Overview

Computer Vision II

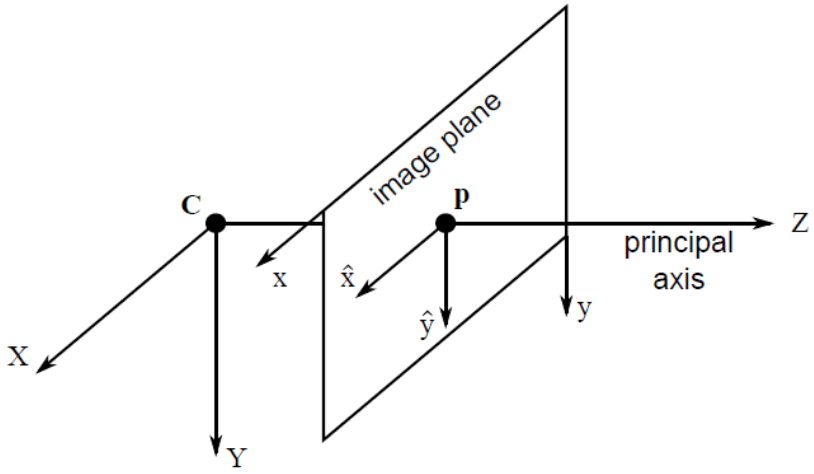
CSE 252B

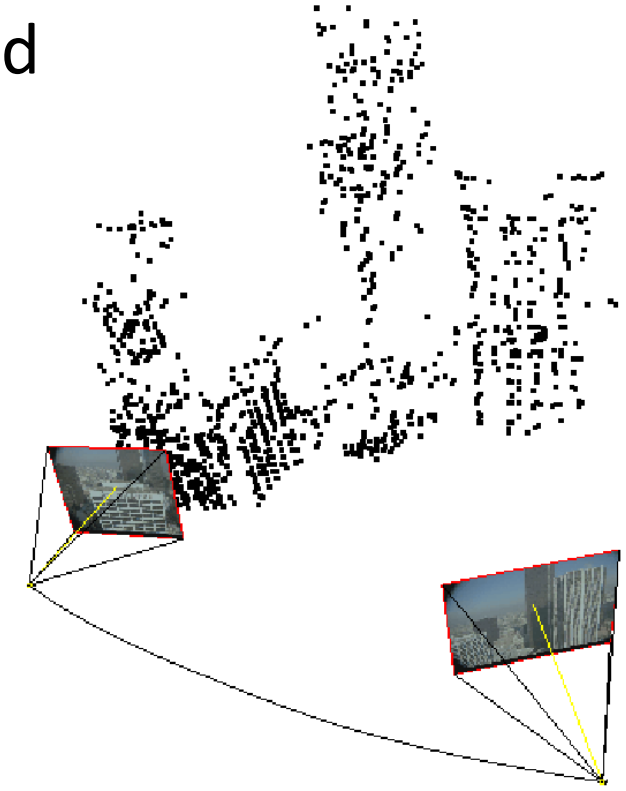
CSE 252B: Computer Vision II

- CSE 252A: Computer Vision I is not a prerequisite
- Today
  - Course overview
  - Logistics
  - Lecture: feature detection and matching (simple)
- Lectures will be boardwork with occasional slides and videos

Principal Topic

- Imaging geometry
  - Single-, two-, three-, and *n*-view geometry
  - Calibrated and uncalibrated

