臺北醫學大學

Biomedical Imaging

生物醫學影像學

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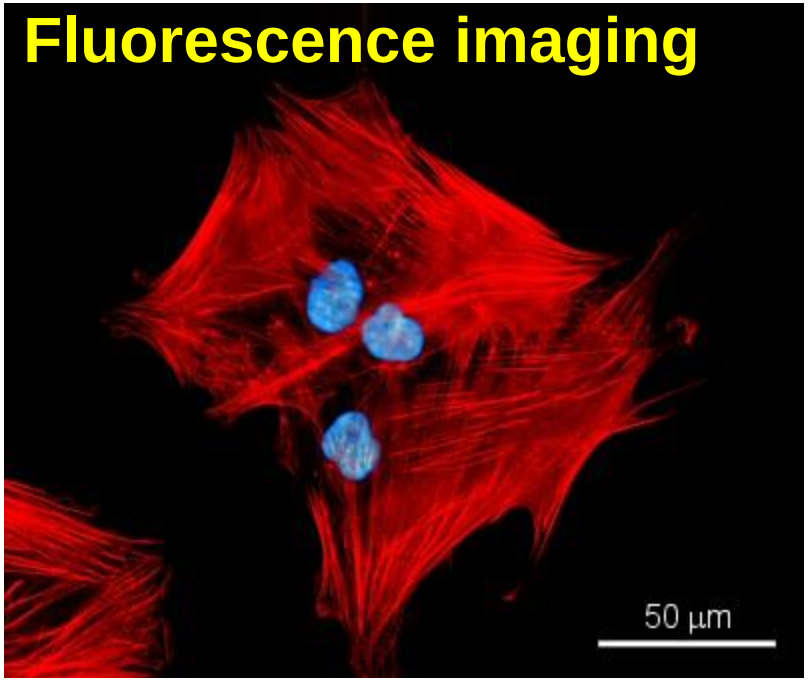
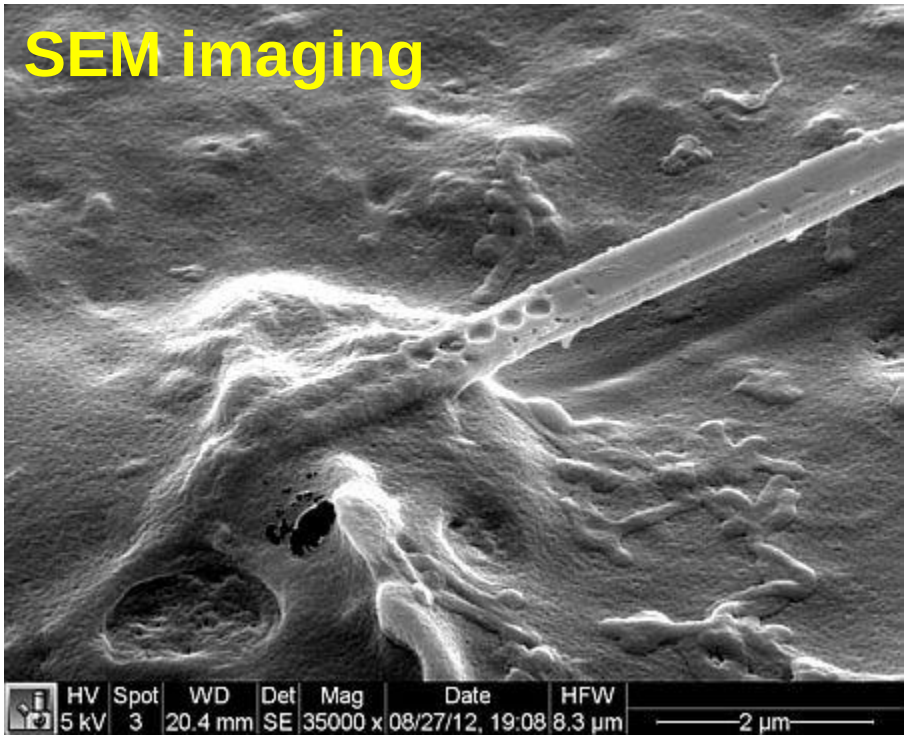
Course Outline

