MEDICAL IMAGING PROCESSING

FOURTH STAGE

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Image Types, and Image File Formats with MATLAB examples and extended homework

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Lec 2

Medical image representation consists of two components:

Metadata – provides structure and descriptive information about the image.

•**Image data** – raw pixel intensity values.

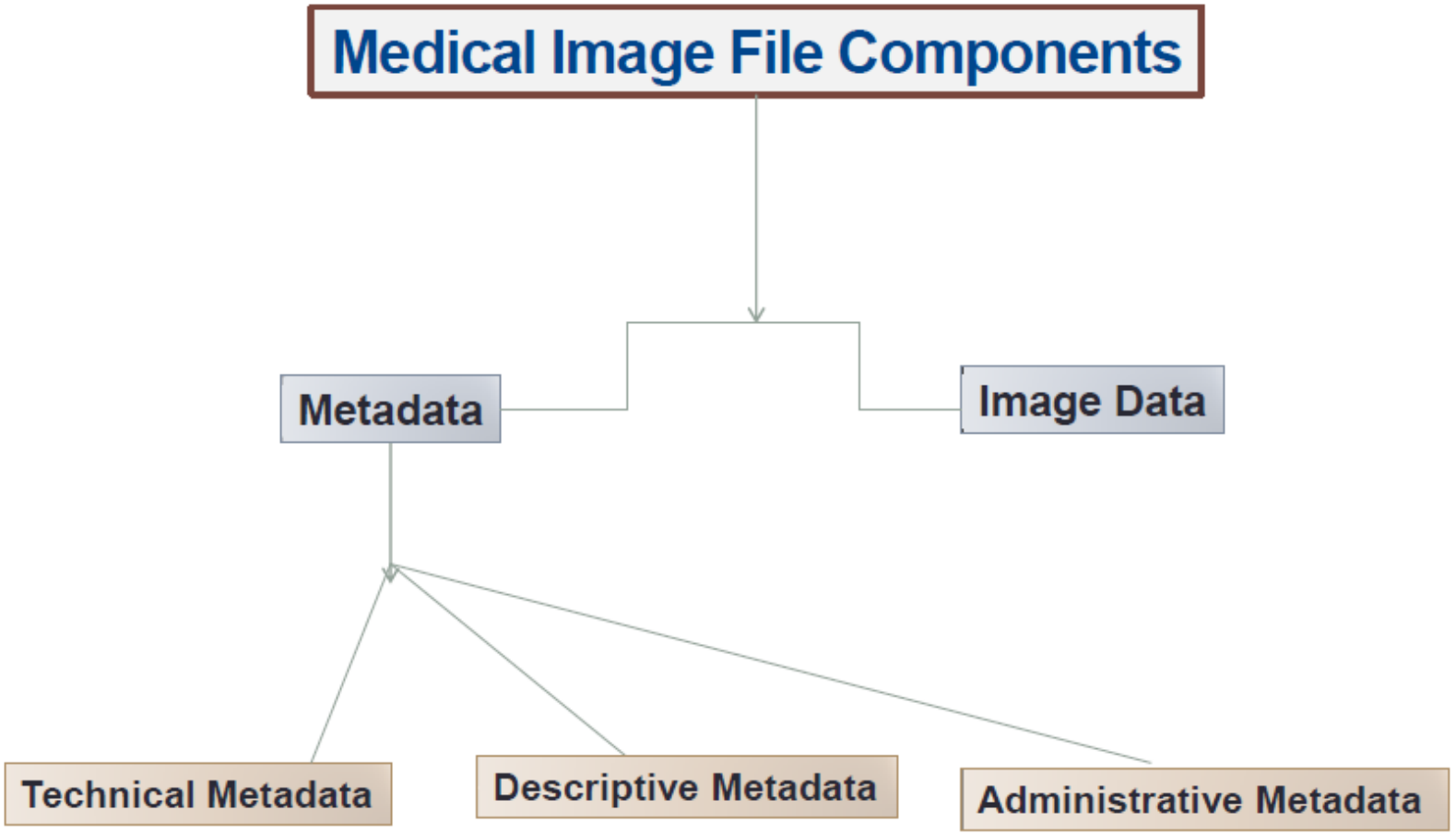
•**Metadata**:

•Stored at the beginning of the image file or in a separate header file.

