Design and implementation of Motion-JPEG on Medical imaging Application

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Abstract: - Medical Imaging is being increasingly used to display and analyze data obtained from different acquisition equipments. The distribution rate of PACS is getting higher in many hospitals, but it is coming to the front in a matter of great importance - processing of medical imaging with efficiency, swiftness, an analysis and a delivery of physician's opinion. In this paper, we propose the efficient method to be able to decipher hundreds of medical images. On exploring the Motion-JPEG (M-JPEG), this paper showed the possibilities for the management of medical images with the design of each JPEG file format and the improvement to diagnose the moving pictures.

Key-Words: - PACS, DICOM, JPEG, Motion-JPEG.

1 Introduction

PACS (Picture Archiving and Communication Systems) transmits and receives a DICOM (Digital Imaging Communication in Medicine) image at the network environment. The demand to utilize medical images and information stored in high-capacity memory equipments is increasing in the wired/wireless Internet environment using PC or mobile terminals. The data used in hospitals needs to process a significantly high-capacity image communication. In this kind of situation, the physicians need to invest a lot of time for deciphering medical images. In order to improve these problems, it needs the technology to compress and playback the moving pictures with hundreds of medical images. For implementing the technology with these hundreds of pictures, M-JPEG can be a candidate [1][2].

M-JPEG uses intraframe coding technology that is very similar in technology to the I-frame part of video coding standards. It means that the medical images can be thought as I-frame. M-JPEG is also commonly used in internet blog, a design of the background for mobile terminals or moving picture imaging [2][3]. Fig. 1 shows the Ever Media Player (KTFT) like M-JPEG viewers [4]. It has the low resolution files to be adjusted to the usage of mobile terminals. Fig. 2 shows the interface of PACSPLUS that is a DICOM image viewer from Medical Standard [5].

Fig. 1. Ever Media Player (KTFT).

PACSPLUS can playback the moving pictures with each DICOM image. This paper tries to improve the efficiency of management and transmission as making an M-JPEG file format.

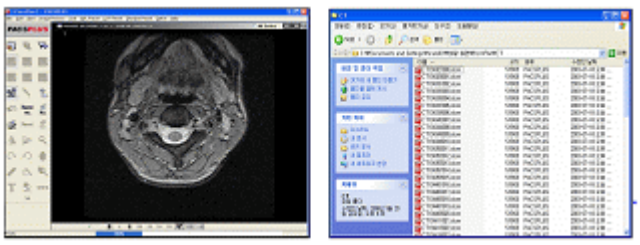

Fig. 2. Medical Standard PACSPLUS

PACS will store DICOM objects and data from all the enterprise's information systems, including radiology, laboratory, cardiology, billing, and other administrative applications. Fig. 3 shows an overview

of a full PACS system. It describes PACS ability to capture X-ray, MR, CT and ultrasound images in a digital format and allow these images to be accessed by physicians via computer for immediate diagnosis.

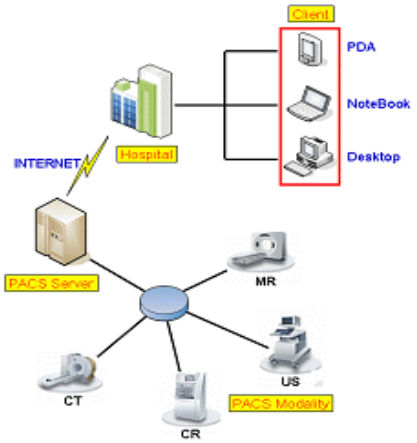

Fig. 3. A general PACS system.

