



JOHNS HOPKINS

WHITING SCHOOL
of ENGINEERING

Applied Medical Image Processing

Medical Image File Format Basic Concepts

Introduction

- Medical image can consist of:
 - Projection or planar images (X-ray)
 - Series of images representing a slice through volume (multi-slice 2D imaging)
 - 3D image acquisition
 - Time series (3D+time)
 - Meta-data such as tensor data
- File Formats:
 - Describes the organization of image data.
 - Describes interpretation of pixel data.

Pixels

1. Pixel/Voxel: 2D/3D image element resulted from sampling and image reconstruction. It maps to a measurement value.
2. Pixel Depth: # of bits to encode information.
 - Example: 8 bits/pixel or 1 byte/pixel.
 - An image with an array size of 256×256 with 2 bytes per pixel can take $256 \times 256 \times 2 = 131072$ bytes of memory. Two bytes allow 2 possible intensity value ranges:
 - 2^{16} : (0-65535)
 - 2^{15} : -32767 \rightarrow + 32767 intensity values and one bit for the sign."
 - Other examples are single precision (32 bits), double precision (64 bits), or complex numbers.

Endianness

- Big Endian
- Little Endian
 - They determine how data should be stored in memory. If the data is stored as one byte, then there is no difference. However, if data is stored using two bytes or more, then the order in which data is stored makes a difference.
- Example: consider two bytes:
 - 00000001
 - 11000010

These can be stored in memory in two ways:

- Little endian: (least significant byte in left followed by the most significant byte in right) $11000010\ 00000001 = 2^{15} + 2^{14} + 2^9 + 2^0 = 49665$
- Big endian (most significant byte in left followed by the least significant byte in right): $00000001\ 11000010 = 2^8 + 2^7 + 2^6 + 2^1 = 450$

Color Interpretation

- Monochrome (grayscale)
- Color Map
 - Psuedocolor (one sample per pixel mapped to a color map)
 - True color (multi channel data- Three samples per pixel such as RGB)
 - Example: DTI FA color map or Doppler echo

Image Header

- Stores important information about the medical image. EX. Array size, spatial resolution, pixel depth, image acquisition parameters, scanner coordinate system, and so forth.
- Header size can be fixed or variable. For a fixed header size pixel data always starts after a fixed byte size. For the variable header size information is stored in the header, in the form of tag information, which determines the location in bytes from which pixel data starts.
- Pixel data can be compressed using lossy (irreversible) or lossless (reversible) algorithms. Obviously, it is desirable to avoid schemes that can significantly affect image quality that can interfere with clinical diagnosis.
- Metadata in the header and pixel values in the image can both be stored in one single file (EX. DICOM). Alternatively, header metadata and pixel data are stored in two different files such as header file (.hdr) and image file (.img) (Example is Analyze file format).



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