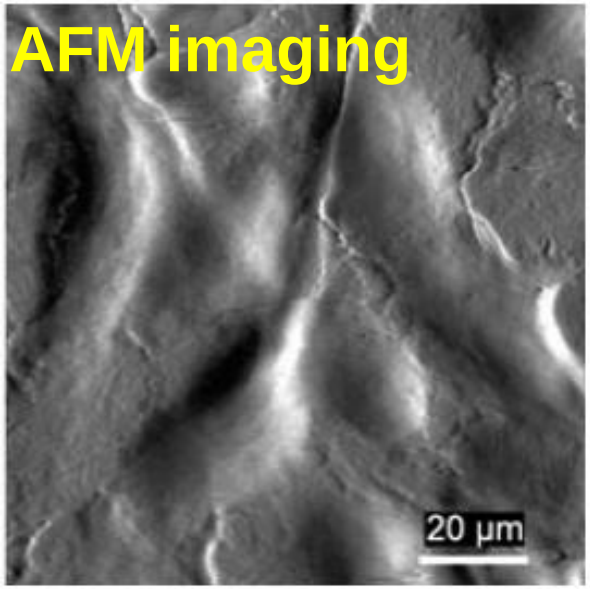
1. Course Introduction
2. Basic Optics and Light Microscopes
3. Fluorescence/Confocal/TIRF Microscopes
4. FRET Techniques and Photo-Spectroscopic Imaging
5. Single Molecule Detection
6. Cell Imaging
7. Atomic Force Microscopy (AFM)
8. Scanning Electron Microscope (SEM)
9. Transmission Electron Microscopy (TEM)
10. Digital Image Processing Using MATLAB


Part I
Images in Matlab
MATrix LABobratory
Hubble Telescope—Deep Space Photo
http://www.hubblesite.org

Examples of Biomedical Imaging





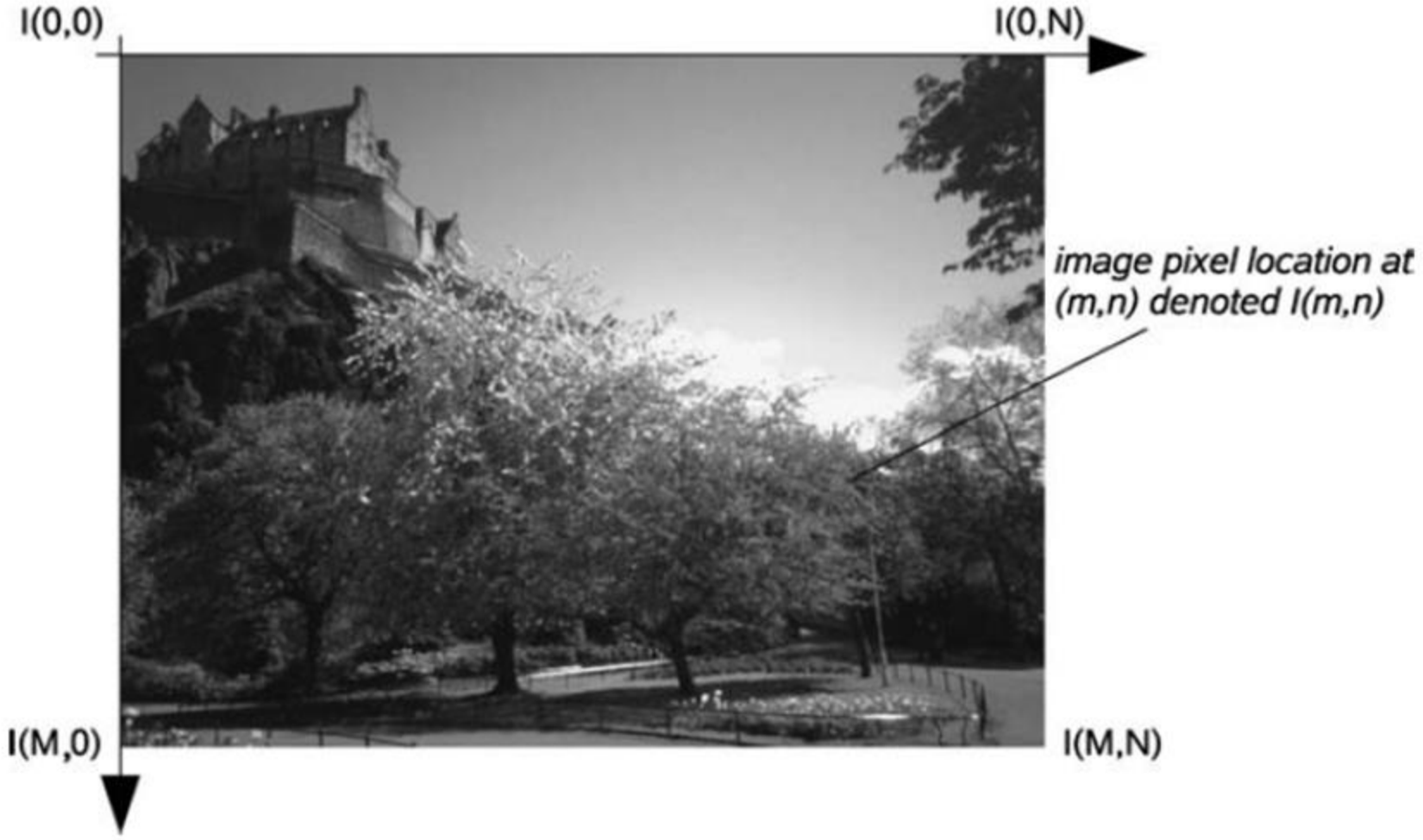


This scanning electron microscope (SEM) image shows a nanobeam probe, including a large part of the handle tip, inserted in a typical cell. (*Image courtesy of Gary Shambat, Stanford School of Engineering*)

