Image Processing with MATLAB
Lecture 1: Introduction

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Course Purpose:

- This course provides hands-on experience with performing image analysis.
- Examples and exercises demonstrate the use of appropriate MATLAB® and Image Processing Toolbox™ functionality throughout the analysis process.
- Humans are primarily visual creatures – above 90% of the information about the world (*a picture is better than a thousand words*)

Course Contents:

- (Lec. 1) Introduction
- (Lec. 2) Working with Images in MATLAB
- (Lec. 3) Working with Images in MATLAB
- (Lec. 4) Image Enhancement Techniques
- (Lec. 5) Filtering Images
- (Lec. 6) Image Restoration Techniques
- (Lec. 7) Feature Extraction Using Segmentation and Edge Detection
- (Lec. 8) Image Registration

Weighting of Assessments:

Assessment	Weight
Mid-term Examination	20 %
Final Examination	60 %
Practical Examination	10 %
Semester work	10 %
Total	100 %

Working with Images:

- Image types
- Importing and exporting images
- Displaying images
- Finding image characteristics
- Converting image formats

Applying Image Enhancement Techniques:

- Adjusting image intensity
- Enhancing images using arithmetic operations
- Correcting image alignment – Rotating images
- Cropping and resizing images

Filtering Images:

- Low pass filters
- High pass filters

Image Restoration Techniques:

- Reducing noise
- Deblurring images
- Correcting background illumination

Feature Extraction Using Segmentation and Edge Detection:

- Image thresholding
- Edge detection
- Color-based image segmentation

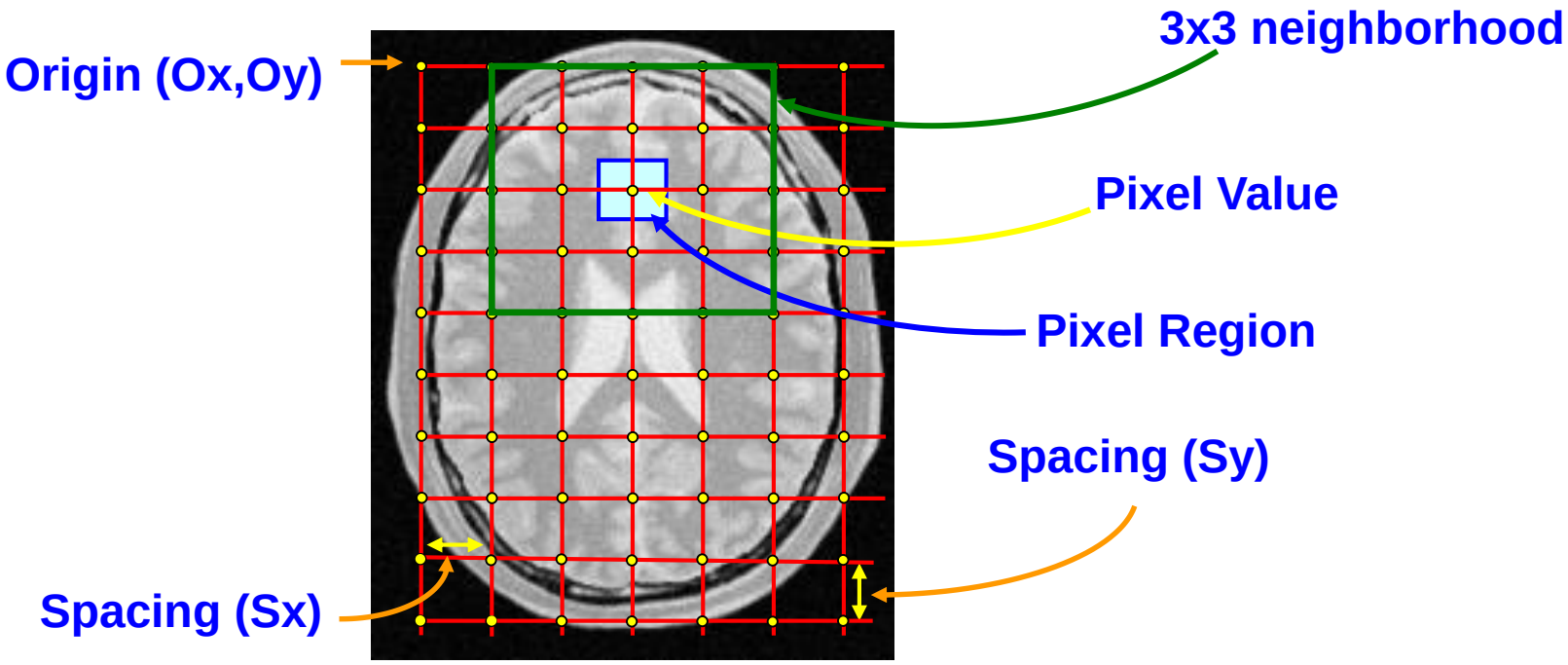
Image Registration and Image Reconstruction :

