MATLAB DEMONSTRATIONS

The Appendix to this lab contains a full list of MATLAB Demonstrations and images. Follow the steps below and comment on the results when requested.

We will only use a few on the Image Processing Demo list; however, after completing the lab, you are welcome to go back and investigate the other demonstrations. At this time, the Discrete Cosine Transform demo does not work. Click on info to get more detail on the MATLAB functions used. The instructor will give you additional instructor developed functions in subsequent labs.

Thresholds and break-point frequencies are normalized and can only have values from 0 to 1. Certain demos only permit a range of values or require values to be odd.

To launch the MATLAB demos, type at the prompt the demo m file name. For example, the first demo is an Edge Detection Demo, to launch it, type at the prompt:

>> edgedemo

1. Edge Detection Demo: edgedemo
First derivative and second derivative edge detection and thresholding.

- Select Edge Detection and click on the run button.

- Each time you select an image, make the threshold non-automatic by clicking on the circle under Automatic Threshold and click on Apply. Even thought it may show non-automatic threshold, you may have to click on it again to get the Apply button to appear.

- Using the Circuit and Saturn images, apply Sobel and Gaussian Laplacian to these images. Notice that the n Sobel generates more noise than The Gaussian Laplacian. Why? (Hint: lower the sigma for the Gauss Laplacian)

Answer: _____________________________________________________________________________
_____________________________________________________________________________________

- Look at the results of using a Sobel x or Sobel y wopr by changing the direction from both.

- Examine the effect of changing the threshold (normalized 0 to 1) for the Circuit image when using a Sobel pair. What threshold do you think produces a “clean” edge image? Answer: __________

2. 2-D Filtering and Filter Design: firdemo
2-D Finite Impulse Response (FIR) filters from frequency specification. fsamp2, fwind1, fwind2 and ftrans2 are all methods to design a small wopr using the G(u,v) of the desired filter.

- Use fsamp2 and fwind1 methods applied to the vertigo image. For fwind1, you will need to select a windowing method.
- Using low-pass filters with a cutoff frequency of 0.1 (min of 0.01 permitted) and an order of 9 (min of 5 permitted) determine the best and worst filter regarding preservation of the original image. If you select fwind1, then also specify the windowing method you selected.

**Best: ____________________________ worst ____________________________**

- Using high-pass filters with a cutoff frequency of 0.4 and an order of 9 determine the best and worst filter regarding preservation of the original image. If you select fwind1, then also specify the windowing method you selected.

**Best: ____________________________ worst ____________________________**

- Experiment on other images like the Saturn image using different orders and the same cutoff frequency.

3. **Intensity Adjustment & Histogram Equalization: imadji demo**

Contrast Adjustment and Histogram Equalization: adjust intensity values using brightness, contrast, and gamma correction, or by using histogram equalization.

- Use the Circuit and Tire images.

- For each of the images,
  a. Equalize the image and sketch the Intensity Transformation (map) that changes p intensities to q, equalized intensities.

  b. Change the Operation to Intensity Adjustment and click on the +/- Contrast buttons such that the end points of the piece wise linear fit match those of the equalization Intensity Transformation. Record p_min and p_max from the Instensity Transformation below (p_min and p_max are the corners of the Intensity Transformation):

  For the Circuit image:  p_min = _____________ and p_max = _____________

  For the Tire image :  p_min = _____________ and p_max = _____________

- Now adjust gamma. Click on the +/- Gamma until the Intensity Transformation roughly matches the equalization Intensity Transformation. Record the Gamma value below (you may use the drag options to adjust the Intensity transformation):

  For the Circuit image:  Gamma = _________________

  For the Tire image :  Gamma = _________________

- Does your Intensity Transformation produce an image that is approximately the same as an equalized image?

  Circuit:  No ____ Yes ______

  Tire    :  No ____ Yes ______
4. **Noise Reduction Filtering: nrfiltdemo**

Noise reduction filtering demo. Use the menu under the original image to select among a number of images. Edit the fields to specify the density of the noise. Press "Add Noise" to apply the noise. Use the menus under the third image to select the type of noise removal filter and the size of the neighborhood. Press "Apply Filter" to filter the corrupted image.

