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# DICOM Image Compression and Decompression Techniques

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**Abstract:** The increasing volume of medical data generated by new imaging modalities is causing many issues in the medical field. All these modalities related to patient(s) are saved in a standard format called DICOM. Uploading and retrieving such large volume of medical data to and from the cloud or other databases is becoming very challenging with this digitization. Hence, we propose to develop a DICOM compression and decompression tool that helps in compressing the medical data and hence reduces time in accessing from central databases or cloud. Here, compression includes both reversible and irreversible (lossless and lossy) techniques depending on users Region of Interest. With reversible compression (Lossless), upon decompression, the image is perfectly reconstructed and numerically identical to the original (i.e. the original and decompressed are perfectly correlated). With irreversible compression, data are discarded during compression and cannot be recovered. Upon compression frequency content to which the human eye is insensitive is removed. Upon decompression, the discarded information cannot be recovered, resulting in some reconstruction interpretation.

**Keywords:** DICOM, compression.

## I. INTRODUCTION

DICOM stands for Digital Imaging and COmmunications in Medicine. It is an international standard related to the exchange, storage and communication of digital medical images and other related digital data [1]. The DICOM standard covers both the formats to be used for storage of digital medical images and related digital data, and the protocols to be adopted to implement several communication services which are useful in the medical imaging workflow. DICOM was born back in year 1993 by initiative of the American College of Radiology (ACR) and of the National Electrical Manufacturers Association (NEMA). It is often referred to as “DICOM 3.0”, as it is an evolution of the previous ACR-NEMA 2.0 standard.

The main purpose of the DICOM standard is to allow cross-vendor interoperability among devices and information systems dealing with digital medical images, as long as all the involved actors comply with the DICOM standard [4]. The modern medical imaging systems and Equipment’s like X-Rays, Ultrasounds, CT (Computed Tomography), and MRI (Magnetic Resonance Imaging) support DICOM and use it extensively. All medical images are stored in DICOM format. The medical imaging equipment’s creates the DICOM files. Each DICOM file not only holds the images but also holds patient information (name, ID, sex and birth date), important acquisition data (e.g., type of equipment used and its settings).

DICOM has become the de-facto standard in medical imaging: today, the vast majority of digital medical imaging systems of all major vendors (including acquisition devices, diagnostic workstations, archives, servers, medical printers, etc.) support and comply with portions of the DICOM standard, depending on the services they implement [1]. Also, DICOM has been widely accepted and adopted by medical institutions, including public and private hospitals, diagnostic centers and analysis laboratories of different sizes.

The reality in today’s medical field is that each DICOM file holds a huge amount of data that is difficult to be stored. Hence, we can use a DICOM compression and decompression tool that helps in compressing the medical data and hence reduces time in accessing from central databases or cloud. Here, compression includes both reversible and irreversible (lossless and lossy) techniques depending on users region of Interest.

## II. LITERATURE OVERVIEW

Ramakrishnan, B [1] propose a method for compressing DICOM images based on the well-known Set Partitioning in Hierarchical Trees (SPIHT) which possess the progressive transmission capabilities useful for telemedicine applications. The author here compares the proposed method with the Joint Photographic Experts Group (JPEG) where the images have to be first compressed to the required level and only then can be transmitted. But in the proposed method, the header and image data is separated from the DICOM image where the header is transmitted first with necessary modifications and then the image data is compressed using SPIHT and transmitted. Here, the author uses two techniques for compression. The techniques are Wavelet Based Compression and SPIHT (Set Partitioning in Hierarchical Trees).

Sathish Kumar.S [2] proposes hybrid image compression model for efficient transmission of medical image using lossless and lossy coding for telemedicine application.

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Here, the author uses Fast- discrete curvelet transform with adaptive arithmetic coding for loss less compression. Since there is lot of demand for increasing the storage space in hospitals, the compression of the recorded medical images is very much necessary. This would infer the necessity for a compression scheme that would give a very high compression ratio. The author here provides a method of employing both methods of compression in an intelligent manner to achieve better compression ratio and less error rate and the regions of diagnostic importance are undisturbed in course of achieving energy efficiency. The proposed method will be evaluated through parameters like mean square error, quality factor and compression ratio.

Lalitha Y.S, M.V.Latte [3], discusses about a medical application that contains a viewer for digital imaging and communications in medicine (DICOM) images as a core module. Here, the author proposes an application that enables scalable wavelet-based compression, retrieval, and decompression of DICOM medical images and also supports ROI coding/decoding. Furthermore, the author specifies that the proposed application is appropriate for use by mobile devices activated in a heterogeneous network. The proposed methodology involves extracting a given DICOM image into two segments, compressing the region of interest with a lossless, quality sustaining compression scheme like JPEG2000, compressing the non-important regions with an algorithm that has a very high compression ratio and that does not focus on quality (SPIHT). The authors convey that with this type of the compression work, energy efficiency is achieved and after respective reconstructions, the outputs are integrated and combined with the output from a texture based edge detector. Thus the required targets are achieved and texture information is conserved.

