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Medical Imaging Processing

Types of Medical Images- Digital Image Representation

By

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Study Year : 2023-2024

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MEDICAL IMAGE FORMAT

Representation of medical images requires two major components namely, metadata and image data and shown in Figure (1). *Metadata* provides the structure and information about the image. Metadata stored at the beginning of an image file or separate file as a header which containing technical, descriptive and administrative metadata. Technical metadata includes image dimension, depth of pixel and spatial resolution, camera settings, and dots per inch. *Image data* is the raw intensity values to represent the pixels. Each pixel has its own memory space to save the intensity in term of bits called depth per pixel. In, binary image each pixel is store in a single bit either zero or one. X-ray, CT, MRI are produced grey scale images with 8 bits or 16 bits. The number of gray levels between black to white depends on number bits used to represent the pixel. PET and SPECT scanner has given colour images with 24 bits per pixel in a respective red-green-blue palette.

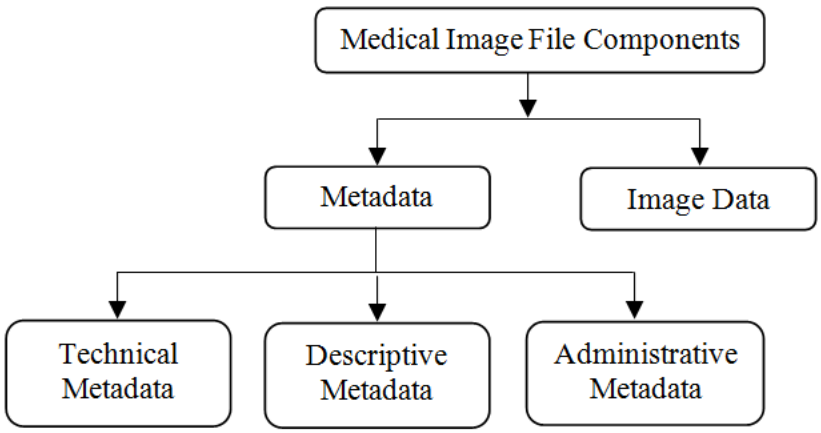

Fig. 1. Medical image file components formats

Medical image files were stored in two ways:

- The first is metadata stored in an image itself. The main advantage of the first method is all the image information stored in a single file. On the other hand problems may arise when extracting or modifying information from the file because of its size and complex structure.
- The second method uses separate file to store the metadata information called a header with .hdr extension. Famous file formats used in the medical industry is shown in Figure (2).

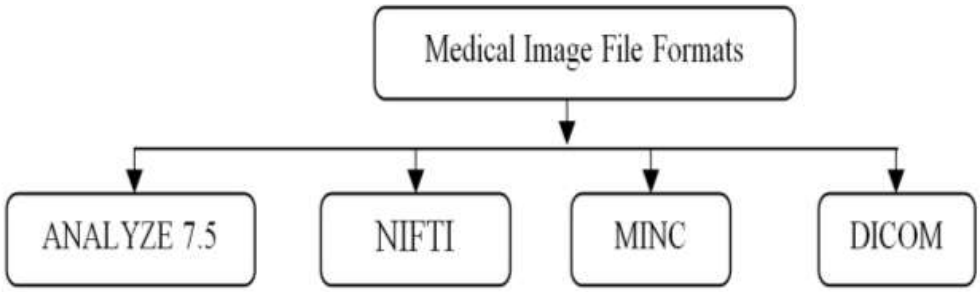

Fig.3.3: Major medical image file formats

Where,

- Analyze 7.5 is a file format for storing MRI data developed by the Biomedical Imaging Resource (BIR) at Mayo foundation in late 1980.
- NIFTI overcomes the drawbacks of Analyze 7.5 developed at the early of 2000 by National Institute of Health.
- MINC 1.0 file format was designed for a flexible way to store medical data upon the NetCDF (Network Common Data Format). It was developed by Montreal Neurological Institute (MNI) from1992.

- Digital imaging and communication in medicine (DICOM) is a communication standard developed by American College of Radiology (ACR) and National Electrical Manufacturers Association (NEMA) in 1993.