DICOM is a standard communication protocol that has been adopted in PACS. In general, DICOM specifies that image information represents an Information Object which is defined in Information Object Definition (IOD) [6]. Such an IOD includes attributes which are patient's name, an examination type, a date and etc. The attributes of an IOD describe the properties of a Real-World Object Instance. The related attributes are grouped into modules which represent a higher level of semantics documented in the module specifications found in Annex C of the DICOM standard. The commanding words are relating to Service Classes which are defined in DICOM Message Service Element (DIMSE). Attributes are encoded as Data Elements using the rules, the Value Representation and the Value Multiplicity concepts specified in PS 3.5 of the DICOM Standard. For specific Data Elements, the Value Representation and Value Multiplicity are specified in the Data Dictionary in PS 3.6 of the DICOM Standard. In this paper, we have used some part among current DICOM standards.

Table 1 and 2 show an example of a patient IOD with some modules and a patient identification module with some attributes.

2 M-JPEG (Motion-JPEG)

M-JPEG is the technology that each video frame was compressed to a JPEG file format and deal with a JPEG compression/restoration by real time. It is also

Table 1. An example of patient IOD.

Module	Module description
Common SOP	SOP contains the common information.
Patient relationship	Refer the related patient SOP
Patient identification.	Identification of a patient
Patient description	Description of patient information
Patient diagnosis	Medical examination information

Table 2. An example of patient identification modules.

Attribute	Tag	Description
Name	(0010, 0010)	Patient name
Patient ID	(0010, 0020)	Patient ID or code related hospital identification
Issuer of patient ID	(0010, 0021)	Facility name issuing patient ID
Birthname	(0010, 1005)	patient birthname
Mother's birthname	(0010, 1060)	Mother's birthname
Medical record material identifier.	(0010, 1090)	Identifier to find the previous medical record

applied to the motion picture compression method with still images. M-JPEG is based on a JPEG image, and be kinds of the moving picture streams which listed between JPEG frames as putting time information [7][8]. As a standard is not fixed, every each vendor is developing the codec independently unlike M-JPEG2000. The relating codec can be founded by Pegasus[1] and Morgan Multimedia[2] Co. Ltd with a charge. Since the implementation of M-JPEG is easier than that of other moving picture file formats, it can be possible to process for reading, encoding, transforming, decoding and displaying for image data. In case of medical application, the image quality, which is one of important issues, has been uniformly maintained regardless of the data complexity. It showed the disadvantage relating to the compressibility or large amount of data size, but such problems are supplemented by developing M-JPEG2000 [9][10].

2.1 JPEG

The JPEG standard for image compression is comprised of a toolkit that has three distinct components: baseline lossy, extended lossy, and lossless. A baseline lossy JPEG - the most widely implemented of the three different approaches, utilizes

[1] http://www.jpg.com/pvmjpegdownload.htm
[2] http://www.morgan-multimedia.com/technicalsV3.htm

the discrete cosine transform (DCT) to decompose an image into sets of spatial frequency coefficients. The characteristics of JPEG2000 [8][9] can embody the lossy and lossless compression at the same time in one encoded bit stream, and has shown more excellent quality than the existent JPEG with the high compressibility.

JPEG is used in various ways in the current hospitals - from the comparison before/after surgical operation of skin clinic to the transmission for the optimized JPEG image on Internet. For example, a foreign company GENESIS Digital Imaging, Inc.[3] developed the Omni-WEB PACS which used a JPEG compression technique. In domestic hospitals, the PACS solution MAROSIS from Marotech, Inc. has been established in EulJi university hospital with the JPEG2000 compression technology and proved the high quality of an image. The web-based PACS solution named STARTPACS.net from Infinitt, Inc.[4] has been applied to the JPEG2000 compression on the low bandwidth and be able to show the efficient image display.