## III. COMPRESSION METHODS

*A.* Reversible compression (Lossless)

Upon decompression, the image is perfectly reconstructed and numerically identical to the original (i.e. the original and decompressed are perfectly correlated) [2].Lossy image compression is a three step algorithm (Fig 1): In the first step the original image is transformed in order to eliminate the inter-pixel redundancy. Then, quantization is done to remove psycho-visual redundancy. The bits are then encoded to get more compression from the coding redundancy.

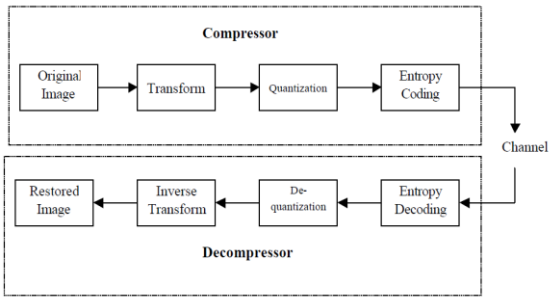


Fig 1: Reversible compression

*B.* Irreversible compression (lossy)

With irreversible compression (Fig 2), data are discarded during compression and cannot be recovered. Upon compression frequency content to which the human eye is insensitive is removed [2]. Upon decompression, the discarded information cannot be recovered, resulting in some reconstruction interpretation.

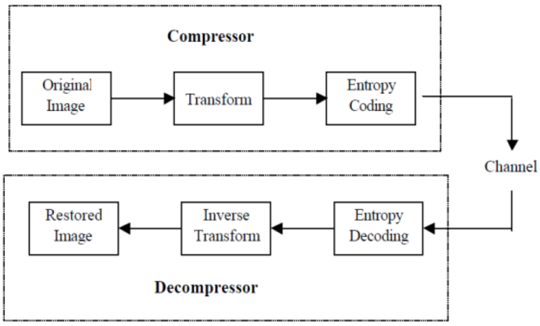


Fig 2: Irreversible compression

Lossless image compression is a two-step algorithm: In the first step the original image is transformed in order to eliminate the inter-pixel redundancy. In the second step, an entropy coder is used to remove coding redundancy.

## IV. PROPOSED SYSTEM

The proposed system uses the JPEG 2000 compression standard for the compression and decompression. The overview of the standard is discussed below:

JPEG 2000 Compression Standard

The JPEG2000 standard provides a set of features that are of importance to many high-end and emerging applications by taking advantage of new technologies. It addresses areas where current standards fail to produce the best quality or performance and provides capabilities to markets that currently do not use compression. The markets and applications better served by the JPEG2000 standard are internet, color facsimile, printing, scanning, digital photography, remote sensing, mobile, and medical image. Each application area imposes some requirements that the standard should fulfill. Some of the most important features that this standard should possess are the following [5].

- Improved compression efficiency
- Lossy to lossless compression
- Multiple resolution representation
- Region of interest (ROI) coding

This wavelet compression is accomplished through the use of the JPEG 2000 encoder1, which is pictured in Figure 3. This is similar to every other transform based coding scheme. The transform is first applied on the source image data. The transform coefficients are then quantized and entropy coded, before forming the output.

The decoder is just the reverse of the encoder. Unlike other coding schemes, JPEG 2000 can be both lossy and

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lossless. This depends on the wavelet transform and the quantization applied.

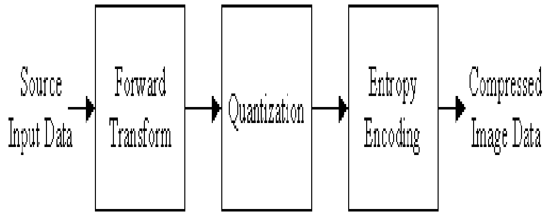


Figure 3: JPEG 2000 Block diagram

The JPEG 2000 standard works on image tiles. The source image is partitioned into rectangular non-overlapping blocks in a process called tiling. These tiles are compressed independently as though they were entirely independent images.

All operations, including component mixing, wavelet transform, quantization, and entropy coding, are performed independently on each different tile. The nominal tile dimensions are powers of two, except for those on the boundaries of the image.

Tiling is done to reduce memory requirements, and since each tile is reconstructed independently, they can be used to decode specific parts of the image, rather than the whole image. Each tile can be thought of as an array of integers in sign-magnitude representation. This array is then described in a number of bit planes.

These bit planes are a sequence of binary arrays with one bit from each coefficient of the integer array. The first bit plane contains the most significant bit (MSB) of all the magnitudes.