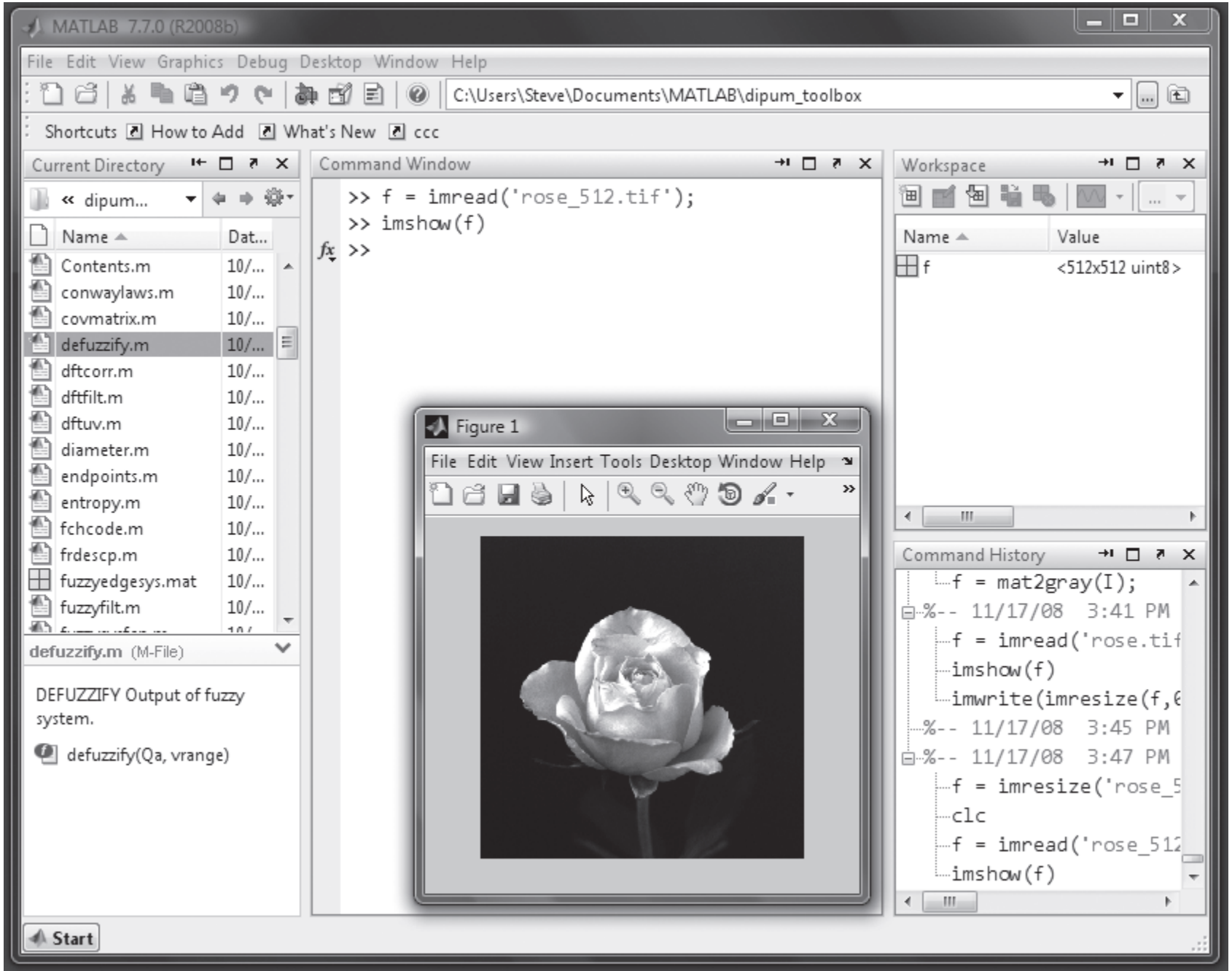
http://www.bioopticsworld.com/articles/2013/03/light-emitting-bioprobe-fits-in-a-single-cell.html