2.2 Design of M-JPEG File Format and Transmission Packet

In order to implement the M-JPEG compression, there are many approaches but it is better idea that is making one M-JPEG file with multiple JPEG images. The reason is that there is no specific M-JPEG file format. A JPEG image is including the marker regarding information related to the output and compression of an image in files. The marker indicates the starting part as a SOI (Start of Image, 0xffd8) and the ending part as EOI(End of Image, 0xffd9). The file format was reconstructed by putting the frame header information before the JPEG frame. The information of the amount and dimension of a JPEG image is stored in the frame header. The file header contains the string 'MJPEG' showing the M-JPEG file identification, the whole size and the number of frame. Fig. 4 showed the proposed M-JPEG file format. The M-JPEG file has the advantage for the network transmission by containing the header information. In addition, it can be possible to find out the file information with only header information. For example, when we have a 300 DICOM images as of each image 516KB, the total amount of DICOM images become 154MB. As a result of the encoding process to M-JPEG file, the size of a DICOM image is reduced by 27KB and the total amount of a single M-JPEG file is reduced by 8MB.

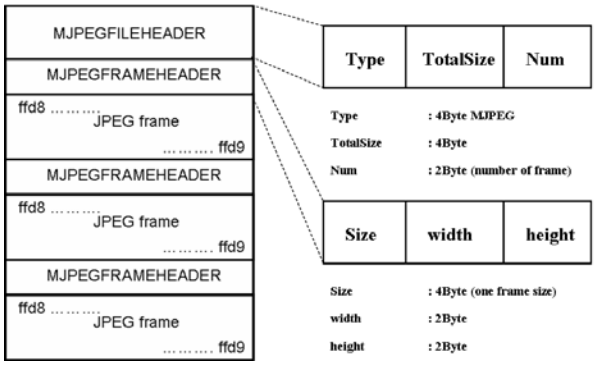

Fig. 4. M-JPEG file format.

Since the application program distinguishes the allocated process properly and figures out the memory size, it is necessary to design the packet structure as shown in Fig. 5, Table 3 and 4.

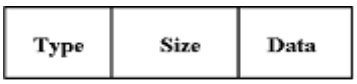

Fig. 5. A simple packet structure.

Tale 3. A Network Packet

	Size	Description
Type	1Byte	PACKET_CONTENT PACKET_MJPEGFILEHEADER PACKET_MJPEGFRAMEHEADER PACKET_MJPEG PACKET_MJPEGLIST PACKET_MJPEGSELECT PACKET_MJPEGLISTCHAGE PACKET_NOFILE
Size	4 Bytes	Size of image
Data	4500 Bytes	MJPEGFILEHEADER MJPEGFRAMEHEADER Image data MJPEG file name

3 The experimental results

M-JPEG is a kind of moving picture streaming technology with a JPEG compression scheme to each frame. In general, the end user downloads the encoded moving picture file from the internet or other network and playbacks it in real time. M-JPEG system also has similar functions such as the management of encoded DICOM images and the playback the transmitted M-JPEG files. Fig. 6 shows the diagram of M-JPEG system. In order to implement these systems, three

[3] http://www.genesisdigital.com/medwebpacs.php
[4] http://www.infinitt.com

Table 4. A packet description.

PACKET	Description
PACKET_CONNECT	The server delivers the connectivity to the client
PACKET_MJPEGLIST	Transmission for M-JPEG file list managed on a server
PACKET_MJPEGLISTCHANGE	Notification for the changes of M-JPEG file list on a server
PACKET_MJPEGSELECT	The client requests the M-JPEG file from a server
PACKET_MJPEGFILEHEADER	Transmission of M-JPEG file header information
PACKET_MJPEGFRAMEHEADER	Transmission of M-JPEG file frame information
PACKET_MJPEG	Transmission of M-JPEG packet information
PACKET_NOFILE	Notification of the requested file existence

parts is applied. Table 5 describes the implemented modules of the M-JPEG system.

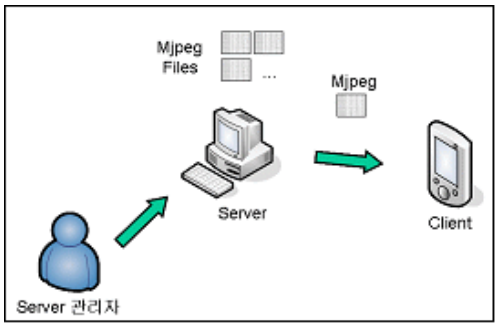

Fig. 6. The diagram of M-JPEG system.

