Implement of Integration Compression Environment Using Medical Images

Eun-Hyoung Chu* · Mu-Hun Park*

Changwon University

E-mail : miss_chu@hanmail.net

ABSTRACT

Large medical images in PACS are compressed for saving storage space and improving network speed. The integrated compression environment was designed and developed for uniting of various compression methods. Various compression algorithm-RLE compression, lossless JEPG, JPEG, was built into it, complying with DICOM. A image compression using DWT was also implemented in it. And a unified algorithm of lossless compression and lossy compression was designed to improve images quality and to make compression ratios high. And integrated compression environment was operating together with a database program for efficient and user-friendly management.

key word

The integrated compression environment, RLE compression, lossless JPEG, JPEG, DWT

I . Introduction

Medical images in PACS(Picture Archiving and Communication System) are made at many hospitals every day. Large medical images require both large storage space and long transmission time. To overcome these problems, PACS apply lossless compression or lossy compression to medical images[1][2].

Compression methods divide into two classes-lossless compression and lossy compression. Although lossless compression methods can reconstruct compressed source image data without loss of data, lossless compression ratios are about to two from four times as low as lossy compression ratios. Although lossy compression lose source data in compressing images, after undergoing a medical examination for high compression ratios lossy image compression in PACS was performed with requiring a clinical validation[2].

In this paper, the integrated compression environment, was designed and developed for uniting of various compression methods. Various compression methods -RLE(Run Length code) compression, lossless JPEG and JPEG(Joint Photographic Experts Group) -were built into the integrated compression environment and tested, complying with the DICOM 3.0. A compression algorithm using DWT(Discrete Wavelet Transform) was also implemented in it. And a unified algorithm of lossless compression and lossy compression was designed to improve images quality and to make compression ratios high. Diverse medical images can be compressed by each compression methods. And integrated compression environment was operating together with a database program so that related information of medical can be delivered[2][3][4][5].

II. DICOM

DICOM 3.0 Standard specified standard methods for transferring images and associated information between devices manufactured by various vendors, including a hardware interface, a set of software commands, and a consistent set of data formats.

The Data Element structures are defined in Figure 1.

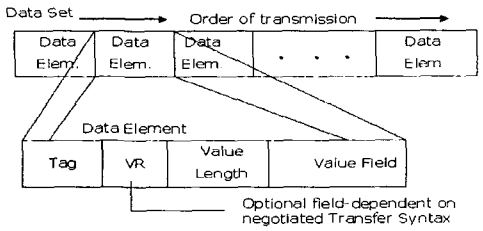


Fig. 1. DICOM Data Structure

A Data Element is made up of fields. Three fields are common to all there Data Element structures; these are the Data Element Tag, Value Length, and Value Field. A fourth field. Value Representation, is only present in the two Explicit VR Data Element structures[3].

III. System configuration

1. compositions of system

Personal computer, 512MBytes memory, and a 19"inch color monitor are used to develop the integrated compression environment. It was implemented by *Visual C++ Program* language for friendly and visual environment.

The integrated compression environment consist of file open, file store, the unified compression using lossless and lossy algorithm, various compression, reconstruction, and information.

Figure2 illustrates the whole integrated compression environment. Figure3 present grouping of implemented compression methods.

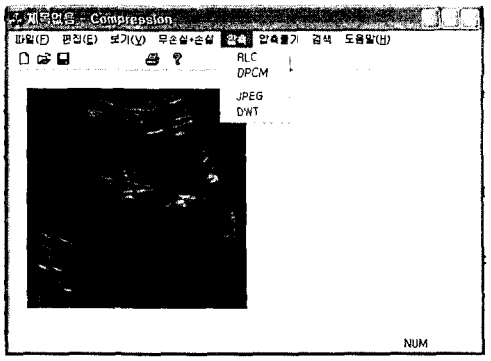


Fig. 2. Universal picture of Integration Environment

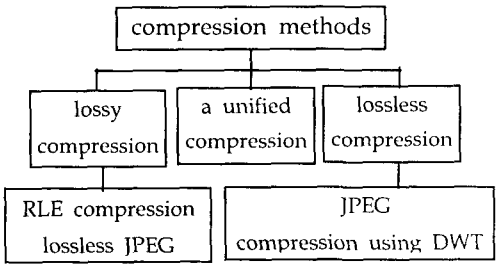
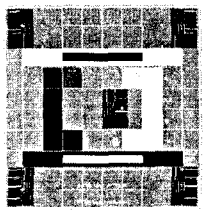


Fig. 3 Various compression methods

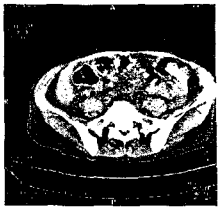
Figure 4 present various medical images that comply with DICOM Standard. Medical images -Standard image, ultrasonic image, MR(Magnetic Resonace) CT(Computer tomography) -had been used to illustrate how a implemented system operate.



(a) Standard image

(b) Ultrasonic image

(c)Magnetic Resonace Image



(d)Computer tomography Image

Fig. 4. Original Images

Table 1. Gray-Level and Capacity of Original Images

	capacity (Kbytes)	magnitude (pixels)	gray -level
Standard image	1024	1024*1024	256 level (0~256)
Ultrasonic image	64	256*256	
Magnetic Resonace Image	64	256*256	
Computer tomography Image	256	512*512	

Measure of the used images, capacity and

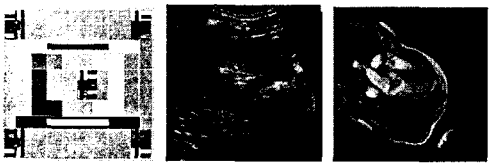
gray-level of images was listed at table 1.