•Types:

•**Technical metadata**: image dimensions, pixel depth, spatial resolution, camera settings, DPI.

•**Descriptive & administrative metadata**.


Medical Image File Components
Metadata
Image Data
Technical Metadata
Descriptive Metadata
Administrative Metadata

Medical Image File Components

- **Metadata** – provides structural and contextual information about the image. It can be divided into three categories:
- •**Technical Metadata**: Includes pixel dimensions, spatial resolution, bit depth, camera settings, and DPI.
- •**Descriptive Metadata**: Contains information describing the image content and purpose.
- •**Administrative Metadata**: Holds management-related details such as file ownership, creation date, and access rights.
- •**Image Data** – represents the actual raw pixel intensity values of the image. Each pixel stores its intensity in terms of bit depth. Depending on modality:
- •Binary images → 1 bit per pixel (0 or 1).
- •X-ray, CT, MRI → Grayscale (8 or 16 bits).
- •PET, SPECT → Color images (24-bit RGB).

Medical Image File Storage Methods

- **Single File Storage**
- Both **metadata** and **image data** are stored together in one file.
- Metadata is usually at the beginning (header).
- Examples: DICOM, TIFF.
- **Separate File Storage**
- **Image data** is stored in one file.
- **Metadata** is stored separately in another file (text, XML, or JSON).
- Provides flexibility for updating metadata without altering the image.

Medical Image File Formats

- **1-Analyze 7.5**
- •Developed by the *Biomedical Imaging Resource (BIR), Mayo Foundation* in the late 1980s.
- •Designed for storing **MRI data**.
- •Limitation: Less flexible, lacked standardized metadata handling.

- **2-NIFTI (Neuroimaging Informatics Technology Initiative)**
- •Developed in the early 2000s by the *U.S. National Institutes of Health (NIH)*.
- •Built to **overcome the drawbacks of Analyze 7.5**.
- •Widely used in brain imaging research (fMRI, MRI).

Medical Image File Formats

3- MINC 1.0 (Medical Imaging NetCDF)

•Developed by the Montreal Neurological Institute (MNI) in 1992.

•Based on NetCDF (Network Common Data Format).

•Designed for flexibility in storing medical image data.

4- Digital Imaging and Communications in Medicine (DICOM)

•A global standard for storing, transmitting, and communicating medical images and related data.

•Developed in 1993 by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA).

Digital Image Representations

- Key Concepts:

•**Pixels**: The smallest unit of a digital image.

•**Resolution**: Number of pixels in width × height (e.g., 1920×1080).

•**Bit Depth**: Number of bits used to represent color (e.g., 8-bit, 24-bit).

•**Color Models**:

•**RGB** (Red, Green, Blue): Used for screens.

•**CMYK** (Cyan, Magenta, Yellow, Black): Used for printing.

•**Grayscale**: Shades of gray from black to white.

Image as a Matrix

Image as a Matrix Each pixel = numerical value.

Grayscale: values [0–255].

Color: 3 channels (R, G, B).

Bit Depth: number of bits used to represent a pixel.

1-bit: black & white.

8-bit: 256 gray levels.

24-bit: 16 million colors (RGB).

Image Analysis

- **Definition**:
- •The process of extracting meaningful information from medical images using computational and mathematical techniques.
- •**Main Steps in Image Analysis**:
- •**Preprocessing** – Enhancing image quality (e.g., noise reduction, contrast adjustment).
- •**Segmentation** – Dividing the image into meaningful regions (e.g., separating organs, tissues, or lesions).
- •**Feature Extraction** – Measuring attributes such as shape, texture, intensity, or edges.
- •**Classification** – Grouping or labeling regions based on features (e.g., tumor vs. normal tissue).
- •**Visualization & Quantification** – Displaying results and generating measurements (e.g., tumor volume, blood flow).

Applications in Medicine:

Diagnosis (detecting tumors, lesions).

•**Treatment Planning** (radiation therapy, surgical guidance).

•**Monitoring** (disease progression, therapy response).

•**Research** (biomarkers, functional studies).