- Basics of image registration

Low level image processing

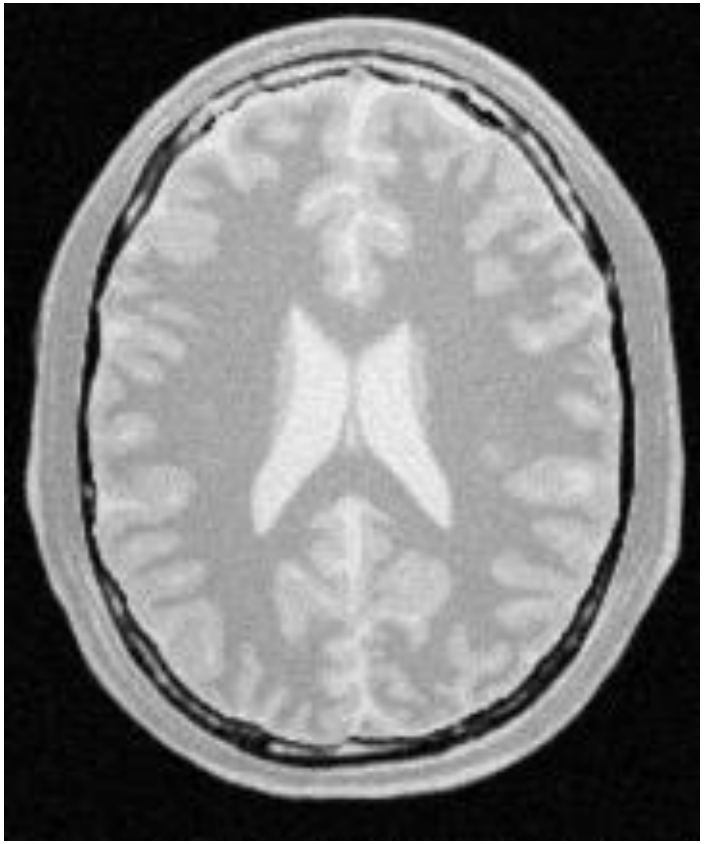
- Very little knowledge about the content of the images.
- Data are the original images, represented as matrices of intensity values, i.e. sampling of a continuous field using a discrete grid.
- Focus of this course.

Low level image processing



Low level image processing

- Image compression
- Noise reduction
- Edge extraction
- Contrast enhancement
- Segmentation
- Thresholding
- Image restoration



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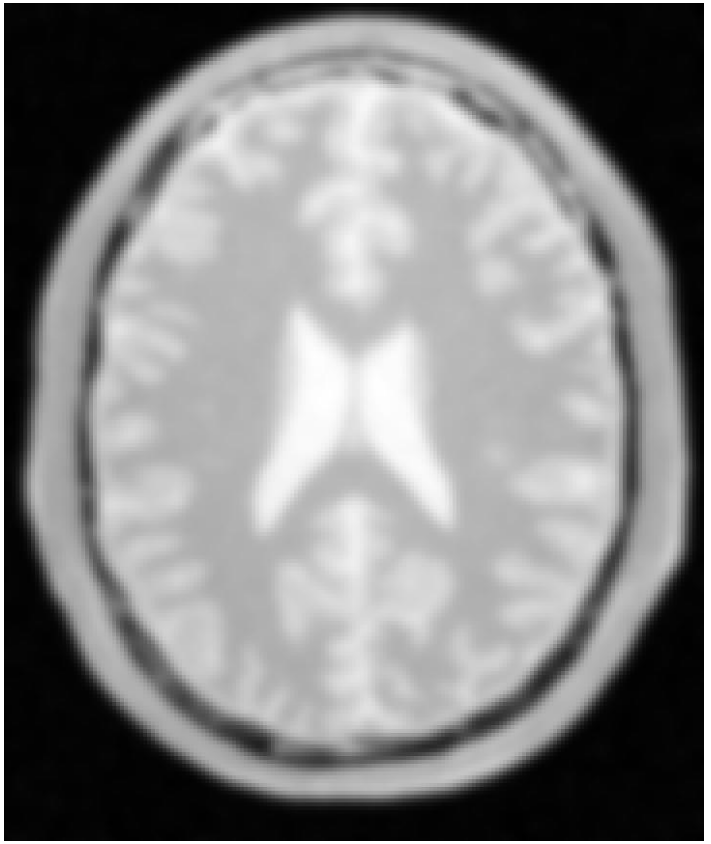

