

MATLAB for Image Processing

BE 244 Medical Image Processing and Analysis

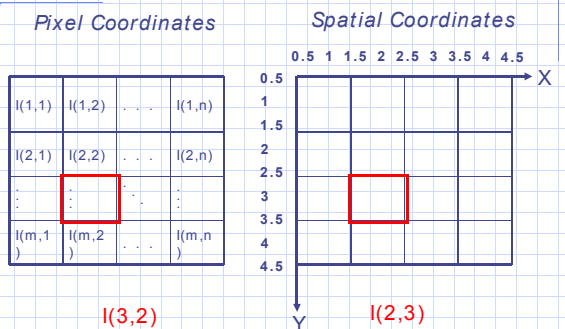
Outline

- ◆ Image Array Indexing
- ◆ Intensity Coding Schemes
- ◆ Data Formats
- ◆ Data Conversions
- ◆ Importing & Exporting Images
- ◆ Image Display

Image Array Indexing

- ◆ Image: 1 or more 2D arrays $I(m,n)$
- ◆ Each element of $I(m,n)$ is a pixel
- ◆ Pixel coordinates (m,n) :
 - Most common for images
 - m rows increase top to bottom
 - n columns increase left to right
- ◆ Spatial coordinates (x,y) :
 - Allows non-integer indexing
 - Center of ULC pixel is $(1,1)$
 - ULC origin is $(0.5,0.5)$
 - x columns & y rows !!! ← Opposite pixel coordinate indexing

Image Array Indexing



Intensity Coding Schemes

- ◆ Binary images: $[0,1]$
- ◆ Intensity images: $[0:1]$ or uint8
- ◆ Index images: $M \times 3$ color map matrix
- ◆ RGB images: $M \times N \times 3$

All image data is of type uint or double

Binary Images

B

1	1	0	0
0	0	0	1
0	1	0	1

Binary Image

The binary image shows a 4x4 grid of pixels. The top row has two black pixels followed by two white pixels. The second row has two white pixels followed by two black pixels. The third row has a white pixel, a black pixel, a white pixel, and a black pixel.

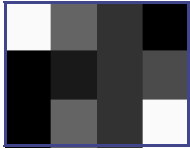
- ◆ Data Matrix (B)
 - $M \times N$
 - B & W image
 - Only two values
 - $[0,1]$
 - [on, off]
 - [true,false]
 - etc.
 - Often used as masks for selecting regions-of-interest (ROIs) from other images

Intensity Images

I

250	100	50	0
0	25	50	75
0	100	50	250

Intensity Image



Data Matrix (I)

- $M \times N$
- Grayscale image
- Each value designates an intensity
- [0:1] or [0:255] (uint8)

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Index Images

map

		R	G	B
1	1	0	0	
2	0	1	0	
3	0	0	1	
4	1	1	0	
5	1	1	1	
6	0	0	0	

Colormap Matrix (map)

- $C \times 3$ matrix
- 3 cols: Red, Blue, Green
- C rows: Color vector [0:1]
- Also called a color lookup table (LUT)

X

1	2	3	4	5
6	4	6	1	2
3	1	3	5	4

Data Matrix (X)

- $M \times N$
- Each value points to a specific color vector in the colormap

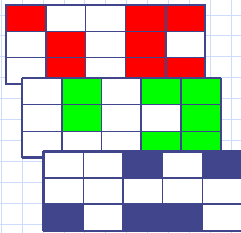
Index Image



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RGB Images

R



Data Matrix

- $M \times N \times 3$ $RGB(m,n,i)$
- Each color page (aka bitplane) has values [0:1]
- An individual pixel color is defined by the corresponding values in the three color pages

RGB Image



All image files are actually 3D, where the 3rd variable is 1 for grayscale images

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Multiframe Images (IMF)

- ◆ Also called "volume images"
- ◆ Each image in the set is a frame
- ◆ $IMF = cat(4, I_1, I_2, I_3, \dots)$ where 4 indicates the concatenation dimension
- ◆ $IMF = (m, n, i, j)$
 - $i =$ RGB variable
 - $j =$ frame index

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Image and Data Formats

	Indexed	Intensity	Binary	RGB
Double Data	Image: $M \times N$ int array [1:P] Colormap: $C \times 3$ float array [0:1]	$M \times N$ float array [0:1]	$M \times N$ logical array [0 1]	$M \times N \times 3$ float array [0:1]
Uint8 Data	Image: $M \times N$ int array [1:P-1]; $P < 256$ Colormap: $C \times 3$ float array [0:1]	$M \times N$ int array [0:255]	$M \times N$ logical array [0 1] nb $1 = white$	$M \times N \times 3$ int array [0:255]
Uint16 Data	Image: $M \times N$ int array [1:P-1]; $P < 65536$ Colormap: $C \times 3$ float array [0:1]	$M \times N$ int array [0:65535]	Not supported	$M \times N \times 3$ int array [0:65535]

Ref. MathWorks Training Manual

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Image Data Conversions

- ◆ `ind2gray` - indexed to intensity
- ◆ `int2rgb` - indexed to RGB
- ◆ `gray2ind` - intensity to indexed
- ◆ `rgb2ind` - RGB to indexed
- ◆ `mat2gray` - matrix to intensity image
- ◆ `im2bw` - threshold image to create binary image
- ◆ `im2double` - image array to double array
- ◆ `im2uint8` - image array to 8-bit int array
- ◆ `im2uint16` - image array to 16-bit int

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Importing & Exporting Images

- ◆ `iminfo` - returns file information
- ◆ `imread` - reads image
 - Indexed Images:
`[X,map]= imread('file.fmt')`
 - Intensity, RGB, & Binary Images:
`X= imread('file.fmt')`
- ◆ `imwrite` - writes image

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Displaying Images

- ◆ `figure` - opens new window for displaying image
- ◆ `imshow` - displays image using IPT preferences
- ◆ `mov = imovie(MFW); movie(mov)`

- ◆ `image` - create and display image object
- ◆ `imagesc` - scale data and display as an image
- ◆ `montage` - displays multiframe image as a montage
- ◆ `colorbar` - display colorbar of the indexed image
- ◆ `colormap` - sets colormap

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Image Processing Toolbox Preferences

- ◆ `iptgetpref` - Get IPT preference
- ◆ `iptsetpref` - Set IPT preference
- ◆ Settable preferences:
 - `ImshowBorder`: [{ 'loose' }, 'tight']
 - `ImshowAxesVisible`: ['on', { 'off' }]
 - `ImshowTruesize`: [{ 'auto' }, 'manual']
 - `TruesizeWarning`: [{ 'on' }, 'off']

default values shown in { }

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