The Two-dimensional Discrete, Digital Image

The 2-D Cartesian coordinate space of an M x N digital image



The MATLAB Desktop with its typical components



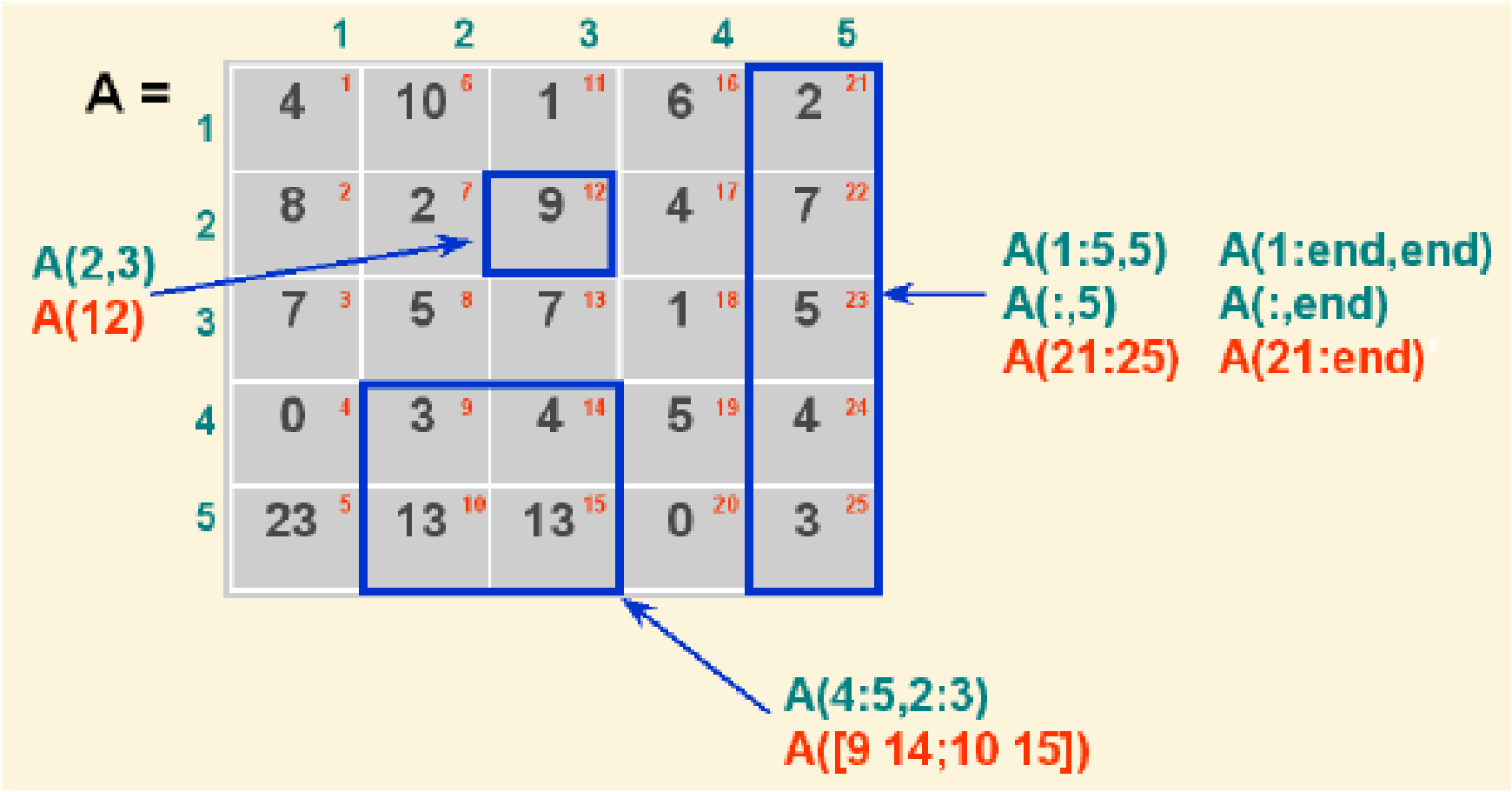
Coordinate Convention in the Image Processing

