

Computer Vision, CS378/395T, Fall 2007
Outline of topics

- Image formation
 - Perspective, orthographic projection properties, equations, effects
 - Pinhole cameras
 - Thin lens
 - Field of view, depth of field
- Color
 - BRDF
 - Spectral power distribution
 - Color mixing
 - Color matching
 - Color spaces
 - Human perception
- Binary image analysis
 - Histograms and thresholding
 - Connected components
 - Morphological operators
 - Region properties and invariance
 - Distance transform, Chamfer distance
- Filters
 - Application/effects of
 - Convolution properties
 - Noise models
 - Mean, median, Gaussian, derivative filters
 - Separability
- Edges, pyramids, sampling
 - Image gradients
 - Effects of noise
 - Derivative of Gaussian, Laplacian filters
 - Canny edge detection
 - Corner detection
 - Sampling and aliasing
 - Pyramids – construction and applications
- Texture
 - Analysis vs. synthesis
 - Representations
- Grouping
 - Gestalt principles
 - Clustering: agglomerative, k-means, mean shift, graph-based
 - Graphs and affinity matrices
- Fitting
 - Hough transform
 - Generalized Hough transform
 - Least squares

- Incremental line fitting, k-means
 - Robust fitting: RANSAC, M-estimators
 - Deformable contours, energy functions
- Multi-view geometry
 - Human stereopsis and disparity
 - Geometry of two views: stereo rigs
 - Case of calibrated cameras and parallel optical axes
 - Epipolar geometry and the epipolar constraint
 - Triangulation
 - Essential matrix
- Stereo reconstruction
 - Rectification
 - Non-geometric constraints for correspondences
 - Dense vs. sparse stereo matching
- Camera calibration, self-calibration
 - Intrinsic parameters
 - Linear perspective projection equations
 - Estimating the projection matrix
 - Fundamental matrix
 - Robust computation for uncalibrated views
- Local invariant features
 - Classes of transformations
 - General interest operators
 - Scale invariant detection, scale-space
 - DoG, SIFT detection of keypoints
 - Affine invariant detection
 - Local descriptors
 - Application for wide baseline stereo
- Indexing local features
 - Search task
 - Bags-of-words representation, computing visual vocabularies
 - Inverted file indexing
- Model-based recognition
 - Interpretation trees
 - Alignment, pose consistency
 - Pose clustering, voting
 - Verification
- Learning and supervised classification
 - Generative vs. discriminative models
 - Bayesian inference
 - Support Vector Machines
 - Boosting, Adaboost
 - Nearest neighbors
 - Cascade of classifiers
- Object recognition examples
 - Eigenfaces
 - Viola-Jones face detection, rectangular features
 - Models of shape and appearance

- Part-based model, learning with weak supervision
- Motion
 - Motion field equations
 - Motion parallax
 - Optical flow
 - Aperture problem and brightness constancy
 - Lucas-Kanade optical flow algorithm
 - Discrete matching algorithm
 - Coarse-to-fine computation
 - Image warping via flow fields
- Tracking
 - Recursive estimation
 - Hidden states and measurements
 - Tracking as inference
 - Linear dynamics models
 - Kalman filter
 - Data association
 - Particle filters, Condensation algorithm
 - Example-based pose estimation+motion graphs