- Use the Flower and Circuit images and the three filter provided to fill out the following table:

<table>
<thead>
<tr>
<th>Flower Image</th>
<th>NOISE TYPE</th>
<th>NOISE PARAMETER(S)</th>
<th>BEST FILTER</th>
<th>MINIMUM SIZE OF FILTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Salt &amp; Pepper</td>
<td>Density = 0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gaussian</td>
<td>Mean = 0, Variance = 0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speckle</td>
<td>Variance = 0.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circuit Image</th>
<th>NOISE TYPE</th>
<th>NOISE PARAMETER(S)</th>
<th>BEST FILTER</th>
<th>MINIMUM SIZE OF FILTER</th>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX TO LAB#1: MATLAB DEMOS

Image Processing Demonstrations:

dctdemo
DCT image compression: you choose the number of coefficients and it shows you a reconstructed image and an error image.

edgedemo
Edge detection: all supported types with optional manual control over threshold, direction, and sigma, as appropriate to the method used.

firdemo
2-D Finite Impulse Response (FIR) filters: design your own filter by changing the cut-off frequency and filter order.

imadjsdemo
Contrast Adjustment and Histogram Equalization: adjust intensity values using brightness, contrast, and gamma correction, or by using histogram equalization.

ipexconformal
Explore a Conformal Mapping: illustrates how to use spatial- and image-transformation functions to perform a conformal mapping.

ipexdeconvblind
Deblurring Images Using the Blind Deconvolution Algorithm: illustrates use of the deconvblind function.

ipexdeconvlucy
Deblurring Images Using the Lucy-Richardson Algorithm: illustrates use of the deconvlucy function.

ipexdeconvreg
Deblurring Images Using a Regularized Filter: illustrates use of the deconvreg function.

ipexdeconvwnr
Deblurring Images Using the Wiener Filter: illustrates use of the deconvwnr function.

ipexgranulometry
Finding the Granulometry of Stars in an Image: illustrates how to use morphology functions to perform granulometry.

ipexmri
Extracting Slices from a 3-Dimensional MRI Data Set: illustrates how to use the image transformation functions to interpolate
and reslice a three-dimensional MRI data set, providing a convenient way to view a volume of data.

**ipexnormxcorr2**  
Registering an Image Using Normalized Cross-correlation: illustrates how to use translation to align two images.

**ipexregaerial**  
Registering an Aerial Photo to an Orthophoto: illustrates how to use the Control Point Selection Tool to align two images.

**ipexrotate**  
Finding the Rotation and Scale of a Distorted Image: illustrates how to use the cp2tform function to get the rotation angle and scale factor of a distorted image.

**ipexsegcell**  
Detecting a Cell Using Image Segmentation: illustrates how to use dilation and erosion to perform edge detection.

**ipexsegmicro**  
Detecting Microstructures Using Image Segmentation: illustrates how to use morphological opening and closing to extract large objects from an image.

**ipexsegwatershed**  
Detecting Touching Objects Using Watershed Segmentation: illustrates use of morphology functions to perform marker-control watershed segmentation.

**ipexshear**  
Padding and Shearing an Image Simultaneously: illustrates how to use the padding options of the image transformation functions.

**ipextform**  
Creating a Gallery of Transformed Images: illustrates how to use the imtransform function to perform many types of image transformations.

**ipss001**  
Connected components labelling slideshow: includes double thresholding, feature-based logic, and binary morphology. All operations are performed on one image.

**ipss002**  
Feature-based logic slideshow containing two examples: the first example shows object selection using AND operations on the `on' pixels in two binary images; the second example shows
filtering and thresholding on a single image.

ipss003
Correction of nonuniform illumination slideshow: creates a coarse approximation of the background, subtracts it from the image, and then adjusts the pixel intensity values to fill the entire range.

nrfiltdemo
Noise reduction using linear and non-linear filters: allows you to add different types of noise with variable densities, and choose a filter neighborhood size.

qtdemo
Quadtree decomposition: select a threshold and see a representation of the sparse matrix and a reconstruction of the original image.

roidemo
Region of Interest (ROI) selection: select an ROI and apply operations such as unsharp and fill. Also displays the binary mask of the ROI.