For example to display dicom image (file.dcm) in matlab See the following codes in figure 3

```
X=imread ('5.png');
imshow(X);
```

Figure 3: Display dcm Image in Matlab

Image analysis

Image analysis is primarily data reduction process. As we have seen, images contain enormous amount of data, typically on the order hundreds of kilobytes or even megabytes. Often much of this information is not necessary to solve a specific computer imaging problem, so primary part of the image analysis task is to determine exactly what information is necessary. Image analysis is used both computer vision and image processing.

For computer vision, the end product is typically the extraction of high-level

information for computer analysis or manipulation. This high-level information may include shape parameter to control a robotics manipulator or color and texture features to help in diagnosis of a skin tumor.

The image analysis process, can be broken down into three primary stages:

1. Preprocessing.
2. Data Reduction.
3. Features Analysis.

Preprocessing Is used to remove noise and eliminate irrelevant, visually unnecessary information. Noise is unwanted information that can result from the image acquisition process, other preprocessing steps might include Gray –level or spatial quantization (reducing the number of bits per pixel or the image size or finding regions of interest for further processing.

Data Reduction Is the second stage of image analysis. it Involves either reducing the data in the spatial domain or transforming it into another domain called the frequency domain, and then extraction features for the analysis process.

In the third stage, Features Analysis , After preprocessing we can perform segmentation on the image in the spatial domain or convert it into the frequency domain via a mathematical transform.

Crop, Zoom, enlarge , shrink, translate and rotate.

The image crop process is the process of selecting a small portion of the image, a sub image and cutting it away from the rest of the image.

For example, to resize dicom image (file.dcm) in matlab
See the following codes in figure 4

```
X=imread ('5.png');
J = imresize(X, 0.3);
figure;
```

```
imshow(J);
```

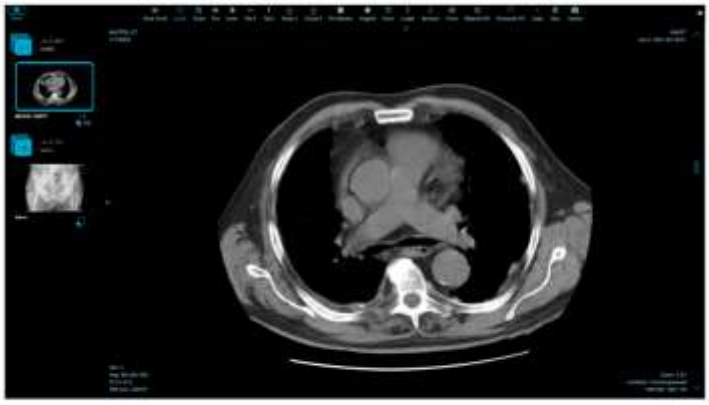

Figure 4: image resize file.dcm

Image Representation

We have seen that the human visual system (HVS) receives an input image as a collection of spatially distributed light energy; this is form is called an optical image. Optical images are the type we deal with every day –cameras captures them, monitors display them, and we see them [we know that these optical images are represented as video information in the form of analog electrical signals and have seen how these are sampled to generate the digital image I(r , c).

The digital image I (r, c) is represented as a two- dimensional array of data, where each pixel value corresponds to the brightness of the image at the point (r, c). in linear algebra terms , a two-dimensional array like our image model I(r, c) is referred to as a matrix , and one row (or column) is called a vector. The image types we will consider are:

1- Binary image

2- Gray scale image

3- Color image

Bubble Sheet Questions

Q1. Why do we need so many different types of image file formats?
a) To make it difficult to convert images between different formats
b) Each format serves a specific purpose or has unique features
c) To limit the compatibility of images across various devices
d) To increase the complexity of working with digital images

Q2. Which image file format is commonly used for compressing images on the World Wide Web (WWW) and offers flexibility in creating files with good image quality?
a) BMP
b) BIN
c) JPEG
d) PPM

Q3. What is the primary advantage of storing metadata within an image file itself?
a) Simplicity in extracting and modifying information
b) Reduction in file size
c) Compatibility with various software
d) Preservation of complex file structure

Q4. Which file extension is commonly used for storing metadata information separately in medical image formats?
a) .jpg
b) .hdr
c) .png
d) .bmp

Q5. In the context of image analysis, what is the main purpose of data reduction?
a) To increase the size of the image dataset
b) To enhance the visual quality of the image
c) To eliminate noise and irrelevant information
d) To extract high-level information for computer analysis