

## Filtering

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### Things to take away from this lecture

- An image as a function
- Digital vs. continuous images
- Image transformation: range vs. domain
- Types of noise
- LSI filters
  - cross-correlation and convolution
  - properties of LSI filters
  - mean, Gaussian, bilinear filters
- Median filtering
- Image scaling
- Image resampling
- Aliasing
- Gaussian pyramids

## Edge detection

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### Things to take away from this lecture

- What is an edge and where does it come from
- Edge detection by differentiation
- Image gradients
  - continuous and discrete
  - filters (e.g., Sobel operator)
- Effects of noise on gradients
- Derivative theorem of convolution
- Derivative of Gaussian (DoG) operator
- Laplacian operator
  - Laplacian of Gaussian (LoG)
- Canny edge detector (basic idea)
  - Effects of varying sigma parameter
- Approximating an LoG by subtraction

## Segmentation

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### Things to take away from this lecture

- Graph representation of an image
- Intelligent scissors method
- Normalized cuts method
- Image histogram
- K-means clustering
- Morphological operations
  - dilation, erosion, closing, opening
- Hough transform

## Motion

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### Things to take away from this lecture

- Optical flow problem definition
- Aperture problem and how it arises
- Assumptions
  - Brightness constancy, small motion, smoothness
- Derivation of optical flow constraint equation
- Lukas-Kanade equation
  - Derivation
  - Conditions for solvability
  - meanings of eigenvalues and eigenvectors
- Iterative refinement
  - Newton's method
  - Coarse-to-fine flow estimation
- Feature tracking
  - Harris feature detector
  - L-K vs. discrete search method
  - Tracking over many frames
  - Prediction using dynamics
- Applications
  - MPEG video compression
  - Image alignment

## Projection

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### Things to take away from this lecture

- Properties of a pinhole camera
  - effects of aperture size
- Properties of lens-based cameras
  - focal point, optical center, aperture
  - thin lens equation
  - depth of field
  - circle of confusion
- Modeling projection
  - homogeneous coordinates
  - projection matrix and its elements
  - orthographic, weak perspective, affine models
- Camera parameters
  - intrinsics, extrinsics

## Mosaics

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### Things to take away from this lecture

- Image alignment
- Image reprojection
  - homographies
  - cylindrical projection
- Radial distortion
- Creating cylindrical panoramas
- Image blending
- Image warping
  - forward warping
  - inverse warping
  - bilinear interpolation

## Projective geometry

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### Things to take away from this lecture

- Homogeneous coordinates and their geometric intuition
- Homographies
- Points and lines in projective space
  - projective operations: line intersection, line containing two points
  - ideal points and lines (at infinity)
- Vanishing points and lines and how to compute them
- Single view measurement
  - within a reference plane
  - height
- Cross ratio
- Camera calibration
  - using vanishing points
  - direct linear method

## Stereo

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### Things to take away from this lecture

- Cues for 3D inference, shape from X
- Epipolar geometry
- Stereo image rectification
- Stereo matching
  - window-based epipolar search
  - effect of window size
  - sources of error
- Active stereo (basic idea)
  - structured light
  - laser scanning

## Multiview stereo

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### Things to take away from this lecture

- Baseline tradeoff
- Multibaseline stereo approach
- Voxel coloring problem
- Volume intersection algorithm
- Voxel coloring algorithm
- Space carving algorithm

## Light and reflection

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### Things to take away from this lecture

- Light field, plenoptic function
- Light as EMR spectrum
- Perception
  - color constancy, color contrast
  - adaptation
  - the retina: rods, cones (S, M, L), fovea
  - what is color
    - » response function, filters the spectrum
    - » metamers
- Finding camera response function (basic idea, not details)
- Materials and reflection
  - what happens when light hits a surface
  - BRDF
  - diffuse (Lambertian) reflection
  - specular reflection
  - Phong reflection model
  - measuring the BRDF

# Recognition

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## Things to take away from this lecture

- Classifiers
- Probabilistic classification
  - decision boundaries
  - learning PDF's from training images
  - Bayesian estimation
- Principle component analysis
- Eigenfaces algorithm