CS 556: Computer Vision
Matlab and C (OpenCV)
Toolboxes, Libraries, and Online Code

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Matlab
Matlab: Image Processing Toolbox

• Images
  – **imread** : Read image
  – **imwrite** : Write Image
  – **imshow** : Display image
  – **im2bw** : Convert image to binary image
  – **im2double** : Convert image to double precision
  – **im2uint8** : Convert image to 8-bit unsigned integers
  – **rgb2gray** : Convert RGB image or colormap to grayscale
  – **imrotate** : Rotate image
  – **imresize** : Resize image
  – **imtransfor** : Apply 2-D spatial transformation to image
  – **bwb boundaries** Trace region boundaries in binary image
  – **bwtraceboundary** Trace object in binary image
  – **bwlabel** Label connected components in 2-D binary image
Matlab: Image Processing Toolbox

- **corner** Find corner points in image
- **edge** Find edges in grayscale image
- **edgetaper** Taper discontinuities along image edges
- **hough** Hough transform
- **houghlines** Extract line segments based on Hough transform
- **houghpeaks** Identify peaks in Hough transform
- **imcontour** Create contour plot of image data
- **imhist** Display histogram of image data
- **regionprops** Measure properties of image regions
- **corr2** 2-D correlation coefficient
- **mean2** Average or mean of matrix elements
- **std2** Standard deviation of matrix elements
- **mmreader** For reading Videos
Matlab: Image Processing Toolbox

- Image Example (Convert image into grayscale and find its edges):
  
  ```matlab
  I = imread('example.jpg');
  I = im2double(I);  %or I=double(I);
  G = rgb2gray(I);
  G = uint8(G);
  figure;
  imshow(G);
  imwrite(G, 'out.png');
  E = edge(G, 'canny', 0.3);
  figure;
  imshow(E);
  imwrite(E, 'outEdge.pgm');
  ```
Matlab: Image Processing Toolbox

Video Example (Convert an movie into grayscale):

```matlab
readerobj = mmreader('example.mpg', 'tag', 'myreader1');
numFrames = get(readerobj, 'numberOfFrames');
l = read(readerobj, 1);
for k = 1 : numFrames
    l = read(readerobj, k);
    G = rgb2gray(l);
    mov(k).img = G;
end
aviobj = avifile('example.avi')
for k = 1 : numFrames
    aviobj = addframe(aviobj, mov(k).img);
end
aviobj = close(aviobj);
```
C (OpenCV)
OpenCV: Installation

- Source Code is available online
- Tutorial and step by step installation
- Noah Kuntz Tutorials
OpenCV: Tutorials

- OpenCV Tutorial 1: Getting started and image manipulation, chapters 1, 2
- OpenCV Tutorial 2: Data Types, chapter 3
- OpenCV Tutorial 3: HighGUI Interface Toolkit, chapter 4
- OpenCV Tutorial 4: Image Processing, chapter 5
- OpenCV Tutorial 5: Image Transforms, chapter 6
- OpenCV Tutorial 6: Histograms and Matching, chapter 7
- OpenCV Tutorial 7: Contours, chapter 8
- OpenCV Tutorial 8: Image Parts and Segmentation, chapter 9
- OpenCV Tutorial 9: Tracking and Motion, chapter 10
- OpenCV Tutorial 10: Camera Models and Calibration, chapter 11
- OpenCV Tutorial 11: Machine Learning, chapter 13
OpenCV: Face Detection and Tracking

- **OpenCV Part 1** Introduction, and how to input from different devices (Images, Videos, Cameras)
- **OpenCV Part 2** Face Detection
- **OpenCV Part 3** Face Tracking
- **OpenCV Part 4** Face Detection using Eigen Faces
- **OpenCV Part 5** Implementing Eigen Faces
OpenCV: Functions

- **OpenCV 1.0 API**
- **OpenCV 2.1 API**
- Functions For Images:
  - cvLoadImage
  - cvSaveImage
  - PyrMeanShiftFiltering
  - Watershed
  - FindContours
  - Threshold
  - CvtColor
  - 2DRotationMatrix
  - Dilate
  - Erode
  - CornerHarris
  - Canny
  - HoughLines2
  - HoughCircles
  - MatchTemplate
OpenCV: Functions