In our experiment, the proposed system employed the M-JPEG encoder/decoder for the personal computer and an Intel Pentium 4 with windows XP OS. For the implementation of application development, we used Visual C++ 6.0 and the MFC (Microsoft Foundation Class) library for the UI(User Interface). A PDA which was a client used Embedded Visual C++ 4.0 MFC to Windows CE Pocket PC 2003 environments, and used a VOImage library for JPEG output.

Table 5. The description of implemented modules.

Module	Description
M-JPEG Encoder/Decoder (PC)	A server manages the generation and management of a M-JPEG file from a series of DICOM images
M-JPEG Server (PC)	A server transmits a M-JPEG file according to the client's request
M-JPEG Client (PDA)	A client decodes and display the transmitted M-JPEG file.

3.1 Encoder

In order to encode the DICOM images to M-JPEG file, we first converted the a set of images to JPEG format by Intel library IJL 1.5 version. The hundreds of DICOM images are stored sequentially the designated file folder and a server generates the encoded file with a M-JPEG format by connecting the starting and ending marker of each JPEG images. At this time, the MJPEGFRAMEHEADER has been put between the MJPEGFILEHEADER and JPEG image. By doing these processes, the M-JPEG file is generated. Fig. 7 describes the M-JPEG encoding process.

Fig 7. A M-JPEG encoding process.

For further description, when we execute the implemented application program in this paper, we have a user interface window. Once we selected the [M-JPEG] and [Encode] on a pull-down menu, the dialog is popped out as shown in Fig. 8.

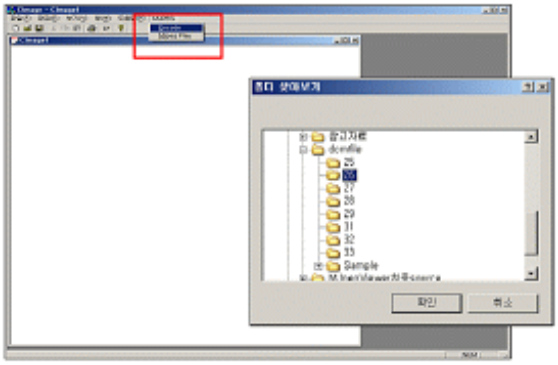

Fig. 8. The example of user interface window.

From the folder which is contained DICOM files to encode, it indicates the file information to generate the M-JPEG file - a path of the selected folder, a file name, and whether it is the right DICOM file or not. The fundamental path to be created for the M-JPEG file can be designated by pressing the MJPEGFiles or [path setting]. The Fig. 9 shows the encoding setting process. After the encoding process, it results in the generation of the M-JPEG file as shown in Fig. 10.

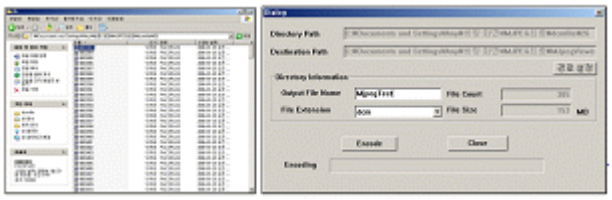

Fig. 9. A encoding setting process.

Fig. 10. The M-JPEG file generation.

3.2 Decoder

In order to playback the M-JPEG moving picture, the user loads the M-JPEG file from the application program viewer. Using the linked list algorithm as shown in Fig. 11, the generated file shows the efficiency for playback and the selection of the interested frame.

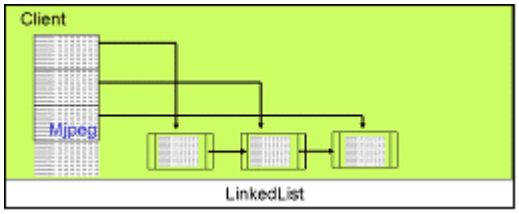

Fig. 11. The linked list approach for the created M-JPEG file.