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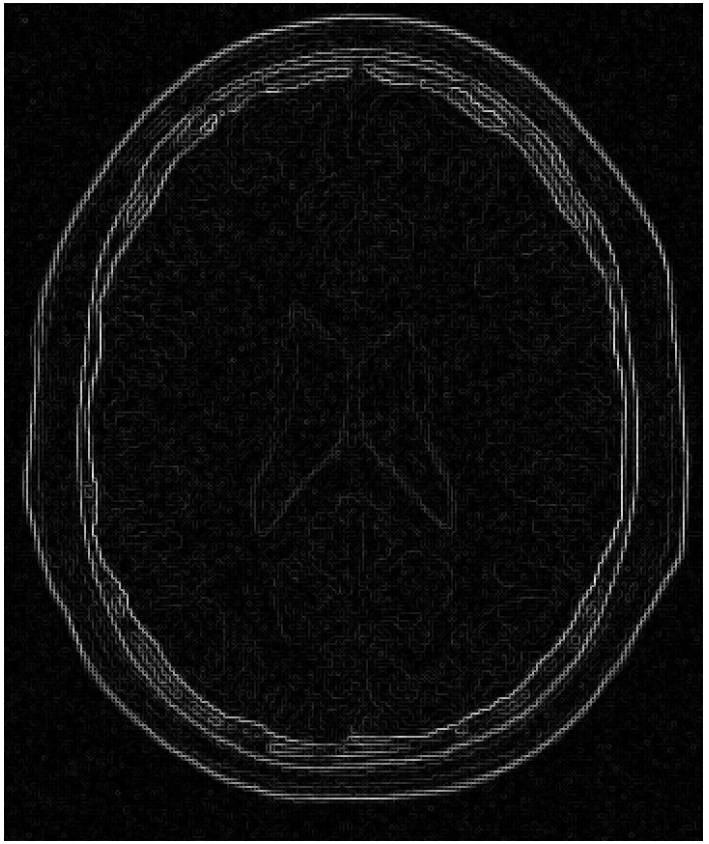

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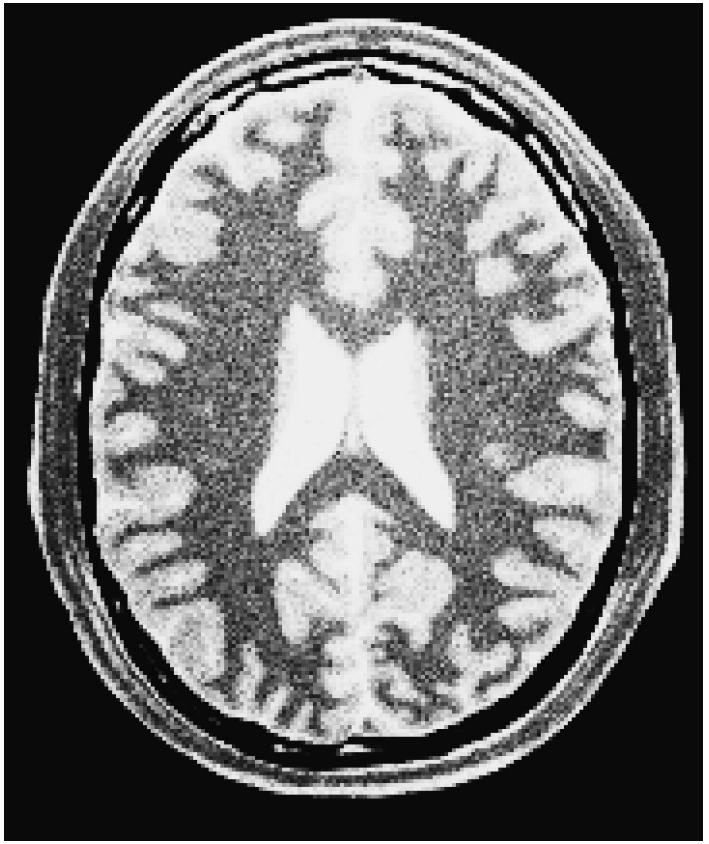

