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Research Article

Research on Conversion of DICOM Multi-Frame Medical Image in to Multimedia Format using MATLAB

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Abstract

DICOM standard has been widely used, most of domestic and international medical imaging equipment such as Computed Tomography, Magnetic Resonance, Positron Emission Tomography etc. has supported DICOM standard. DICOM image contain image and image related information. Read DICOM structure by using matlab and pixel data from multi-frame image are written in to multimedia file. Numbers of images are tested from Computed Tomography, Magnetic Resonance, Positron Emission Tomography, Nuclear Medicine etc. All of them can be converted in to multimedia format. Converted multimedia files can fully meet the demand, which facilitate physicians for better observing the dynamic process of the examining position of patients. Therefore, Converted multimedia file helps physician to diagnosis diseases and improve diagnostic quality and efficiency.

Keywords: *DICOM, Medical Imaging; DICOM file; Multi-frame Imaging.*

1. Introduction

Digital Imaging and Communications in Medicine is the industry standard for transferal of radiologic images and other medical information between computers (N. S. Ujgare, S. P. Baviskar, 2013). Most of medical imaging equipment such as Computed Tomography, Magnetic Resonance, and Positron Emission Tomography etc. has supported DICOM standard. Numbers of multi-frame images exist in DICOM standard, which reflect the dynamic process of the examining position of patients. But, DICOM file is complex. So, common image processing software cannot display, convert and process the DICOM file. Hence it is necessary to read DICOM file and converting the DICOM image files to common format. There are two methods to accomplish it. One is converting DICOM file to bitmap format and then converting bitmap to other formats. Second is read DICOM files and converting them to common formats directly such as JPEG, PNG and TIFF without the help of the bitmap format (LU Xiao-qi, 2010). Both of the methods concentrate on converting DICOM file to the static image format. However, static image format can only reflect the information of the DICOM single frame image or one of the frames in DICOM multi-frame image. Hence, it is necessary to read DICOM file, and convert into multimedia file for display the whole dynamic process and reflect the dynamic information of examining position of patients. It facilitate physician to observe dynamic information for diagnosing patients (Yu GU, Baohua ZHANG, 2010).

2. History of DICOM

DICOM is the First version of a standard developed by American College of Radiology (ACR) and National Electrical Manufacturers Association. As the development of digital computers and equipment started in the 1970's an idea of using digital imaging equipment in medicine has become a reality. In the beginning of the 1980s, it was very difficult for anyone other than manufacturers of computed tomography or magnetic resonance imaging devices to decode the images that the machines generated. Radiologists and medical physicists wanted to use the images for dose-planning for radiation therapy. ACR and NEMA joined forces and formed a standard committee in 1983. Their first version named ACR/NEMA standard version 1.0 was released in 1985. Two revisions of the standard, in October 1986 (No. 1) and in January 1988 (No. 2), followed the initial version 1.0.

In 1988 new material was included in the new revision of the standard and version 2.0 was created. This version gained more acceptances among vendors. In 1993 the third version of the standard was released. Its name was then changed to "DICOM" so as to improve the possibility of international acceptance as a standard (Mario Mustra, Kresimir Delac, 2008).

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3. Related Work

3.1 DICOM image

DICOM stands for "Digital imaging and communication in medicine". It was created by the National Electrical Manufacturers' Association (NEMA).It was created for improve compatibility and workflow efficiency between imaging systems, medical devices, and other information systems used in a hospital environment. This has become the principal standard for the communication of medical images. The basic difference between a DICOM image and an image in other formats like JPEG, TIFF, GIF is that DICOM image contains a 'header' with information such as patient demographics, machine, scan parameters, and a host of other non-image data. DICOM image also contain image data. Thus it is possible to identify the origin of the image, the patient, data acquisition parameters of the study and so on, even if a single image is analyzed in isolation. The adoption of DICOM standards by medical imaging equipment vendors has helped in effective cross-machine communications and made possible integration of imaging equipment from different manufacturers (M. H. Shwehdi, M. A. Abdul-Malek, 2003).