After the user selects the M-JPEG file to be decoded (Fig.12), the user chooses the menu [MJPEG] --> [Play MJPEG] and the selected file is playbacked. Fig. 13 shows the implemented M-JPEG moving picture.

Fig. 12. The selection of M-JPEG file to be decoded.

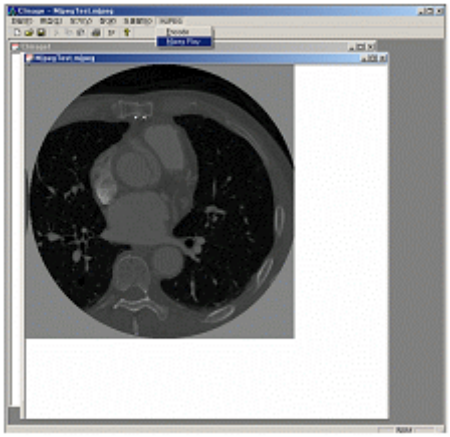

Fig. 13. The replay of the implemented M-JPEG file.

3.3 Server application program

In a server application, the server manages the addition and the deletion of the relevant files and folders and notifies the communication to the client automatically. Table 6 shows the description of the server's actions. Fig. 14 shows the example of the server execution.

Table 6. The description of the server functions.

Module	Description
Execution	Load and display of M-JPEG file information
Initiation	Prepare the request of the client's access
Access and disconnection	Monitor the real-time access and disconnection of the client
Change of the M-JPEG list	Notify the list change/modification to the connected client
Communication	Communicate with a client without user input automatically.

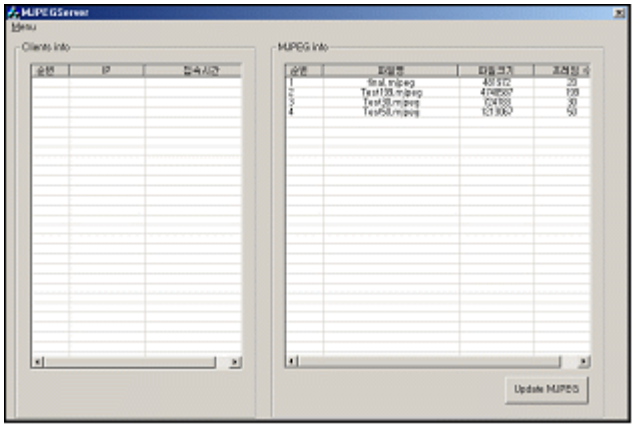

Fig. 14. The example of a server execution

When a client is connected, the server displays the client information. If the M-JPEG files need to be update, the server manager notifies the updated information by clicking the [Update MJPEG] button as shown is Fig. 15. The directory to manage the M-JPEG files is located in the project folder.

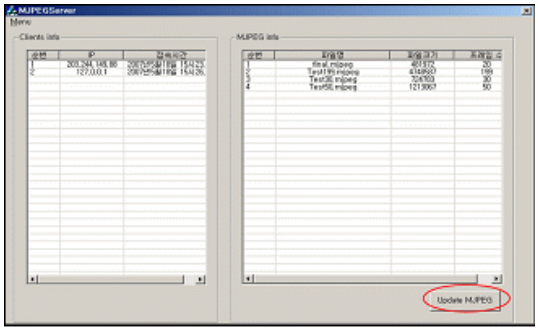

Fig. 15. Display of the file information.

3.4 Client (PDA) application program

A PDA client leads an activation of a server by informing the requested work to a server. Table 7 describes the client application functions.

Table 7. The description of the client functions.

