.

Three approaches:

Reduce Coding Redundancy: - In this we deal the redundancy. With respect to data representation. In this we assume that some pixel values more common than others.

Reduce Interpixel Redundancy: - In this we deal the redundancy with respect to data representation. In this we assume that neighboring pixels have similar values.

Reduce Psychovisual Redundancy :- In this we deal the redundancy with respect to the image content In this we assume that some color differences are imperceptible.

Characteristics of the digital image

Matrix

A digital image matrix is a 2-D array of numbers consisting of columns (M) and rows (N) that define small square regions called picture elements or pixels.

The matrix size affects the spatial resolution of digital images, with larger matrix sizes providing better detail (image sharpness). When larger body parts (for example, chests) are imaged in radiography, it is essential to use larger matrices. Typical matrix sizes for various image types are shown in Table 1.

Table 1: Typical matrix sizes for different types of digital images

Digital Imaging Modality	**Matrix Size and Typical Bit Depth**
Nuclear Medicine	128 x 128 x 12
Magnetic Resonance Imaging	256 x 256 x 12
Computed Tomography	512 x 512 x 12
Digital Subtraction Angiography	1024 x 1024 x 10
Computed Radiography	2048 x 2048 x 12
Digital Radiography	2048 x 2048 x 12
Digital Mammography	4096 x 4096 x 12

Pixels
The pixels that make up the matrix are generally square. Each pixel contains a number (discrete value) that represents a brightness level. The smaller the pixel size, the better the spatial resolution.
Voxels
Pixels in a digital image represent the informations contained in a volume of tissue referred to as a voxel. The voxel information is converted into numerical values contained in the pixels, and these numbers are assigned brightness levels that are represented in the image.
Bit Depth: *The number of bits/pixel is the bit depth*

Handling Digital Image Data Sets in Radiology: The Need for Image Compression:
The evolving nature of digital image acquisition, processing, display, storage, and communications in diagnostic radiology have resulted in an exponential increase in digital image files.Image compression can solve the problems of image data storage and improve image transmission speed requirements for huge amounts of digital data.

III. WHAT IS IMAGE COMPRESSION?

Digital image compression refers to using one or more of many software and/or hardware techniques to reduce information by removing irreversible data and phyciovisual redundancy in images. Thus we would store the data in the compact form. In a process called decompression, we later decode the information and fills in a representation of the images that was removed during compression".

IV. IMAGE COMPRESSION FRAMEWORK

The general framework for digital image data compression is illustrated in Figure

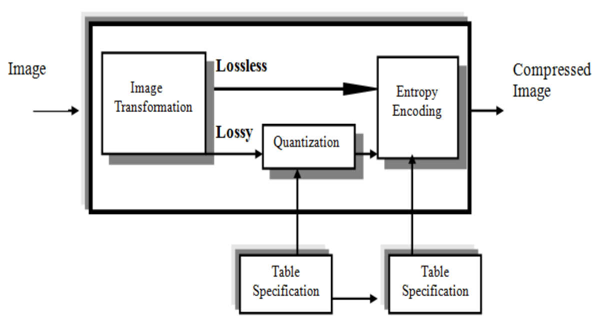

Figure 2: Irreversible Compression Steps

Essentially, there are two types of image compression schemes:

1. "Lossless" or reversible compression
2. "Lossy" or irreversible compression

- In lossless or reversible compression, there is no loss of information in the compressed image data. Furthermore, lossless compression does not involve the process of quantization, but makes use of image transformation and encoding to provide a compressed image
- Lossy or irreversible compression involves at least three steps; image transformation, quantification, and encoding."Transformation is a lossless step in which the image is transformed from gray scale values in the spatial domain to coefficients in some other domain. One familiar transformation is the Fourier Transform used in reconstruction Magnetic Resonance Images (MRI). Other transforms such as the Discrete Cosine Transform (DCT) and the Discrete Wavelet Transform (DWT) are commonly used for image compression. No loss of information occurs in the transformation step. Quantization is the step in which the data integrity is lost. It attempts to minimize information loss by preferentially preserving the most important coefficients where less important coefficients are roughly approximated, often as zero. Quantization may be as simple as converting floating point values to integer values. Finally, these quantized coefficients are compactly represented for efficient storage or transmission of the image"

Irreversible Image Compression
Irreversible image compression (lossy compression) includes three common means of achieving compressed image data; the Joint Photographic Experts Group (JPEG), wavelet and fractal. While the JPEG and wavelet methods are transform-based using the three steps identified (that is, image transformation, quantification, and encoding), fractal methods are based on another 'schema'.

The JPEG compression algorithm can be lossless or lossy, and it was developed for both grey scale and colour images, however for diagnostic images lossy JPEG compression "degrades ungracefully at high compression ratios, with prominent artefacts at block boundaries, and it cannot take advantage of the 8 x 8 pixel blocks' (Erickson, 2002). Additionally, as noted by Mann (2002) "the quantization error can cause objectionable 'ringing' around sharp edges, especially text".