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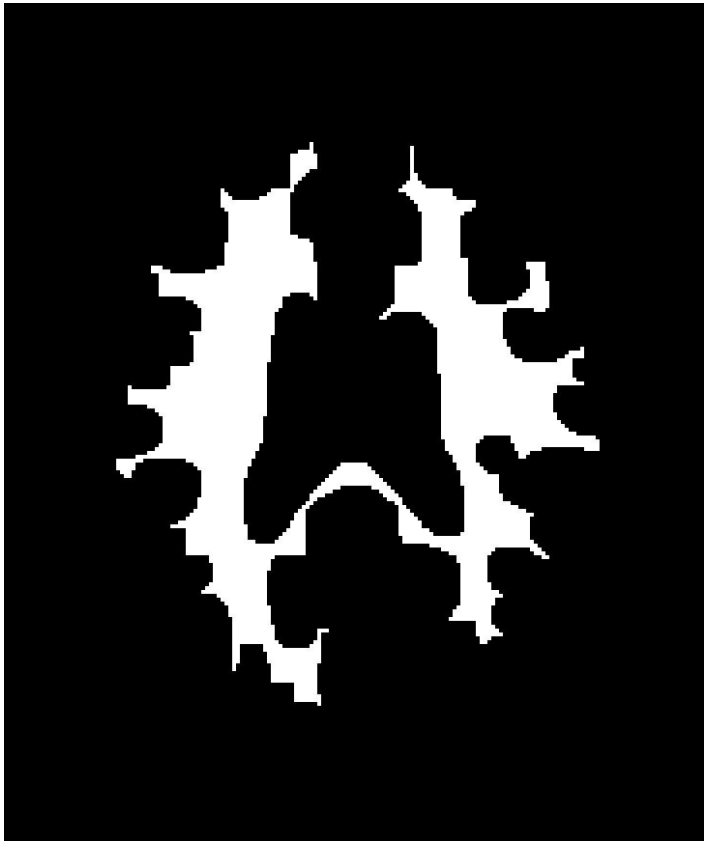

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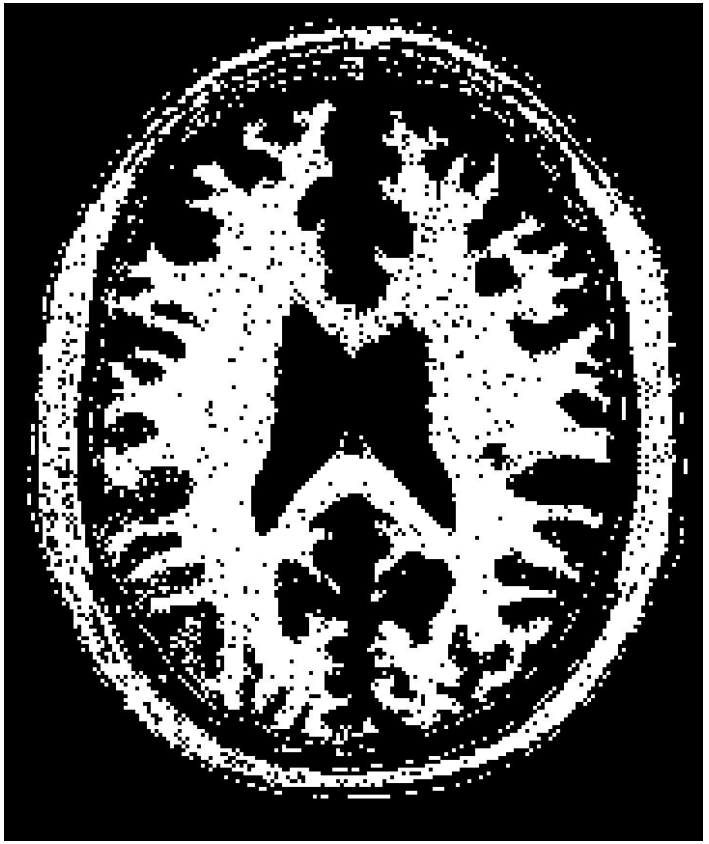