3.1.1 Window display of DICOM image

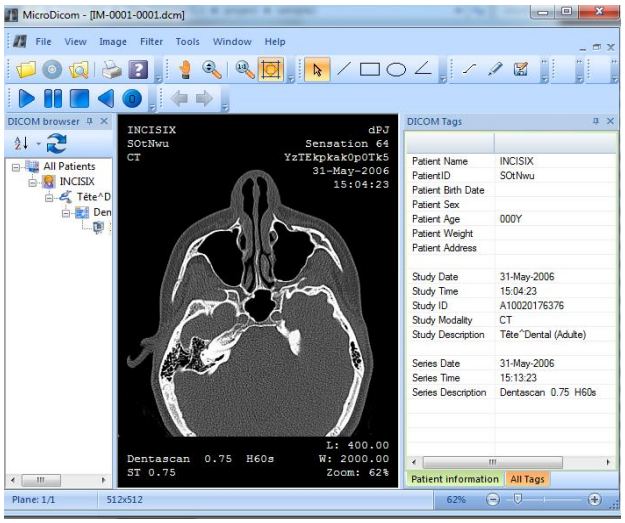

Fig.1.DICOM image

Pixel data stored in DICOM files are 12 bits or 16 bits. But, CRT can only display 8 bits grayscale data. So window display of DICOM image is needed to set window width and window center. Thus, 12 bits or 16 bits can convert to 8 bits by setting window width and window center. Window width refers to the width of displaying images while window center refers to the center of displaying images. Window width and window center can be set according to DICOM images of their own characteristics when programming to implement converting DICOM multi-frame to multimedia.

3.2 Structure of DICOM file

A DICOM file has the following structure

- A preamble of 128 bytes.
- Prefix (4 bytes) where are stored the letters 'D', 'I', 'C', 'M' which represent the signature of the DICOM file.
- Data Set that stores a set of information, such as type of image, Patient name, Patient sex , size of the image, etc
- Pixels that compose the image (s) included into the DICOM file.

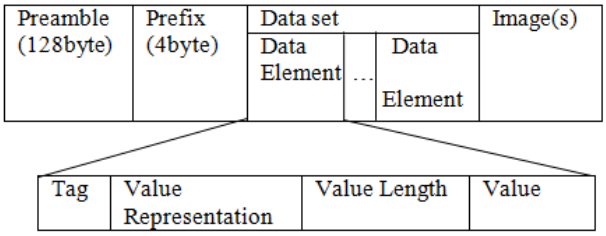

Fig.2. Structure of DICOM file

3.2.1 Data Set

Data Set is collection of Data Elements. Each data element is composed of four parts: tag, value representation (VR), value length (VL) and value. Tag is a unique identifier for a Data Element. The tag is l6 bits unsigned integer ordered pair (gggg, eeee), first 8 bit represent Group number and next 8 bit represent Element number. Value Representation describes the type of data. It describes the size for the value contained in Data Element. Bit of value length is either 16 or 32-bit. It depend on value Representation whether value Representation is explicit or implicit. An even number of bytes containing the Value(s) of the Data Element

3.2.2 Image Coding

Pixel data compose the image. Pixel data (7EE0, 0010) is the last element in data set .it is the most important data unit which contains the data. Pixel data display the medical image. So the pixel data in DICOM file is needed when convert DICOM image to multimedia format or common image format (Liana Stanescu, Dumitru Dan Burdescu, 2006).

3.3 DICOM Services

3.3.1 Composite Services

The composite services were used initially only with images that contain information derived from pixel data, equipment, and patient identification number. Composite Services were intended for storage (C-STORE), query (C-FIND), retrieval (C-GET), and

transfer (C-MOVE) of images. Composite services are useful for other types of information, such as interpretation reports. Composite services are useful in Interpretation data interchange area.

3.3.2 Normalized Services

Normalized services were designed to provide broader information management functionality. Normalized services support the basic information management operations such as create (N-CREATE), delete (N-DELETE), update (N-SET), and retrieve (N-GET), domain-specific operations (N-ACTION), Notification service (N-EVENT-NOTIFY).