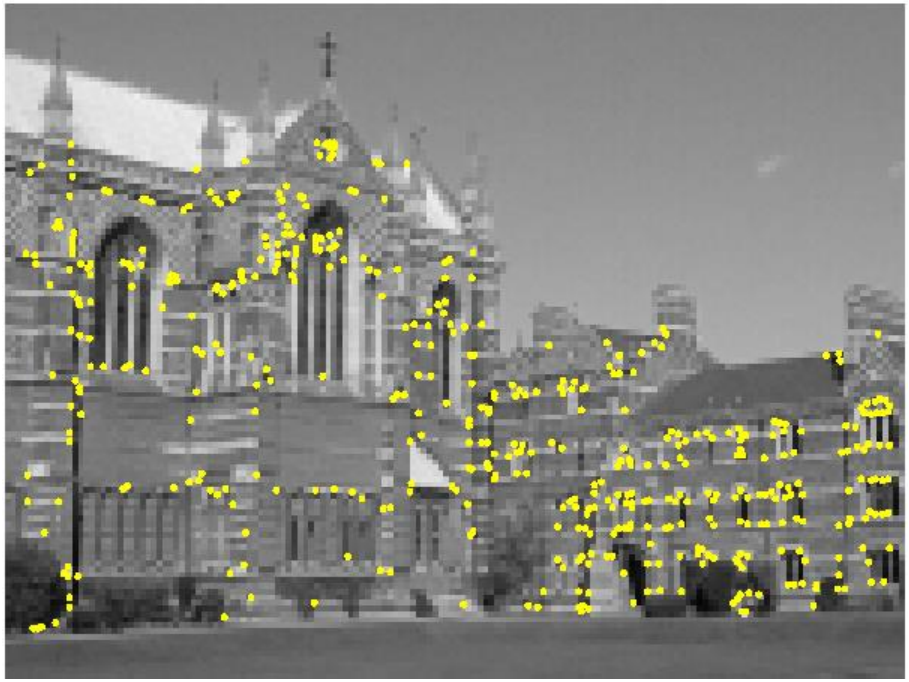


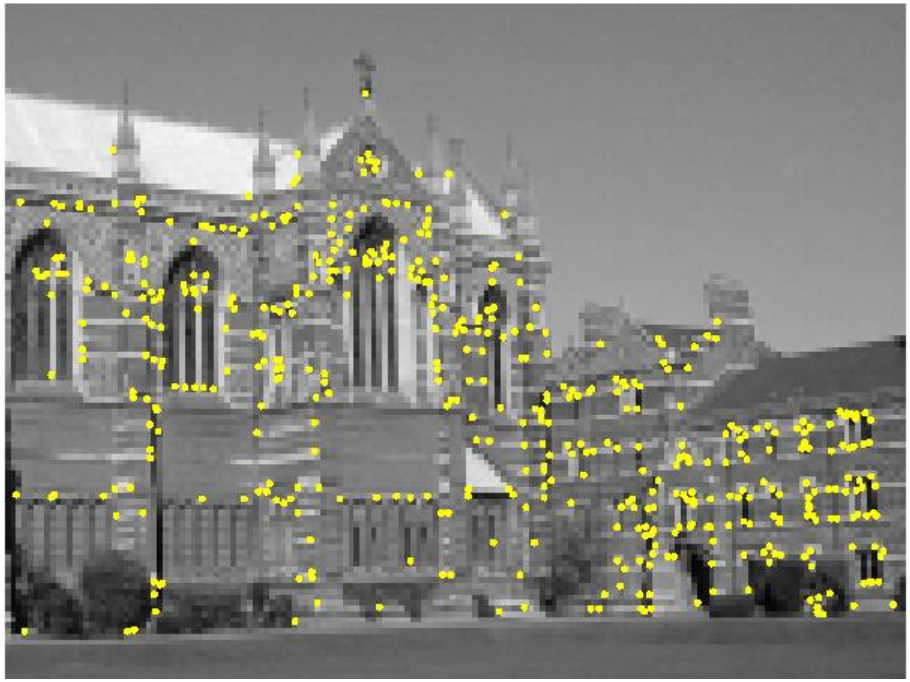


Feature Detection and Matching

Input Images

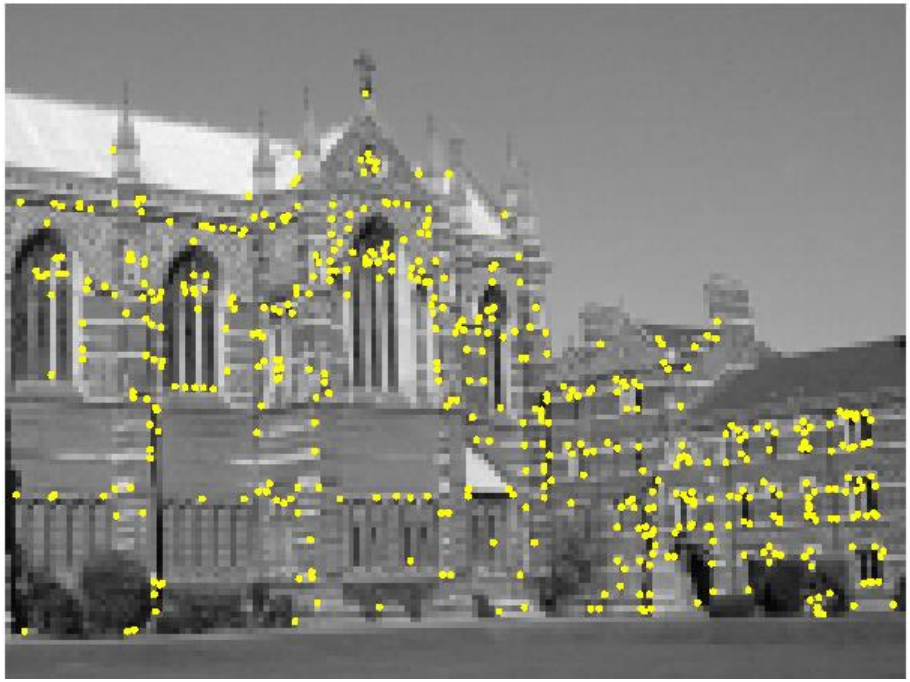
Feature Detection and Matching





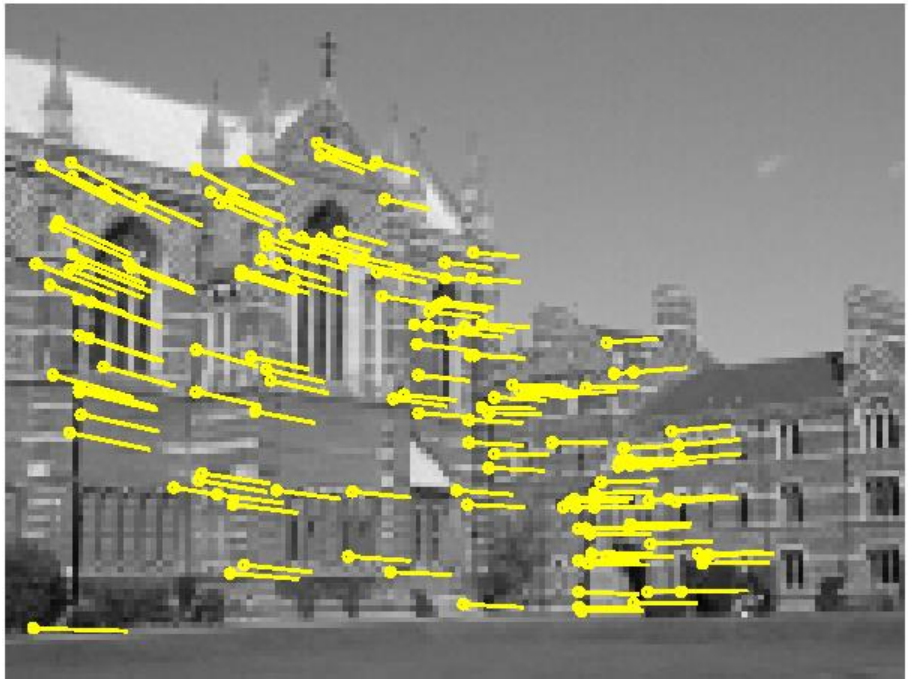
Detected Corners

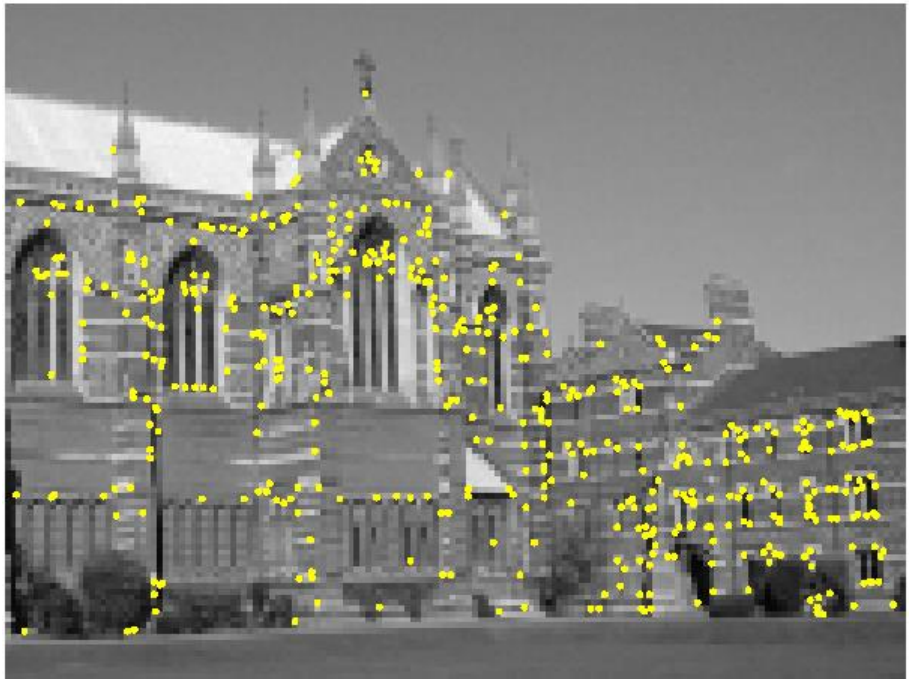
Feature Detection and Matching



Simple Matching

Feature Detection and Matching