Example

```
A =
     1     2     3
     4     5     6
     7     8     9
```

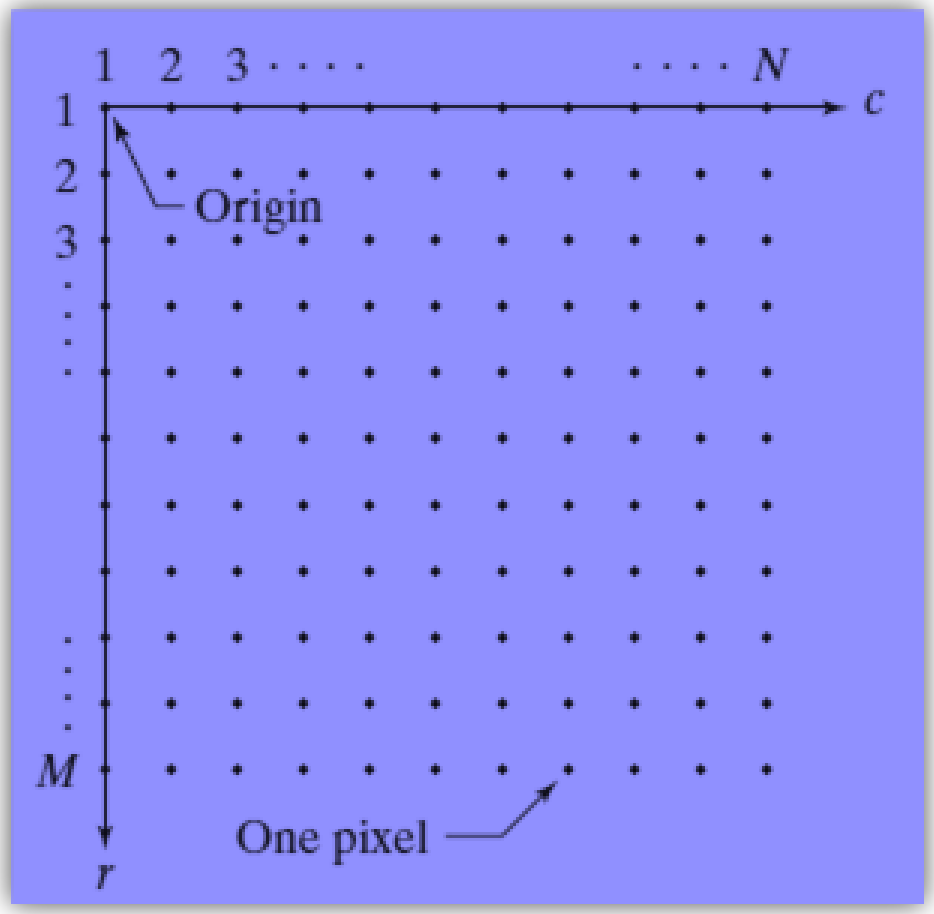
```
>> T2 = A(1:2, 1:3)
T2 =
     1     2     3
     4     5     6
```

Coordinate Convention in the Image Processing

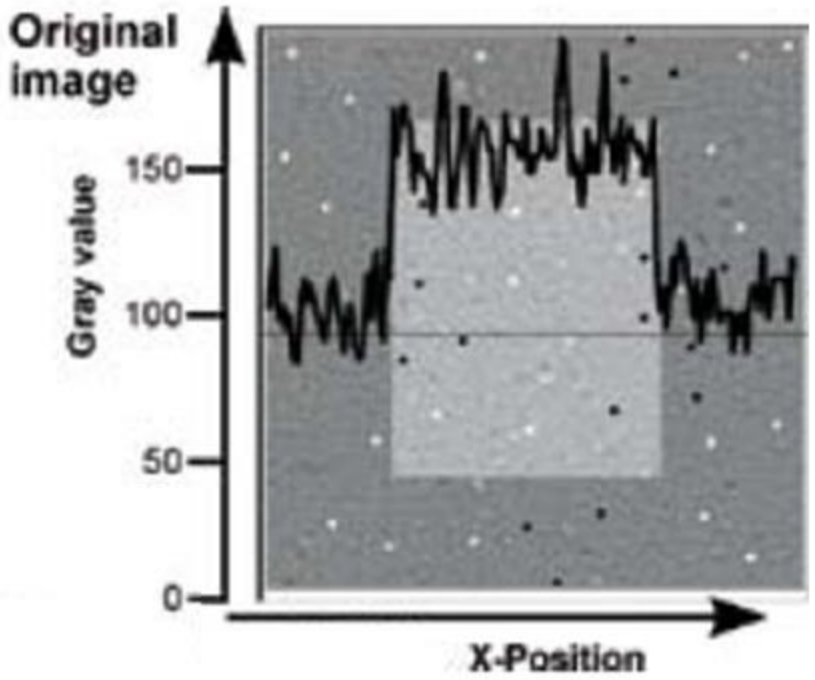


Coordinate Convention in the Image Processing

Array Indexing




```
>> f = imread('chestxray.jpg');
>> f = imread('D:\myimages\chestxray.jpg');
>> imshow(f);
>> imwrite(f, 'DT.bmp')
```



Images in Matlab

Reading, writing and querying (查詢) images

Example 1.1

Matlab code	What is happening?
imfinfo('cameraman.tif')	%Query the cameraman image that %is available with Matlab %imfinfo provides information %ColorType is gray scale, width is 256 . . . etc.
I1=imread('cameraman.tif');	%Read in the TIF format cameraman image
imwrite(I1,'cameraman.jpg','jpg');	%Write the resulting array I1 to %disk as a JPEG image
imfinfo('cameraman.jpg')	%Query the resulting disk image %Note changes in storage size, etc.

Comments

- Matlab functions: ***imread***, ***imwrite*** and ***iminfo***.
- Note the change in file size when the image is stored as a JPEG image. This is due to the (lossy) compression used by the JPEG image format.

Images in Matlab

Basic display of images

Example 1.2

Matlab code	What is happening?
A=imread('cameraman.tif');	%Read in intensity image
imshow(A);	%First display image using imshow
imagesc(A);	%Next display image using imagesc
axis image;	%Correct aspect ratio of displayed image
axis off;	%Turn off the axis labelling
colormap(gray);	%Display intensity image in grey scale

Comments

- Matlab functions: ***imshow***, ***imagesc*** and ***colormap***.
- Note additional steps required when using ***imagesc*** to display conventional images.