3.4 Multimedia Format

3.4.1 AVI (Audio video interleave)

AVI files are a standard developed by Microsoft and it is very popular video file format. It is an uncompressed file format. AVI file is too huge and it will be difficult to be transferred over the Internet. AVI files are mainly used for editing. They are not much of a video sharing format. Most popular video players can open in AVI file format. AVI file can be coded using a variety of codecs.AVI file supports multiple video or audio streams. It supported by video players and mobile devices.AVI contain video and audio data in file container.

3.4.2 WMV (Windows Media Video)

File size is small. File size after compression is very small, which results in poor quality. WMV files are used for streaming and downloading content over the Internet. Windows Media Player is mainly used for play. WMV is used to store video data in a compressed format. WMV was basically Microsoft's version of Real Video's online streaming formats. WMV is a file type which can contain video in one of several video compression formats developed by Microsoft. It is Difficult to play WMV on Apple or Linux players.

3.4.3 MPEG-4 (MP4)

The Motion Picture Experts Group is an international group that was created to develop standards for audio and video file formats. MP4 is a video format mainly used by camcorders and cameras that is gaining popularity. The quality of a video coded using MP4 is very high. Size of file is relatively small. .MP4 standard is becoming more popular than FLV for online video sharing. It is compatible with both online and mobile browsers .it also supported by the new HTML.MP4 audio and video can streamed over internet. MP4 is container format. It can used to store audio and video data.MP4 does not have standard method for coding audio and video information. In MP4 codec is effects on video quality and compression.

4. Proposed System

4.1 Convert DICOM image to AVI Multimedia format

Audio Video Interleave, known by its acronym AVI. It is a multimedia container format. It is introduced by Microsoft in November 1992 as part of its video for Windows technology. Image quality is clear. it can be used across multiple platforms. It is predominant video format because Windows are versatile and Application Program Interface (API) is simple for developing AVI. Core principle of converting DICOM multi-frame image to AVI format is that the pixel data in each frame are written into AVI stream sequentially and then AVI files are created.

Algorithm

Step 1: Read DICOM file for getting information from image.
Step 2: Create AVI file and AVI stream type is set to video stream format.
Step 3: Set variant 'i' to represent first frame.
Step 4: Store DICOM tag information in data file.
Step 5: Convert DICOM image frame array to grayscale.
Step 6: Write grayscale pixel data in to the AVI file using video writer.
Step 7: Set variant 'i+1'to represent second frame.
Step 8: Repeat from step 4 to step 6.
Step 9: When grayscale pixel data from last frame written in to AVI file then close the AVI file.

First of all, Read DICOM files for getting pixel data in it. If file read in DICOM standard, it indicates that format conversion can be done. Secondly, initiate AVI structure. AVI file is created and AVI stream type is set to video stream format. After that AVI file is created successfully. All frames are read from DICOM multi-frame image. Set variant 'i' to represent first frame. After that Convert DICOM image frame array to grayscale. Write grayscale pixel data in to the AVI file using video writer. Grayscale pixel data in each frame are written into AVI frame correspondingly from the first frame to the last frame. When grayscale pixel data from last frame written in to AVI file then close the AVI file

4.2 Convert DICOM image to WMV multimedia format

Windows Media Video (WMV) is a compressed video compression format for several proprietary codecs developed by Microsoft generally contain. WMV files both video and audio components. WMV video uses Windows Media Video encoding, and WMV audio uses Windows Media Audio encoding. Core principle of converting DICOM multi-frame data in each frame are written into AVI stream sequentially and then AVI files are created.

Algorithm

Step 1: Read DICOM file for getting information from image.

Step 2: Create WMV file and customize profile, create profile manager object and writer object.
Step 3: Set variant 'i' to represent first frame.
Step 4: Store DICOM tag information in data file.
Step 5: Convert DICOM image frame array to grayscale.
Step 6: Compress grayscale pixel data from image because WMV is compress format.
Step 7: Write compressed grayscale pixel data in to the WMV file using video-writer.
Step 8: Set variant 'i+1'to represent second frame.
Step 9: Repeat from step 4 to step 7.
Step 10: When grayscale pixel data from last frame written in to WMV file then close the WMV file.