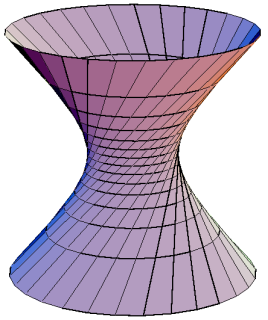


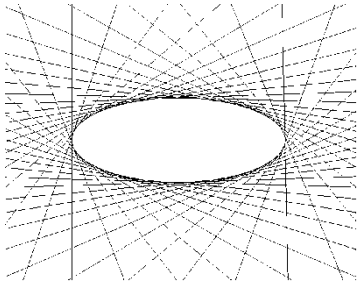


Simple Matching
Including Outlier Rejection

Geometric Primitives

- Points
- Hyperplanes
  - 2D lines, 3D planes, *n*-D hyperplanes
- Hyperquadrics
  - 2D conics, 3D quadrics, *n*-D hyperquadrics
- Dual hyperquadrics
- 3D lines and dual lines





Geometric Transformations

- Euclidean
  - Rotation and translation
- Similarity
  - Rotation, scale, and translation
- Affine
  - Linear and translation
- Projective

Single-View Geometry

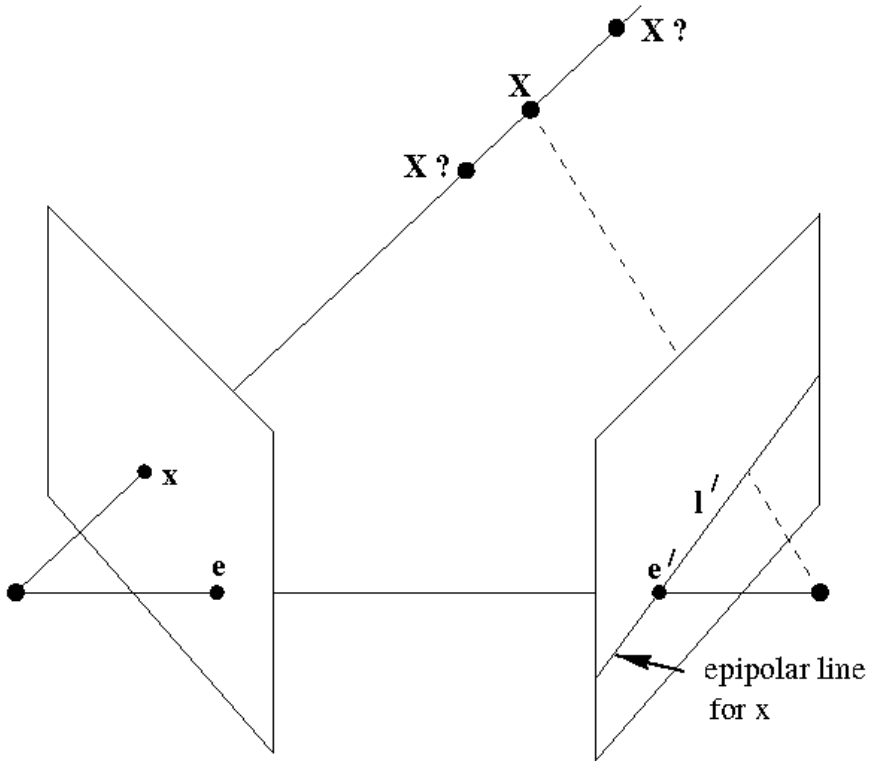
- Calibrated
  - Normalized camera projection matrix
    - Rotation and translation (pose)
- Uncalibrated
  - Camera projection matrix
    - Projective space
    - Euclidean or similarity space
      - Rotation, translation, and calibration matrix

