Review for the Final
CS 635 Review
(Topics Covered)

• Image Compression
  - Lossless
    • Coding Compression
      - Huffman
    • Interpixel
      - RLE
  - Lossy
    • Quantization
    • Discrete Cosine Transform
    • JPEG
CS 635 Review
(Topics Covered)

- Segmentation
  - Edge Detection
    - $1^{st}$ Order Derivatives (Gradient)
      - Sobel Operators
    - Gradient Magnitude and Angle
      - Criteria for edge detection and linking
  - Canny Edge
    - Key: one-pixel edge
    - Introduces the non-maximum suppression
    - 2-level thresholding
Edge Detection
Edge Linking

\[ |\Psi(x, y)| \]

Edges should have similar edge normals
CS635 Review
(Topics Covered)

• Region Segmentation
  - Region Growing
    • Similarity Criteria
  - Region Splitting and Merging
    • Quad-Tree data structure
  - Watershed Algorithm
    • Find regions and merge
  - Segmentation from Motion
    • Temporal Differencing
    • Accumulation buffer
Region Segmentation

Original

Edges

Region-based
CS 635 Review
(Topics Covered)

• **Image Thresholding**
  - Simple form of segmentation
  - **Global Thresholding**
    • Automatic Thresholding
      - We need an automatic technique
      - To be able to reproduce experiments
      - avoid *magic numbers*
    • Iterative Method
    • Otsu Method
  - **Local Techniques**
    • Adaptive Thresholding based on “local” properties
Thresholding

Mean 143
Iterative 131
Otsu 130
CS 635 Review
(Topics Covered)

• **Mathematical Morphology**
  - Operations on bi-tonal images
    • “set” operation using a shape (structuring element)
  - Erosion, dilation, opening, closing
  - Hit-or-miss transform

• **Good for cleaning up noisy images**

• **Techniques using MM**
  - Boundary Extraction
  - Thinning
  - Thickening
  - Prunning
Morphology

Open
(erosion+dilation)

Close
(dilation+erosion)
Morphology

Combining the operations
Morphology

- Boundary extraction

$$\beta(A) = A - (A \ominus B)$$
Gray-Level Morphology

Our Pal  Dilation  Erosion
CS 635 Review
(Topics Covered)

- **Representation and Description**
  - Some Desirable Features
    - Representation should be
      - Translation, Rotation, Scale Invariant
  - Chain Codes
    - Differential Chain Codes
  - Polygonal Approximation
  - Segment Splitting
  - Signatures
  - Boundary Segments
  - Convex Deficiency
  - Medial Axis Transformation (MAT)
  - Shape Number
  - Fourier Descriptors
  - Topological operators
CS 635 Review
(Topics Covered)

• Template Matching
  - Correlation, Normalized Correlation
  - Sum Absolute Difference
  - Sum Squared Difference
  - Need some non-max-suppression

• Object Recognition
  - Face Database
  - Eigen-faces
    • Compact Representation
    • Fast search speeds
Template Matching

Template

Correlation Response

SAD Response
Object Recognition

Database of faces [objects]

Given an "new" image,
Can you tell who this is?

Huge Memory and Search Problem

Use PCA
(Principal Component Analysis)

Eigen-Faces
CS 635 Review
(Topics Covered)

• Hough Transform
  - Interesting approach for finding shapes
  - Votes for possible parametric contributions
  - Robust to noise
  - Sensitive to quantization
Hough in Practice

(a) Accumulator in parameter space (circle with r=30)

(b) 4 Peaks
CS 635 Review
(Topics Covered)

• Video Processing and Compression
  - De-interlacing (remove the interlacing effect)
  - Optical Flow (Motion Estimation)
  - Object Tracking

• Compression
  - MPEG
    • JPEG + Motion Estimation
    • I, P, and B Frame Encoding
    • Predictive frames use motion vectors, encodes difference (as DCT blocks)
Optical Flow

De-Zoom  
Zoom  
Translate (or rotation)
Video Compression

- Encode motion vector \((u,v)\) for each macroblock
- Encode residual error as 4 8x8 DCT blocks

**FRAME TYPES**
- **I Intra-frame**
- **P Predictive Frame**
- **B Bi-directional Predictive Frame**

**Groups of Pictures (GOP)**
- Logically organized
- IPB sequence
CS 635 Review
(Topics Covered)

• **Image Based Rendering (IBR)**
  - New reformulation of graphics as it relates to images
    • Use images to represent scene
      - No explicit geometric model
    • Warping Equation
      - Unifies 3D and 2D warping
  - New/old idea in graphics to use images to give the impression of detail
Following Examples

• The following are examples
• Consider how you would solve them
  - There may be several solutions
    • Often involved specific processing for the task
    • Often involved lots of magic numbers
      - Goal is to minimize magic number usage
  - There may be no good solution
    • Welcome to the world of IP 😊
There are 3 objects

Screws
Nuts
Washer

Can you identify (and locate) them?

Industrial Image Task
Image Enhancement

- Home User Market
  - Simple, easy to use software for your parents
  - Embedded Processing for Consumer Cameras
- Forensics Imaging
(Going, R.)
He calls us back.
(Stops)
My pride fell with my fortunes;
I’ll ask him what he would.
(Returning)
Remove the Marks

Assume you know where the marks are.

What if you didn’t know where the marks were?

Is the problem ill-posed?
Count the “Objects”
(Classic Blob Detection Problem)
Correct Pixelization
Detect the Features
(Track over time)
Detect the Object
(Detect Features inside the Object)

Microscopy Imaging
(mi-kros'-ke-pe)
Normalize Background Intensity
Fruit Inspection

- Detect bad fruit
- Determine the detect (identify the disease)
Extract the Object?
Find the fish?
(Tracking in Video)