- MatchShapes
- CalcImageHomography
- FindHomography
- CalibrateCamera2
- FindExtrinsicCameraParams2
- Undistort2
- WarpPerspective
- GetPerspectiveTransform
- WarpAffine
- GetAffineTransform.
- FindChessboardCorners
- DrawChessBoardCorners
- FindFundamentalMat
- ComputeCorrespondEpilines
- ConvertPointsHomogenous
- DrawChessBoardCorners
OpenCV: Functions

• Functions For Videos:
  – CvCapture
  – cvCreateVideoWriter
  – cvWriteFrame
• Functions For Camera
  – cvCreateCameraCapture
  – cvQueryFrame
• Functions For Display
  – cvWaitKey
  – cvSetMouseCallback
  – cvSetTrackbarPos
  – cvGetTrackbarPos
  – cvNamedWindow
  – cvShowImage
Online Code
Keypoints

- **Affine Covariant Features** (Matlab and Linux binaries)
  - Harris-Affine & Hessian Affine
  - MSER
  - Salient regions
- **Ivan Laptev** (Matlab)
  - Harris-Affine & Hessian Affine
- **David Lowe** (Matlab)
  - Sift
- **Luc Van Gool** (Matlab and C)
  - SURF
- **Engin Tola** (Matlab and C)
  - Daisy
Camera Calibration

- Jean-Yves Bouguet (Matlab)
- Christian Wengert (Matlab)
  - Add on to the main toolbox
Epipolar Geometry

- **Multiple View Geometry** (Matlab)
  - Fundamental Matrix
  - Image correspondences
  - Homography
- **Peter Kovesi’s Matlab Functions** (Matlab)
  - Homography
  - Ransac
  - Line Fitting
- **The Fundamental Matrix Song**
Tracking

• **Fabian Wauthier** (Matlab)
  – Motion Tracking

• **Hungarian Algorithm** (Matlab)
Matching

- **DTW** (Matlab)
- **William Brendel**
  - CDTW (C)
Segmentation

- **NCUT** (Matlab)
- **Berkeley** (Matlab under Linux 64-bits)
- **MeanShift** (C code and Windows Binaries)
  - More details for adding Binary to Matlab
  - More details for MeanShift
  - More Code for MeanShift
- **Watershed** (Matlab)
Object Detection

- **Pedro F. Felzenszwalb** (Matlab under Linux)
- **Navneet Dalal** (OpenCV and Linux Binaries)
- **Bastian Leibe** (OpenCV and Linux Binaries)
Other

- **Computer Vision Software**
- **CVPR TOOLBOX**
  - cvEuclid - Euclidean distance
  - cvMahaldist - Mahalanobis distance
  - cvGmm - Construct a GMM structure
  - cvGmmEm - Train Gaussian Mixture Models (GMM) using EM algorithm.
  - cvGmmPdf - Probability Density Function of Mixtures of Gaussian
  - cvHarrisCorner - Harris Corner Detector
  - cvHisteq - Histogram Equalization
  - cvHistnorm - Histogram Normalization or Streching
  - cvKmeans - K-means clustering
  - cvKnn - K-Nearest Neighbor classification
  - cvLda - Fisher's Linear Discriminant Analysis (FLDA or LDA)
  - cvLdai - Inverse LDA Projection
  - cvLda - Projects feature vectors into LDA space
  - cvLibmsvmPredict - Multi-class extension of LIBSVM [1]
  - cvLibmsvmTrain - Multi-class extension of LIBSVM [1]
  - cvMatchTemplate - Template Matching
  - cvMeanCov - Compute mean and covariance (variance for 1-D)
Other

- cvPca - Principal Component Analysis
- cvPcaDiffs - Distance "in" and "from" feature space [1]
- cvPcaDist - Distance between a point to a PCA space
- cvPcaInvProj - Inverse PCA Projection
- cvPfa - Principal Feature Analysis (Feature Selection)
- cvrKnn - Run Interface of cvKnn
- cvSvmSimple - SVM Classifier for linearly separable data
- cvuNormalize - (CV Utility) Normalize Array in [low, high]
- cvuOpenCvLoad - (CV Utility) Load data in OpenCV CvFileStorage XML format
- cvuOpenCvSave - (CV Utility) Save data in OpenCV CvFileStorage XML format
- cvuPowerlawFit - (CV Utility) Curve fitting by power law form $y = p(1)x^{p(2)}$