Projection and Back-Projection

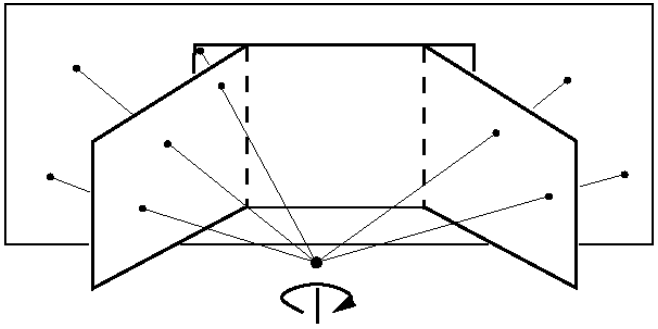
- Projection
  - Same dimension
    - e.g., 2D to 2D
  - Higher dimension to lower dimension
    - e.g., 3D to 2D
- Back-projection
  - Lower dimension to higher dimension
    - e.g., 2D to 3D
    - Introduces ambiguity

Two-View Geometry

- Calibrated
  - Essential matrix
- Uncalibrated
  - Fundamental matrix

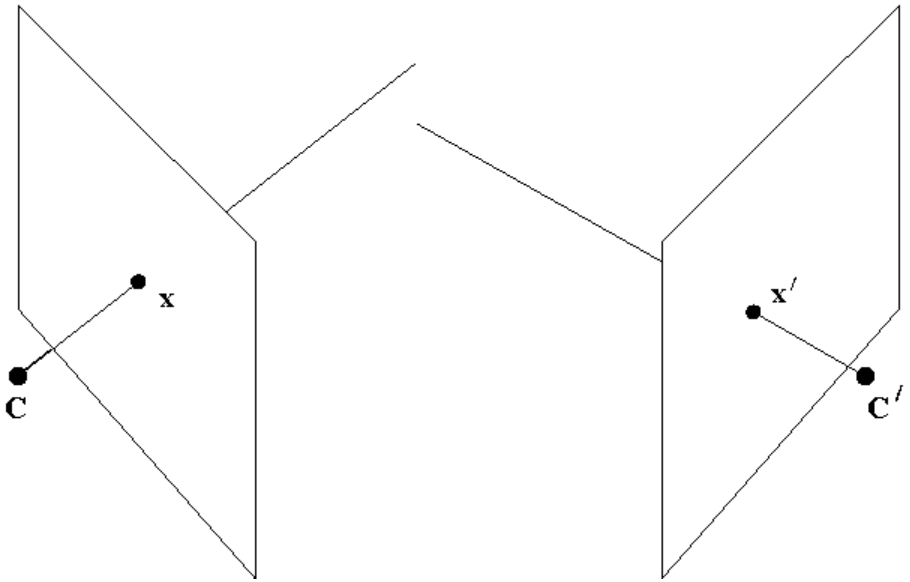


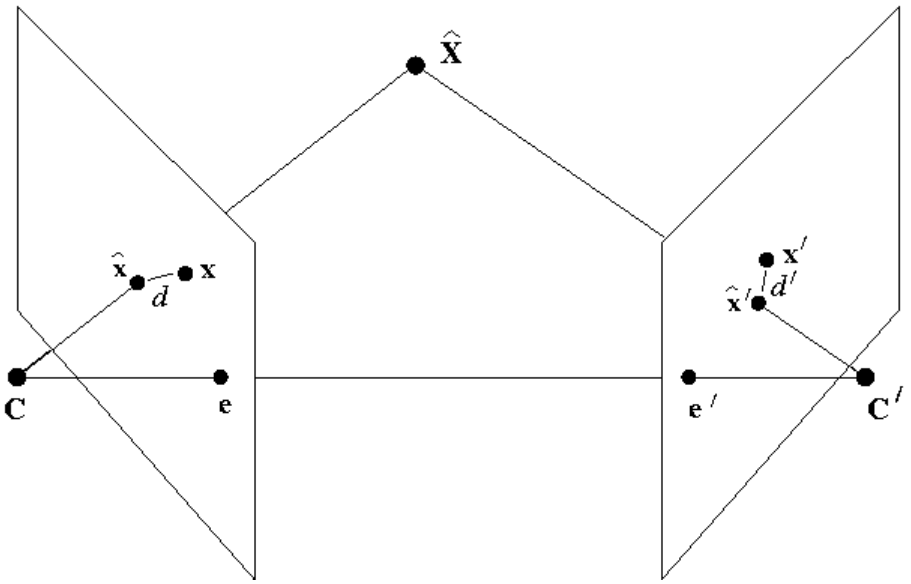
Camera Rotation Only



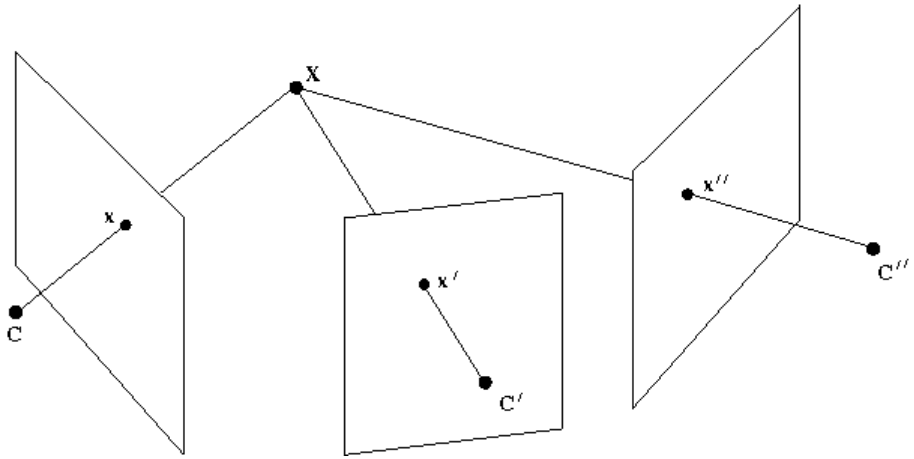
Mosaic construction from images

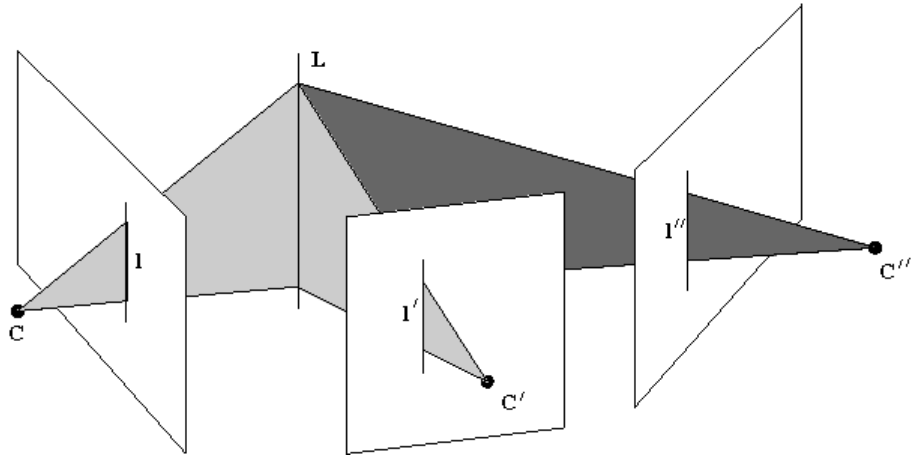
Two-View Triangulation





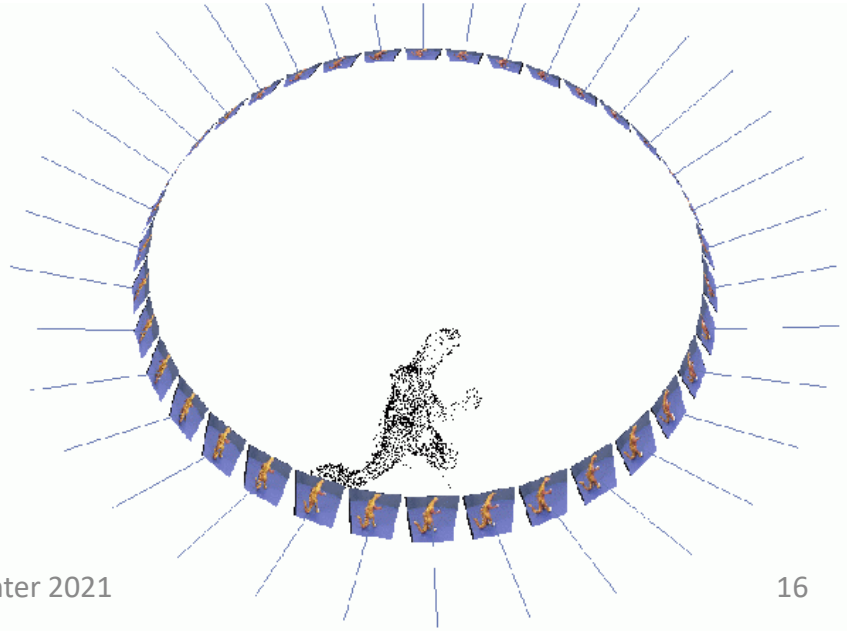
Three-View Geometry





Other Topics

- *n*-view geometry
  - Triangulation
  - Bundle adjustment and 2D block adjustment
- From projective to affine and metric reconstruction
- Auto-calibration



Common Problem: Model Estimation

- Minimal solution
  - Used in outlier rejection
- Linear estimation
- Nonlinear optimization
  - Use linear estimation for initial estimate
  - Iterative process to determine global optimum

Results

The Syllabus