Images in Matlab

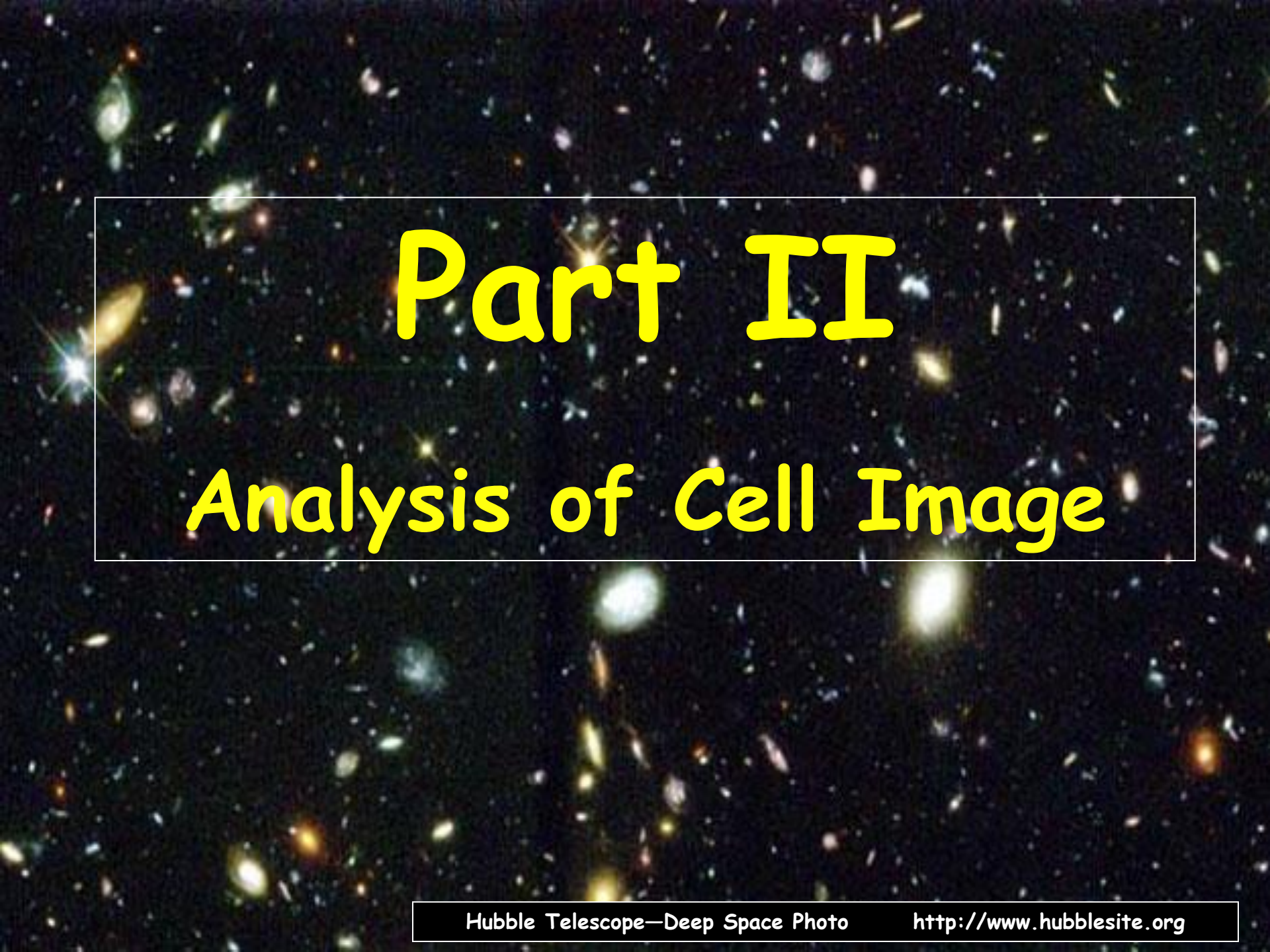
Basic display of images

Example 1.4

Matlab code	What is happening?
B=imread('cell.tif');	%Read in 8 bit intensity image of cell
C=imread('spine.tif');	%Read in 8 bit intensity image of spine
D=imread('onion.png');	%Read in 8 bit colour image
subplot(3,1,1); imagesc(B); axis image;	%Creates a 3 × 1 mosaic of plots
axis off; colormap(gray);	%and display first image
subplot(3,1,2); imagesc(C); axis image;	%Display second image
axis off; colormap(jet);	%Set colourmap to jet (false colour)
subplot(3,1,3); imshow(D);	%Display third (colour) image

Comments

- Note the specification of different colour maps using ***imagesc*** and the combined display using both ***imagesc*** and ***imshow***.