To overcome these problems, wavelet compression techniques (lossy compression) are now used. As described by Schomer et. al. (1998) "the wavelet transform is a powerful mathematical tool with many unique qualities that are useful for image compression and processing applications… By exploiting spatial and spectral information redundancy in images, wavelet-based methods offer significantly better results for compressing medical images than do compression algorithms based on Fourier methods, such as the discrete cosine transform used in the Joint Photographic Experts Group"

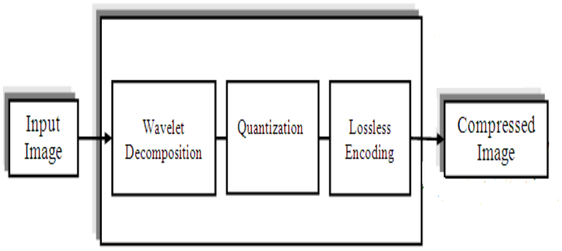

Figure 3: The basic framework for wavelet compression (Schomer et. al. 1998)

Wavelet compression algorithms (DWT for example) are based on the use of high and low- pass filters coupled with complex mathematics to produce compressed image data.

V. WORKING OF JPEG IN DIGITAL IMAGE FOR REDUCE THE PHYCHIOVISUAL REDUNDANCY

JPEG is an image compression standard which was accepted as an international standard in 1992.IT is alossy compression which takes advantage of the fact that the human eye perceives spatial changes of brightness more sharply than those of color, by averaging or dropping some of the chrominance information in the image.it is Based on the DCT.JPEG is a general image compression technique independent of Image resolution, Image and pixel aspect ratio, Color system, Image complexity.

JPEG is effective because of the following observations.

- Image data usually changes slowly across an image, especially within an 8x8 block
- Therefore images contain much redundancy
- Experiments indicate that humans are not very sensitive to the high frequency data images
- Therefore we can remove much of this data using transform coding
- Humans are much more sensitive to brightness (luminance) information than to color (chrominance)

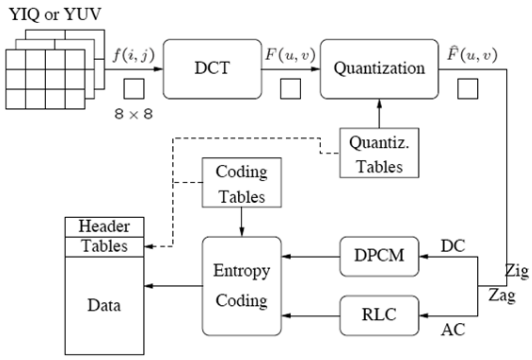

Figure 4: Working of JPEG

The main steps in JPEG encoding are the following

- Transform RGB to YUV or YIQ and subsample color
- DCT on 8x8 image blocks
- Quantization
- Zig-zag ordering and run-length encoding
- Entropy coding

Figure5: Original image

Figure6: Compressed image (Output of JPEG)

VI. VISUAL IMPACT OF IRREVERSIBLE COMPRESSION ON DIGITAL IMAGES

There is a tradeoff between the image quality and Compression ratio means to reduce the size of the compressed image, to reduce storage requirements and to increase image transmission speed and image quality will be reduced. The compression ratio increases, less storage space is required and faster transmission speeds are possible, but image quality degradation.

Image Compression in Digital Radiology: Other Considerations. There are a number of other issues relating to the use of irreversible compression in digital radiology including the visual impact of compression (lossy compression) on diagnostic digital images and methods used to evaluate the effects of compression. Each of these will now be reviewed briefly.

VII. VISUAL IMPACT OF IRREVERSIBLE COMPRESSION ON DIGITAL IMAGES

The goal of both lossless and lossy compression techniques is to reduce the size of the compressed image, to reduce storage requirements and to increase image transmission speed.

The size of the compressed image is influenced by the compression ratio with lossless compression methods yielding ratios of 2:1 to 3:1 and lossy or irreversible compression having ratios ranging from 10:1 to 50:1. It is well know that as the compression ratio increases, less storage space is required and faster transmission speeds are possible, but image quality degradation.

VIII. SUMMARY

In this paper we will discuss about what is data compression and irreversible data compression. How we can use JPEG algorithm in irreversible image compression and how it removes the phychiovisual redundancy.

IX. CONCLUSION

The general idea of Irreversible compression is to store the data in compact form by which we can improve the transmission speed and reduce the storage capacity JPEG is the best one algorithm by which we can compress our image files. .In this Algorithm we use the fractals to recognize the pattern and use the DCT ,Wavelet algorithm to Transform in other format like we convert the CrCbCg into YrCbCv .Thus we reduce the phychiovisual redundancy and compress our images files.

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