Read DICOM files for getting pixel data in it. If file read in DICOM standard, it indicates that format conversion can be done. Secondly, initiate WMV structure. WMV file is created, customize profile and WMV stream type is set to video stream format. After that WMV file is created successfully. All frames are read from DICOM multi-frame image. Set variant 'i' to represent first frame. After that Convert DICOM image frame array to grayscale. Write grayscale pixel data in to the WMV file using video writer. Compress grayscale pixel data from image because WMV is compress format. Compressed Grayscale pixel data in each frame are written into WMV frame correspondingly from the first frame to the last frame. When grayscale pixel data from last frame written in to WMV file then close the WMV file

4.3 Convert DICOM image to MP4 multimedia format

MP4 is method of defining compression of audio and visual digital data. It was introduced in 1998 by ISO/IEC moving picture expert group.MP4 is used for CD distribution, compression of AV data for web, used for steaming media, for voice broadcast television application. Core principle of converting DICOM multi-frame image to MP4 format is that the pixel data in each frame are written into MP4 stream sequentially and then MP4 files are created.

Algorithm

Step 1: Read DICOM file for getting information from image.
Step 2: Create MP4 file and MP4 stream type is set to video stream format.
Step 3: Set variant 'i' to represent first frame.
Step 4: Store DICOM tag information in data file.
Step 5: Convert DICOM image frame array to grayscale.
Step 6: Write grayscale pixel data in to the MP4 file using video-writer.
Step 7: Write compressed grayscale pixel data in to the MP4 file using video-writer.
Step 7: Set variant 'i+1'to represent second frame.
Step 8: Repeat from step 4 to step 7.
Step 9: When grayscale pixel data from last frame written in to MP4 file then close the MP4 file.

First of all, Read DICOM files for getting pixel data in it. If file parse in DICOM standard, it indicate that format conversion can be done. Secondly, initiate MP4 structure. MP4 file is created and MP4 stream type is set to video stream format. After that MP4 file is created successfully. All frames are read from DICOM multi-frame image. Set variant 'i' to represent first frame. After that Convert DICOM image frame array to grayscale. Write grayscale pixel data in to the MP4 file using video writer. Compress grayscale pixel data from image because MP4 is compress format. Compressed Grayscale pixel data in each frame are written into MP4 frame correspondingly from the first frame to the last frame. When grayscale pixel data from last frame written in to MP4 file then close the MP4 file

4. Result and Discussion

Table 1 Comparison between sizes of DICOM file, AVI file, WMV file, MP4 file

DICOM Modality	No. of images	Size of DICOM file	Size of AVI file	Size of WMV file	Size of MP4 file
CT-sample1	361	181MB	4.2MB	1.75MB	1.13MB
CT-sample2	145	72.6MB	2.11MB	1.56MB	1.64MB
MR-sample1	80	10.1MB	359KB	290KB	245KB
MR-sample2	22	2.79MB	209KB	148KB	83KB
PT-sample1	223	7.77MB	462KB	226KB	175KB
PT-sample2	223	7.78MB	426KB	236KB	183KB

In this research paper we have taken sample of DICOM images with various modalities like Computed Tomography, Magnetic Resonance and Positron Emission Tomography with varying image data. Table 1 depicts the comparison matrix with sizing parameter.

Conclusion

Now, DICOM standard has been widely used. Most of medical imaging equipment such as CT, MR, PT support DICOM standard. However, Structure of the DICOM file is so complex. Hence, common image processing software cannot deal with it. Thus, it is necessary to read DICOM file and convert in to multimedia format in order to represent dynamic process of examining position reflected by multi-frame image. This paper implements converting DICOM multi-frame image to three kinds of multimedia formats: AVI, WMV and MP4 through studying DICOM standard, reading DICOM multi-frame image, using Matlab programming. It is found that the image of AVI format is clear and the size of AVI is large; while WMV is compressed format, which is not clear as that of AVI, but size of WMV file is small; MP4 file is clear in quality and small in size. So, a lot of storage space can be saved by WMV file and MP4 file. It assists physician to diagnosis diseases and improve diagnostic quality and efficiency.

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