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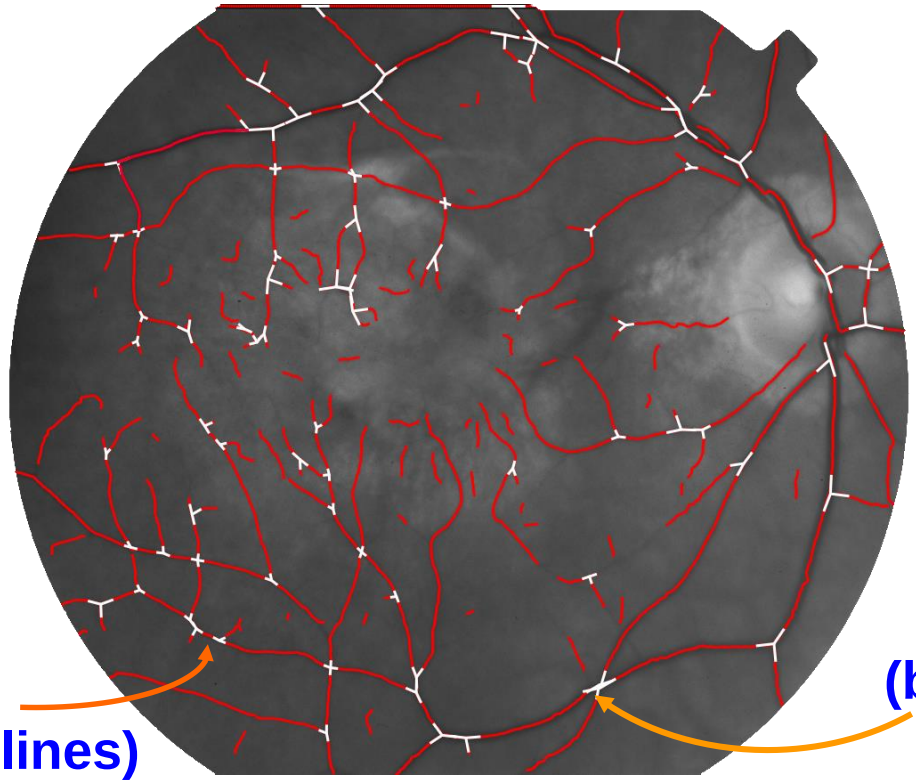
High level image understanding

- To imitate human cognition according to the information contained in the image.
- Data represent knowledge about the image content, and are often in symbolic form.
- Data representation is specific to the high-level goal.

High level image understanding

- What are the high-level components?
- What tasks can be achieved?



Traces (vessel centerlines)

Landmarks (bifurcation/cross over)

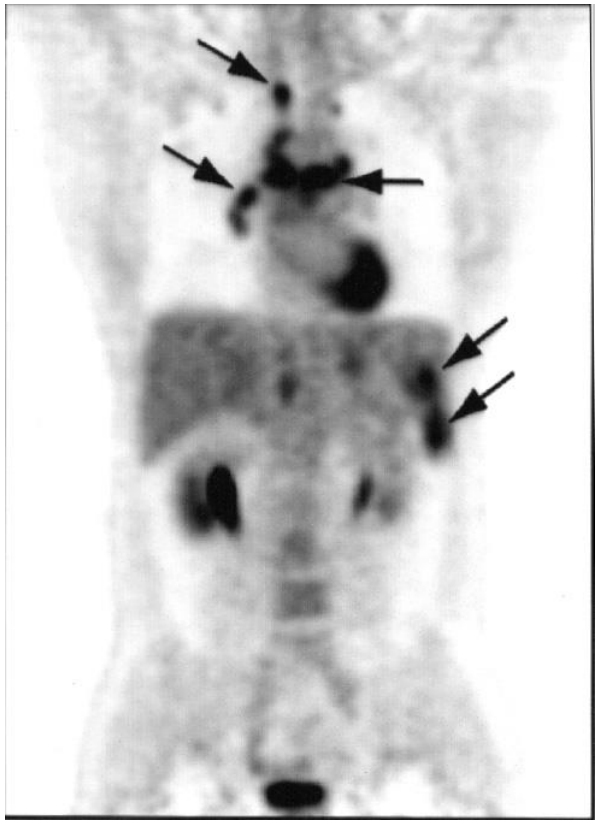
Applications

- Medicine
- Defense
- Meteorology
- Environmental science
- Manufacture
- Surveillance
- Crime investigation

Applications: Medicine

CT

(computed Tomography)



