Lecture 10, Oct 3, 2025

Review Lecture

- Important content by lecture:
  - Lecture 2 (mathematical foundations)
    * Different types of linear transformations and what properties they preserve, what situations they come up in
    * Rotations in 3D (properties of $SO(3)$) and representations (matrix, Euler, axis-angle, quaternion)
  - Lecture 3 (probability and regression)
    * Conditional probability (Bayes' rule)
    * Linear regression, standard linear least squares formulation and solution
    * RANSAC algorithm: working principles, expected/required number of trials to get an outlier-free sample with some probability
  - Lecture 4 (optics)
    * Ideal pinhole camera model
    * Definition of the camera reference frame, optical axis, image plane, principal point
    * Projective map
    * Camera matrices (intrinsics and extrinsics), projecting onto the image plane
    * Lens distortion model
    * Optical effects that degrade images (vignetting, other effects)
  - Lecture 5 (image operations)
    * Point operations (thresholding, brightness, contrast, gamma adjustment, histogram equalization)
    * Linear filtering (convolutions, separable filters)
    * Nonlinear filtering (band-pass, bilateral)
    * Geometric transformations (viewpoint transformation and bilinear interpolation)
    * Regularization?
  - Lecture 6 (image features: detection and description)
    * Important characteristics of features (saliency, locality, repeatability, compactness)
    * Various feature detectors, classical (Harris, SIFT, SURF, FAST, BRISK, BRIEF, ORB) and learned (LIFT)
  - Lecture 7 (image features: matching)
    * Feature descriptor distance functions (SSD between patches, hamming distance, Euclidean distance)
    * Rejecting outliers (RANSAC, ratio test)
    * Binary classification evaluation (confusion matrix, ROC curve)
    * Matching techniques (hashing, k-D trees)
    * KLT tracker (local matching) as alternative to matching through the whole image
  - Lecture 8 (camera pose estimation) ($\star$)
    * Perspective-n-point: problem definition
    * Direct linear transform to solve the homography (as an approximation)
    * Nonlinear least squares (iterative algorithm)
    * Regressing rotations (Wahba problem, Euler angles and rotation matrix/axis-angle formulation)
  - Lecture 9 (stereo)
    * Epipolar geometry (epipolar planes, lines, epipolar point)
    * Stereo preprocessing pipeline (stereo rectification)
    * Stereo camera model (depth from disparity)
    * Foreshortening problem
    * Basic idea of stereo matching algorithms (local vs. global algorithms, window size)
    * Learning based state-of-the-art methods