Part II
Analysis of Cell Image
Hubble Telescope—Deep Space Photo
http://www.hubblesite.org

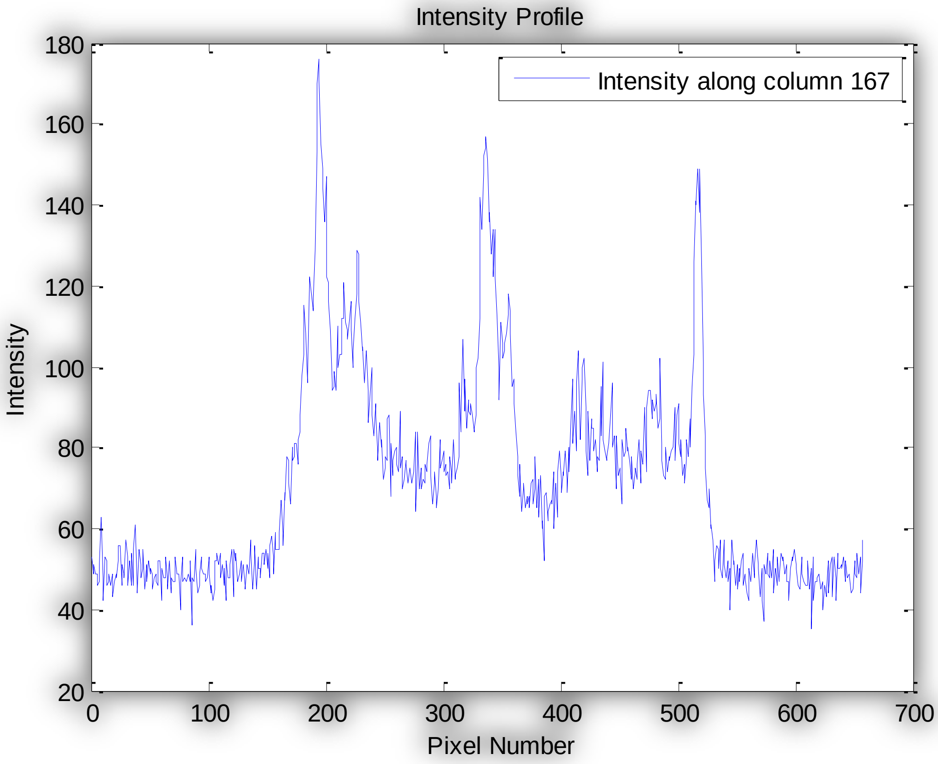
Basic Imaging Processing

```
%%%%%%%%%%%%%%%%%%%
clear all

imfinfo('01-1.bmp');
%imfinfo('01-2.bmp');

a=imread('01-1.bmp');
b=imread('01-2.bmp');

subplot(311);
imshow(a);
subplot(312);
imshow(b);

c=b-a;
%c=b+a;
subplot(313);
imshow(c);
imwrite(c,'01-1_cell_image.bmp')

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

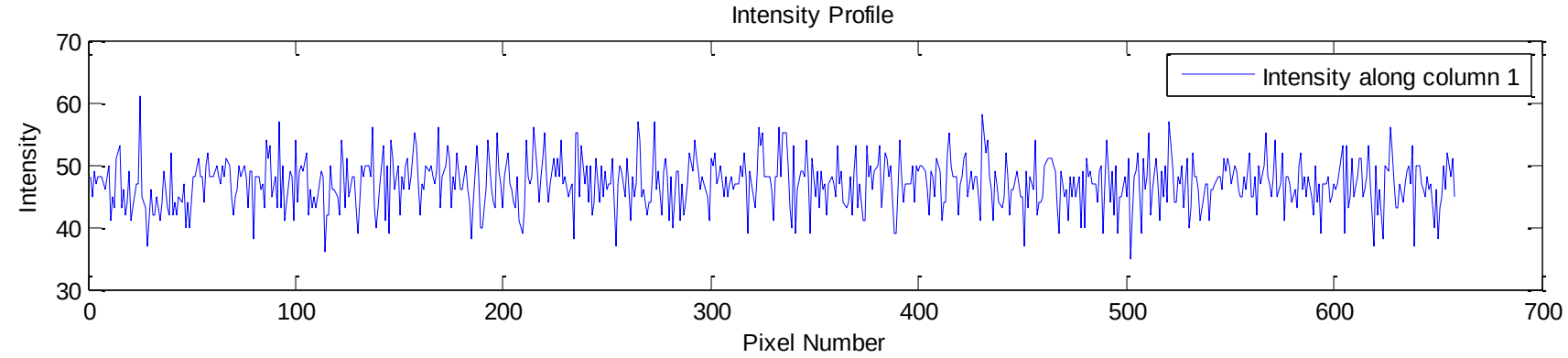
```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all % 清除所有變數 (% 註解)

imfinfo('01-1.bmp');
%imfinfo('01-2.bmp');

a=imread('01-1.bmp');
b=imread('01-2.bmp');

subplot(311);
imshow(a);
subplot(312);
imshow(b);

c=b-a;
%c=b+a;
subplot(313);
imshow(c);
imwrite(c,'01-1_cell_image.bmp')