2. Image compression methods

2.1 RLE compression

RLE compression progress according to the following steps. A sequence of identical bytes is encoded as a two-byte code, count and byte value, and a non-repetitive sequence of bytes is encoded as count and literal sequence of bytes[3].

Figure 5 illustrates reconstructed RLE compression images.



(a)Standard image (b)Ultrasonic image (c)Magnetic Resonace Image

Figure 5. Compressed and reconstructed images by RLE compression

2.2 lossless JPEG

Lossless JPEG perform Differential Pulse Code Modulation using surrounding several pixels' similarity and huffman coding estimating statistical data[2][3][6].

Figure 6 present compressed and reconstructed images by lossless JPEG.

(a) Standard image (b) Ultrasonic image (c) Computer tomography Image

Figure 6. Compressed and reconstructed images by lossless JEPG

2.3 JPEG

Baseline JPEG consist of the following steps. JPEG provides image into 8*8 pixels, performs DCT on each 8*8 block, quantizes DCT coefficient of each block, and encodes data streams taken zigzag scan with huffman codin g · RLE. Figure7 present compressed and reconstructed images using JPEG. Although JPEG is loss compression algorithm, difference between original images and reconstructed images was not recognised by the naked eye[1][2][3][6].

(a) Standard image (b) Ultrasonic image (c) Computer tomography Image

Figure 7. Compressed and reconstructed images using JPEG

2.4 A compression using DWT

The discrete wavelet transform was first applied on the source image data. The transform coefficients are then quantized and coded by huffman encoding · RLE compression.

The decoder is the reverse of the encoder.

Figure 8 was to present compressed and reconstructed images using DWT[6][7][8][9].

(a) Standard image (b) Ultrasonic image (c) Magnetic Resonace Image

Figure 8. Compressed and reconstructed images using DWT

2.5 A unified compression algorithm using lossless and lossy compression

After consulting a doctor, source data of parts of disease were performed lossless compression algorithm and the other data were applied by lossy compression algorithm to improve high ratio compression and to acquire great image quality performance

A unified compression algorithm Compression algorithm using lossless and lossy compression consist of DPCM and JPEG based on DCT[2][3][5][6].

Figure 9 present compressed and reconstructed images using lossless and lossy compression algorithm.

(a)Standard image (b)Ultrasonic image (c)Magnetic Resonace Image

Figure 9. Compressed and reconstructed images using lossless and lossy compression algorithm

3. Compression ratios by various compression

Compression ratios of various compression methods was listed at Table 2. RLE compression and lossless JPEG can reduce network loads. And because JPEG and a compression method using DWT have high compression ratios, these methods can save storage space and reduce transmission time on condition that losing data don't have influence on clinical effects.

Table 2. Compression ratio of Various Compression Methods

the type of compression	medical images	compression ratios
RLE compression	Standard image	6.2 : 1
	Ultrasonic image	1.3 : 1
	Magnetic Resonace Image	1.6 : 1
lossless JEPG	Standard image	2.8 : 1
	Ultrasonic image	1.7 : 1
	Computer tomography Image	1.9 : 1
JPEG	Standard image	14.1 : 1
	Ultrasonic image	11.4 : 1
	Computer tomography Image	7.1 : 1
the compression using DDWT	Standard image	14.2 : 1
	Ultrasonic image	10.8 : 1
	Magnetic Resonace Image	13.4 : 1

4. Database

Databases for the integrated compression environment were managed by MS Access program that supports SQL and window ODBC(Open Database Connectivity). In a paper a table was made to manage related images informations and patients' data, adjusting IOD(information Object Definition) in DICOM standard[3][10].

Table 3. Image Table Structure

Field	Type	Length
patients' name	char	20
patients' ID	char	20
images' name	char	50
the type of compression	char	10
the path of compressed images	char	100

Table 3 present a database table structure. Figure 10 present a database working part

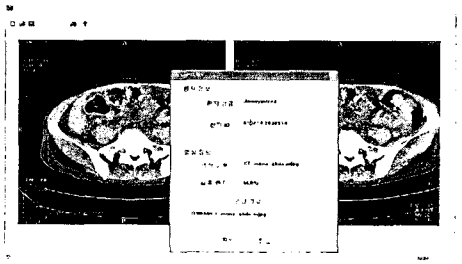


Fig. 10. DataBase Working Picture

IV. Discussion

Medical images have been compressed to save storage space and to improve network transmission speed in PACS.

The integrated compression environment, designed in this paper, can compress various medical images such as CT, MR, ultrasonic images. Compression algorithms - RLE compression, lossless JPEG and JPEG -have been built into the integrated compression environment, complying with DICOM Standard. Also, a compression algorithm using DWT and a unified algorithm of lossless and lossy compression was developed in it. The integrated compression environment can operate together with database program about image

information and patient's data for efficient and friendly use.

Studying fields in future are about ways to increase compression ratios in JPEG and a compression algorithm using DWT and ways to select areas of compression in accordance with the type of image and important degrees.

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