\MATLAB6p1\toolbox\images\imdemos\Contents.m
% Image Processing Toolbox --- demos and sample images
% Demos.
% dctdemo - 2-D DCT image compression demo.
% edgedemo - Edge detection demo.
% firdemo - 2-D FIR filtering and filter design demo.
% imadji demo - Intensity adjustment and histogram equalization demo.
% landsatdemo - Landsat color composite demo.
% nrfiltdemo - Noise reduction filtering demo.
% qtdemo - Quadtree decomposition demo.
% roidemo - Region-of-interest processing demo.
% Slide shows.
% ipss001 - Region labeling of steel grains.
% ipss002 - Feature-based logic.
% ipss003 - Correction of nonuniform illumination.
% Extended-examples.
% ipexindex - Index of extended examples.
% ipexsegmicro - Segmentation to detect microstructures.
% ipexsegecell - Segmentation to detect cells.
% ipexsegwatershed - Watershed segmentation.
% ipexgranulometry - Granulometry of stars.
% ipexdeconvwnr - Wiener deblurring.
% ipexdeconvreg - Regularized deblurring.
% ipexdeconvlucy - Lucy-Richardson deblurring.
% ipexdeconvblind - Blind deblurring.
% ipextform  - Image transform gallery.
% ipexshear  - Image padding and shearing.
% ipexmri    - 3-D MRI slices.
% ipexconformal - Conformal mapping.
% ipexnormxcorr2 - Normalized cross-correlation.
% ipexrotate - Rotation and scale recovery.
% ipexregaerial - Aerial photo registration.
%
% Extended-example helper M-files.
% ipex001    - Used by image padding and shearing example.
% ipex002    - Used by image padding and shearing example.
% ipex003    - Used by MRI slicing example.
% ipex004    - Used by conformal mapping example.
% ipex005    - Used by conformal mapping example.
% ipex006    - Used by conformal mapping example.
%
% Sample MAT-files.
% imdemos.mat - Images used in demos.
% trees.mat  - Scanned painting.
% westconcordpoints.mat - Used by aerial photo registration example.
%
% Sample JPEG images.
% football.jpg
% greens.jpg
%
% Sample PNG images.
% concordorthophoto.png
% concordaerial.png
% westconcordorthophoto.png
% westconcordaerial.png
%
% Sample TIFF images.
% afmsurf.tif
% alumgrns.tif
% autumn.tif
% bacteria.tif
% blood1.tif
% board.tif
% bonemarr.tif
% cameraman.tif
% canoe.tif
% cell.tif
% circbw.tif
% circles.tif
% circlesm.tif
%
% debye1.tif
% eight.tif
% enamel.tif
Sample Landsat images.

Photo credits


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Photograph of Carmanah Ancient Forest, British Columbia, Canada, courtesy of Susan Cohen.

Micrograph of 16-bit A/D converter circuit, courtesy of Steve
Decker and Shujaat Nadeem, MIT, 1993.
m83: M83 spiral galaxy astronomical image courtesy of Anglo-Australian
Observatory, photography by David Malin.
cell: Cancer cell from a rat’s prostate, courtesy of Alan W. Partin, M.D.,
Ph.D., Johns Hopkins University School of Medicine.
board: Computer circuit board, courtesy of Alexander V. Panasyuk,
Ph.D., Harvard-Smithsonian Center for Astrophysics.
LAN files: Permission to use Landsat TM data sets provided by Space Imaging,
LLC, Denver, Colorado.
concordorthophoto and westconcordorthophoto: Orthoregistered photographs courtesy
of Massachusetts Executive Office of Environmental Affairs, MassGIS.
concordaerial and westconcordaerial: Visible color aerial photographs courtesy of mPower3/Emerge.

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