PET

(Positron Emission Tomography

PET/CT

Applications: Meteorology

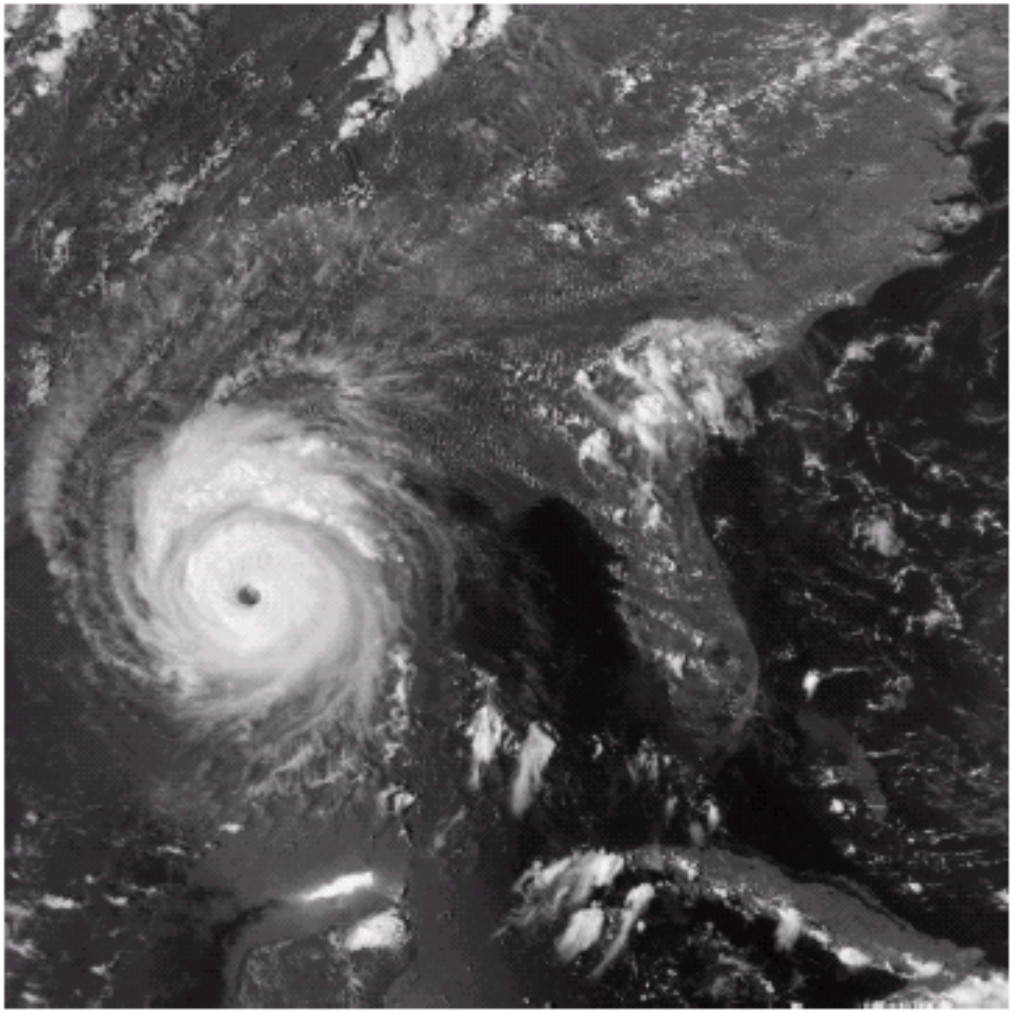


FIGURE 1.11 Multispectral image of Hurricane Andrew taken by NOAA GEOS (Geostationary Environmental Operational Satellite) sensors. (Courtesy of NOAA.)