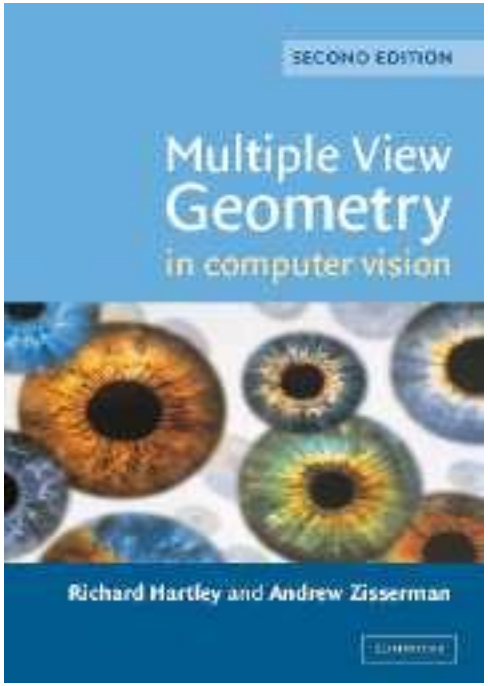
- Instructor: Ben Ochoa
- TA: Udayan Joshi
- Course website
  - https://cseweb.ucsd.edu/classes/wi21/cse252B-a/
- 18 lecture meetings
  - 2 university holidays (Jan 18 and Feb 15)
- Class discussion
  - Piazza

The Syllabus

- Grading
  - 5 homework assignments (100% of grade)
    - By hand and programming using Python
    - Significant amount of work, but rewarding
    - Start early!
    - Prepare reports using Markdown or LaTeX
    - Late policy: 15% grade reduction for each 12 hours late
      - Will not be accepted 72 hours after the due date
  - No midterm exams
  - No final exam
  - Piazza
    - Ask (and answer) questions using Piazza, not email
    - Good participation could raise your grade (e.g., raise a B+ to an A-)

Textbook

- Multiple View Geometry in Computer Vision, 2nd edition
  - Richard Hartley and Andrew Zisserman
- Download the corrections and errata



Collaboration Policy

It is expected that you complete your academic assignments on your own and in your own words and code. The assignments have been developed by the instructor to facilitate your learning and to provide a method for fairly evaluating your knowledge and abilities (not the knowledge and abilities of others). So, to facilitate learning, you are authorized to discuss assignments with others; however, to ensure fair evaluations, you are not authorized to use the answers developed by another, copy the work completed by others in the past or present, or write your academic assignments in collaboration with another person.

Academic Integrity Policy

Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind.

Academic Integrity Violation

If the work you submit is determined to be other than your own, you will be reported to the Academic Integrity Office for violating UCSD's Policy on Integrity of Scholarship. In accordance with the CSE department academic integrity guidelines, ***students found committing an academic integrity violation will receive an F in the course***.

Wait list

- Number of enrolled students is limited by
  - Size of room
  - Number of instructional assistants (TAs and tutors)
- General advice
  - Wait for as long as you can
- UCSD policy: concurrent enrollment (Extension) students have lowest priority