Module	Description
Execution	A client is executed
Access to a server	Connect to a server with IP and port information and wait the packet whether it is connected or not
Access completion	If the access is completed, the client gets from a M-JPEG list and stores to a M-JPEG list Dialog from the server.
Notification of the updated list	If updated, a client gets the new information.
Display the M-JPEG list dialog	Display a list to identify the M-JPEG files
M-JPEG file selection	Select a M-JPEG file and transmit the relavant file to the server.
Display	Display the M-JPEG file

The Fig. 16 shows the an initialization stage after executing a PDA. This screen capture is utilized by Cerdisp (Remote Display Control application from Microsoft) to monitor the real-time PDA process.

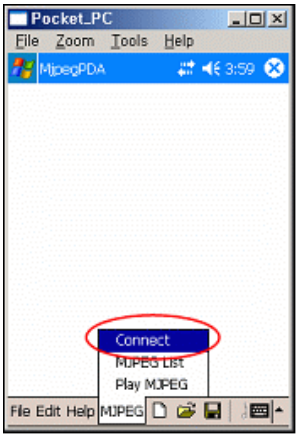

Fig. 16. The initiated stage of a PDA

After clicking the [Connect] menu, it displays the dialog to put the server IP and port number in Fig. 17.

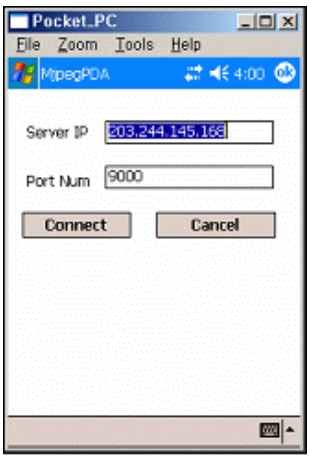

Fig. 17. A server access.

From the [MJPEG List] menu, it displays the transmitted M-JPEG files as shown in Fig. 18. The each file contains the file name, file size and the number of frames.

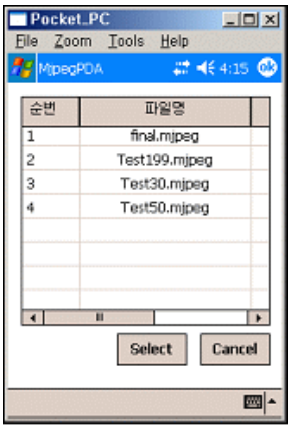

Fig. 18. A search of M-JPEG file list

In order to display the selected M-JPEG file, it playbacks the created moving picture. Fig. 19 shows one snapshot from the moving picture.

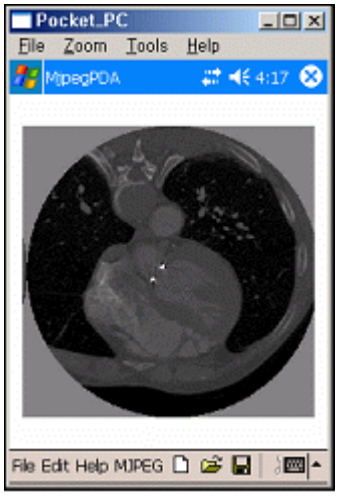

Fig. 19. An snapshot of the M-JPEG moving picture.

In our experiment, we used the 300 frames of CT heart images (each 516KB) and 320 frames of MR renal images (each 514KB) formatted by DICOM standard. and reproduce the M-JPEG file. The encoding, decoding and playback time showed 30 seconds, 4 seconds, and 27 seconds respectably. In PDA environment, the experiment resulted in a bit interruption with the limitations of PDA performance in comparison with a desktop PC. Hereafter, the DICOM images are acquired and assured without the seamlessness by the acquisition equipment, there will be no inconvenience for the physicians.

4 Conclusions

In medical image processing, the M-JPEG technology might bring the loss if the image difference is bigger and bigger between frames in a computation of the motion vector in comparison with other codecs like MPEG-4 or H.264. In this paper, we showed the capability of the fast diagnosis and the efficiency to diagnose the hundreds of images. With a development of hardware performances, it can be applicable in the ubiquitous environment using the mobile terminals.

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