Applications: Environmental Science

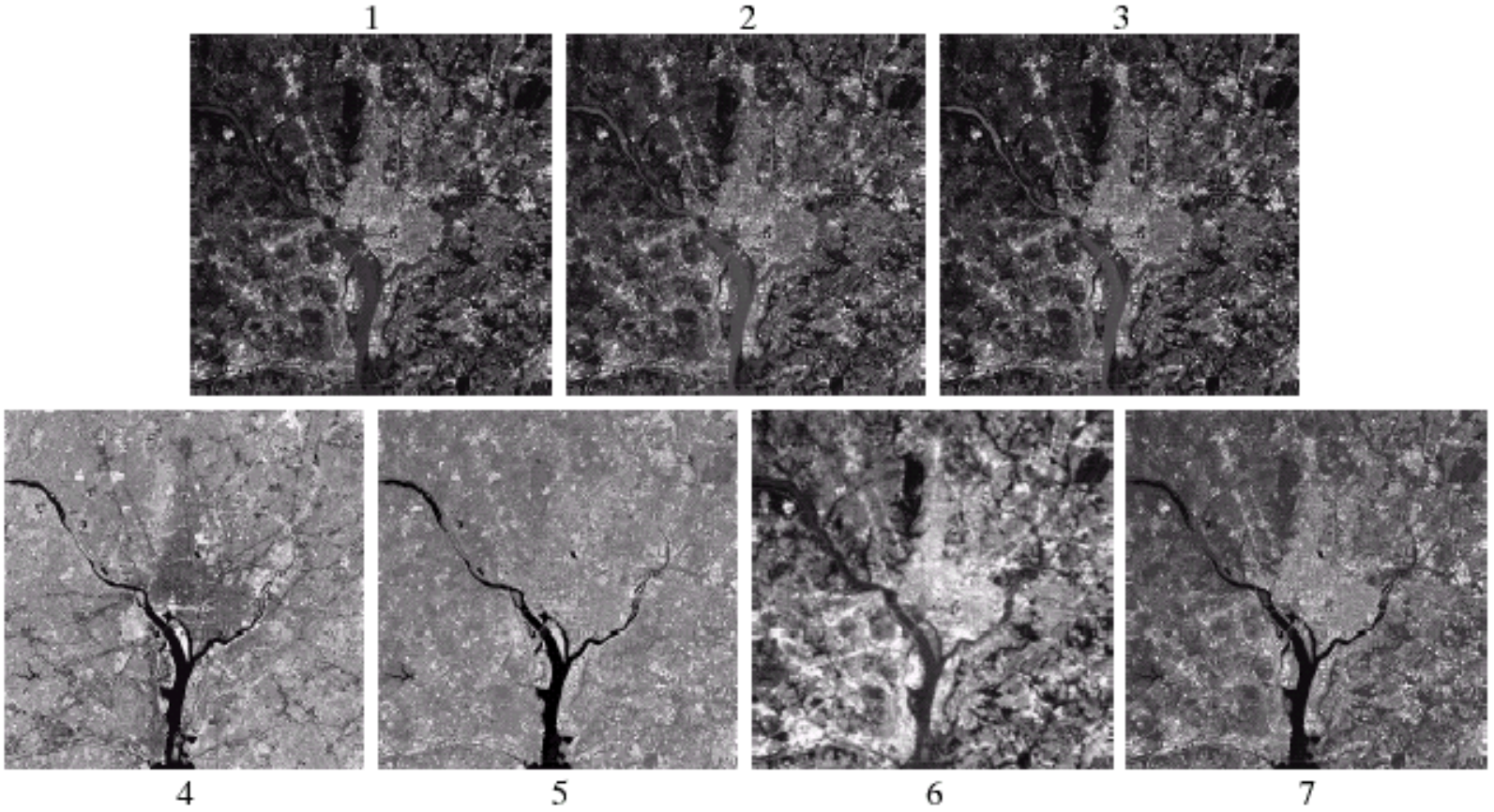
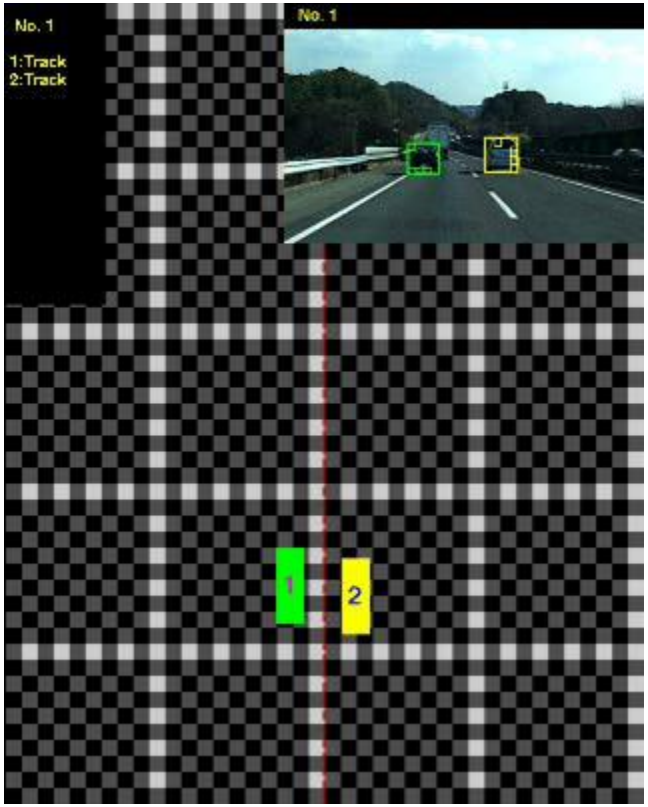