Practical side

To display a **DICOM (DCM) image** in **MATLAB**, you can use the built-in functions **dicomread** and **imshow.**

1**-% Read the DICOM image**

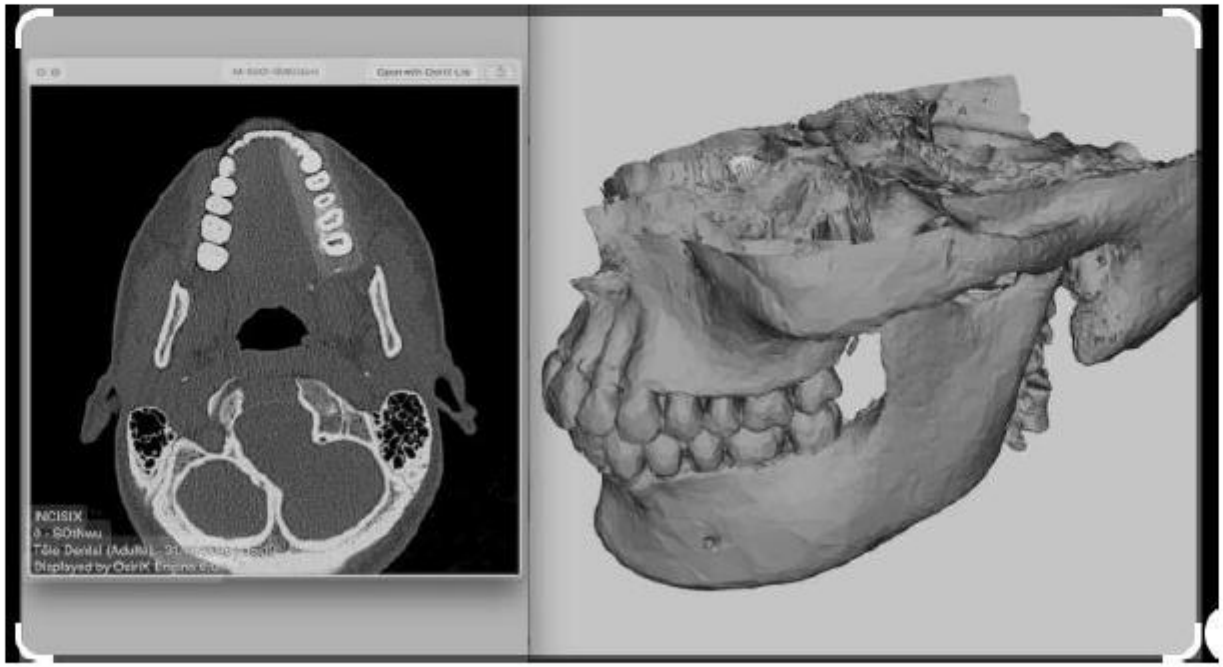
- img = dicomread('filename.dcm');

2-% Display the image

- figure;
- imshow(img, []);
- title('DICOM Image');

- **3-Display DICOM metadata (optional)**
- info = dicominfo('filename.dcm');
- disp(info);

shows a **DICOM slice (CT scan)** on the left, and a **3D reconstruction of the skull/jaw** on the right.



1. Display a single DICOM image

% Read and display one DICOM slice

- img = dicomread('filename.dcm');
- figure;
- imshow(img, []);
- title('DICOM Slice');

3D Rendering (like your screenshot, right side)

- % Convert volume to double
- V = double(vol);

- % Choose an isosurface threshold)
- isoValue = 500;
- p = patch(isosurface(V, isoValue));

- **% Styling**
- isonormals(V, p);
- p.FaceColor = [0.8 0.8 0.8];
- p.EdgeColor = 'none';

- **% Lighting**
- daspect([1 1 1]);
- view(3);
- axis tight;
- camlight;
- lighting gouraud;

Assignment??

- **Q1.** Why do we need so many different types of image file formats?
- **Q2.**Which image file format is commonly used for compressing images?
- **Q3.** What is the primary advantage of storing metadata within an image
- **Q4.** Which file extension is commonly used for storing metadata information separately in medical image formats?

Homework ?

- Types of Medical Images??

GOOD LUCK EVERYONE