The second array contains the next MSB of all the magnitudes, continuing in the fashion until the final array, which consists of the least significant bits of all the magnitudes.

The figure 4 depicts the entire flow chart of the proposed system. Here, initially the input dcm file is read from the MYSQL database. Check if the file is read. If the file is read then perform compression by selecting Region of Interest (ROI).

Here compression is performed by using the patented JPEG 2000 compression standard. If the file is not read then display the message telling us to select the input dcm file and then click compress.

Now browse for output j2k file. If the file is selected then decompress the file using the patented JPEG 2000 standard. If the file is not selected then displays the message telling us to select the output j2k file and then click on decompress.

Now, browse the output dcm file and input dcm file. If the files are selected then perform comparison and display the message if the files are equal or not equal. If the files are not selected then display the message telling us to select the input and output dcm files.

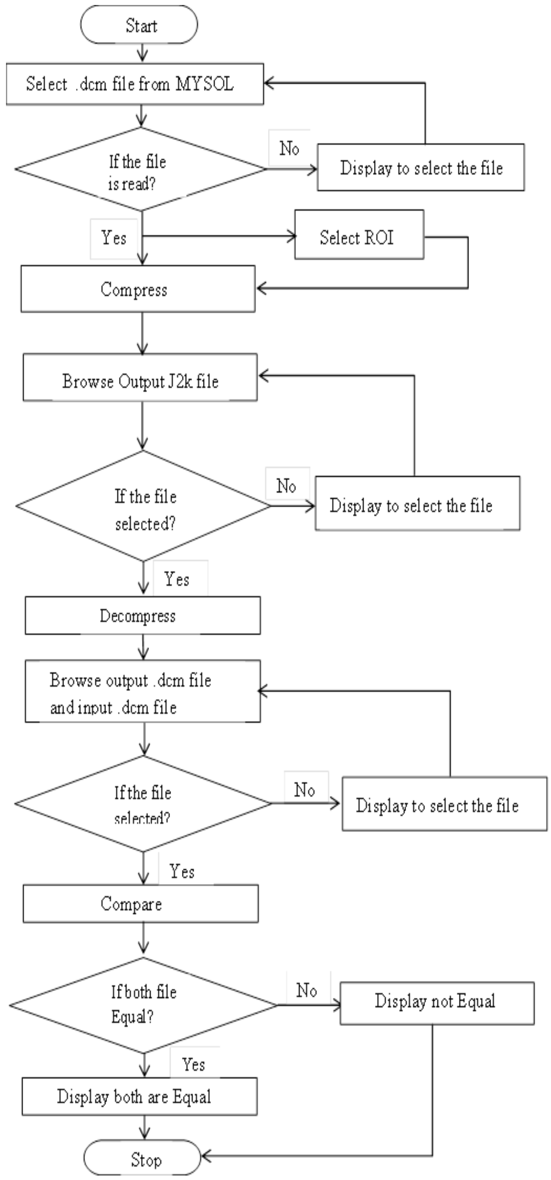


Figure 4: Shows the entire flowchart of the proposed system.

## V. COMPARISION BETWEEN JPEG AND JPEG 2000

JPEG 2000 offers numerous advantages over the old JPEG standard, and several of these advantages will be discussed. One main advantage is that JPEG 2000 offers both lossy and lossless compression in the same file stream, while JPEG usually only utilizes lossy compression. JPEG does have a lossless compression engine, but it is separate from the lossy engine, and is not used very often. Thus, when high quality is a concern, JPEG 2000 proves to be a much better compression tool. Because of the way the compression engine works, JPEG 2000 promises a higher quality final image, even when using lossy compression. Since the JPEG 2000 format includes much richer content than existing JPEG files, the

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bottom line effect is the ability to deliver much smaller files that still contain the same level of detail as the larger original JPEG files. The JPEG 2000 files can also handle up to 256 channels of information as compared to the current JPEG standard, which, by reason of common implementation, is limited to only RGB (red, green, and blue) data.

## VI. CONCLUSION

This paper presents the overview of DICOM standard and various types of image compression techniques. Compression provides a potential cost savings associated with sending less data over switched telephone network where cost of call is really usually based upon its duration. It also reduces the probability of transmission errors since fewer bits are transferred. There are basically two types of compression techniques. One is Lossless Compression and other is Lossy Compression Technique. This paper also presents the various lossy compression methods and lossless compression methods.

This paper also presents the JPEG 2000 technique and the comparisons between JPEG and JPEG 2000. The proposed work helps us to perform compression and decompression of the DICOM files by retrieving the files from the local database MYSQL. But in future our work can be implemented in a cloud computing environment for retrieving and uploading the files from and to the cloud. Also, for selecting the Region of Interest (ROI) and performing lossless compression we are using the manually scalable Threshold. We can further implement to use automated scaling threshold value in order to get lossless compression of the image.

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