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

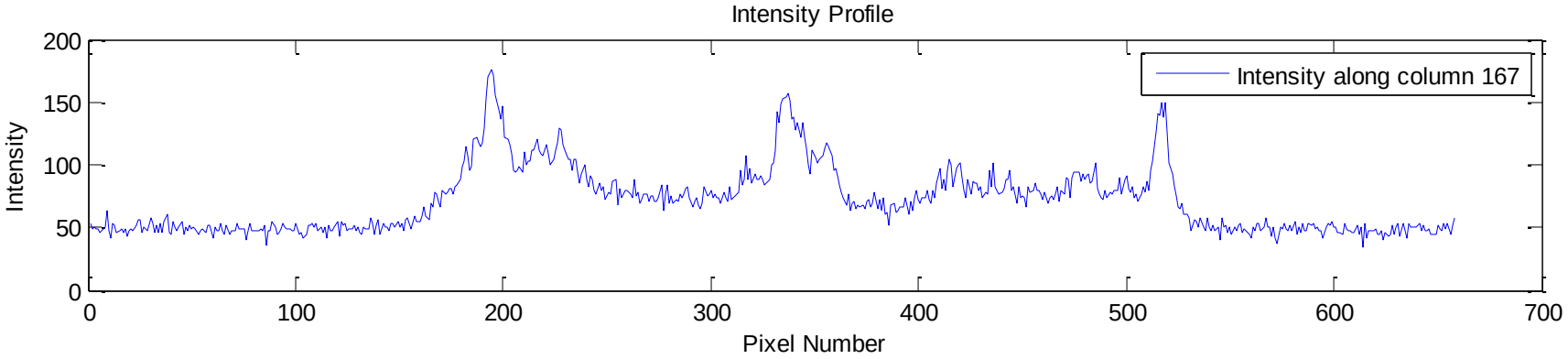
Basic Plotting

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
s_row=a(:,167); % in vertical direction
s_column=a(167,:)'; % in horizontal direction

plot(s_column,'-');
xlabel('Pixel Number');
ylabel('Intensity');
title('Intensity Profile');
legend('Intensity along column 167');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```



Basic Plotting





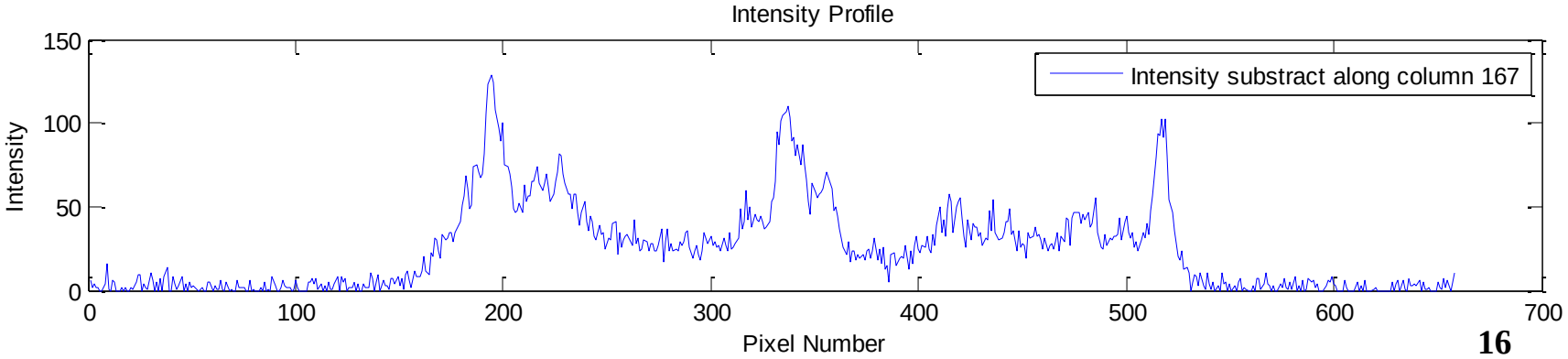


Image Processing Toolbox

R2013a

Getting Started | Examples | Release Notes

› Import, Export, and Conversion

Image data import and export, conversion of image types and classes

› Display and Exploration

Interactive tools for image display and exploration

› Geometric Transformation, Spatial Referencing, and Image Registration

Scale, rotate, perform other N-D transformations, provide spatial information, align images using automatic or control point registration

› Image Enhancement

Contrast adjustment, morphological filtering, deblurring, and other image enhancement tools

› Image Analysis

Region analysis, texture analysis, pixel and image statistics

Color

Color transforms, support for International Color Consortium (ICC) profiles

Code Generation

Generate C/C++ code and MEX functions for toolbox functions

GPU Computing

Run image processing code on a graphics processing unit (GPU)

http://www.mathworks.com/help/images/index.html

Thanks For Your Attention