FIGURE 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

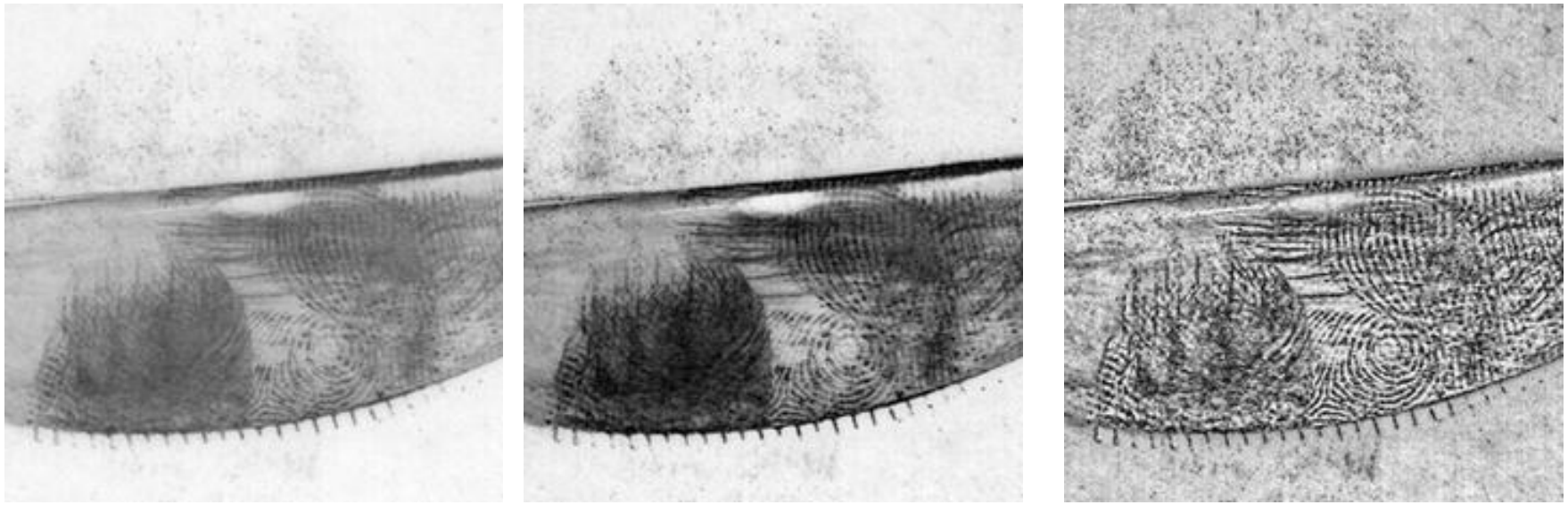
Application: Surveillance



Car Tracking Project from CMU: Tracking cars in the surrounding road scene and then generating a "bird's eye view" of the road.

Courtesy of Simon Baker: http://www.ri.cmu.edu/projects/project_526.html

Applications: Crime Investigation



Fingerprint enhancement

Textbooks

- Problems in picking a good textbook:
  - Hard to find a textbook of the right level --- too easy or too hard.
  - Hard to find a textbook of the right price --- good books tend to be too expensive
- Prescribed:
  - Rafael C. Gonzalez, Richard E. Woods: Digital Image Processing. Prentice Hall; 2nd edition, 2002
- Other references (used in 2005):
  - Alasdair McAndrew: Introduction to Digital Image Processing with Matlab, 2004.

Programming Tools

- Matlab with Image Processing Toolbox for homework exercises
  - MATLAB Tutorial:
    http://www.mathworks.com/products/matlab/matlab_tutorial.html
  - MATLAB documentation:

    http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.shtml
  - User-contributed MATLAB IP functions:
    http://www.mathworks.com/matlabcentral/fileexchange/loadCategory.do?objectType=category&objectId=26

Supplementary files:

- https://www.youtube.com/watch?v=-cSVGwAwZZ4&list=PLEo-jHOqGNyUWoCSD3l3V-FjX9PnHvx5n
- https://www.youtube.com/watch?v=U6c6qCCPJa4&list=PLmcMMZCV897oO5k7pfz23XkzXnCdcKbvn
- https://www.youtube.com/watch?v=7rXlLUx81ic&list=PLR1KtmaCt9BlaeAnan8SumYY2W5G1xFB0

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