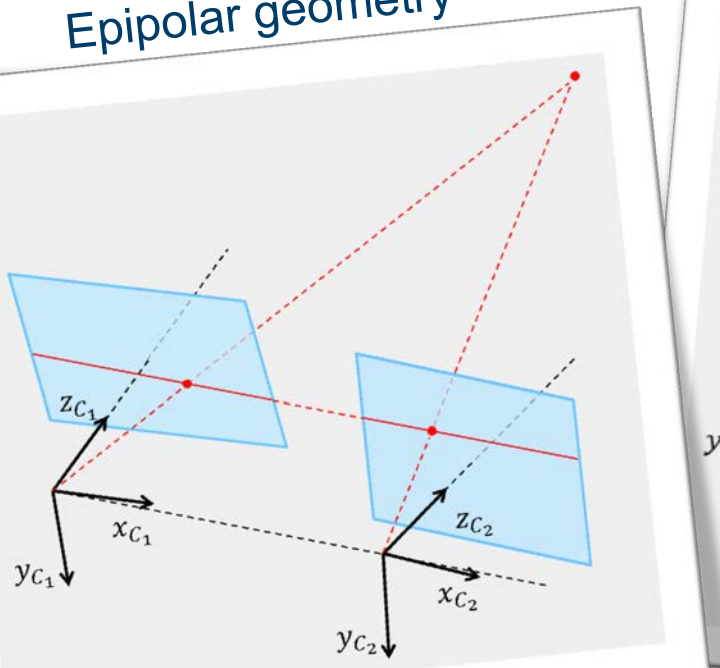
Lecture 6.1
Basic epipolar geometry

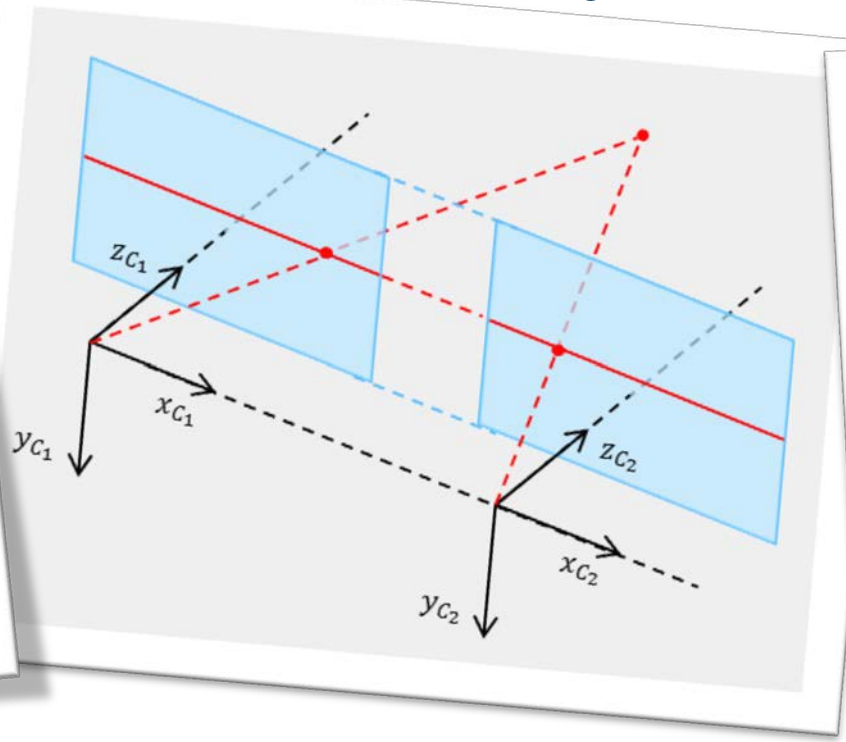
Thomas Opsahl

Weekly overview – Stereo imaging

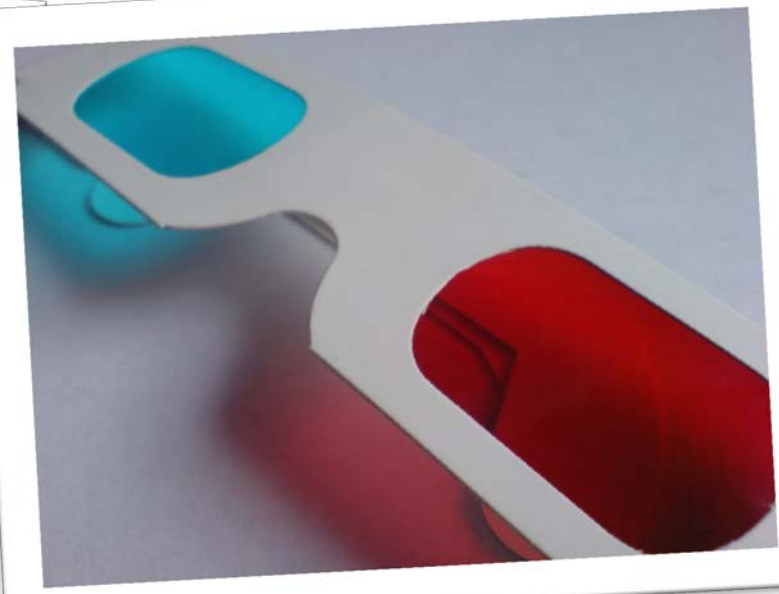
Epipolar geometry



Stereo imaging

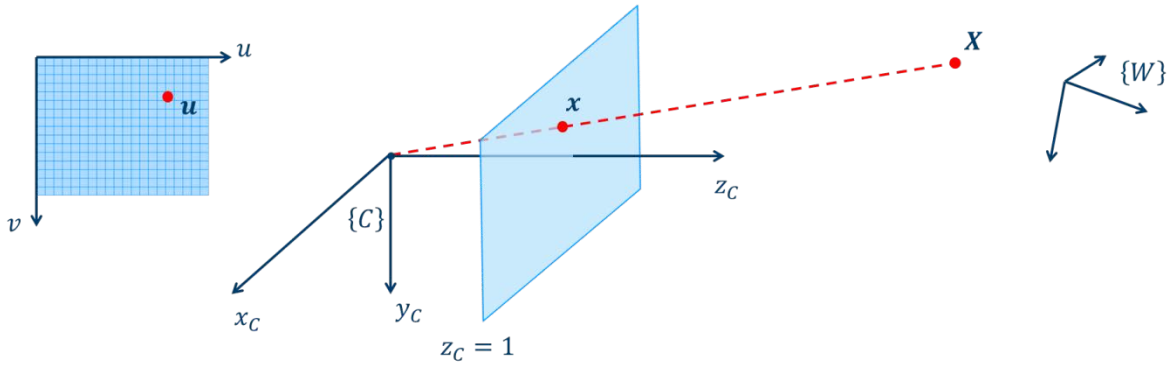


Stereo processing



Introduction

- Single-view geometry
  - Camera model $P\widetilde{\boldsymbol{X}} = \widetilde{\boldsymbol{u}}$
  - Finite projective camera $P = K[R \quad \boldsymbol{t}]$
  - Undistortion
  - Estimating P from 3D-2D correspondences
  - Calibration
  - PnP



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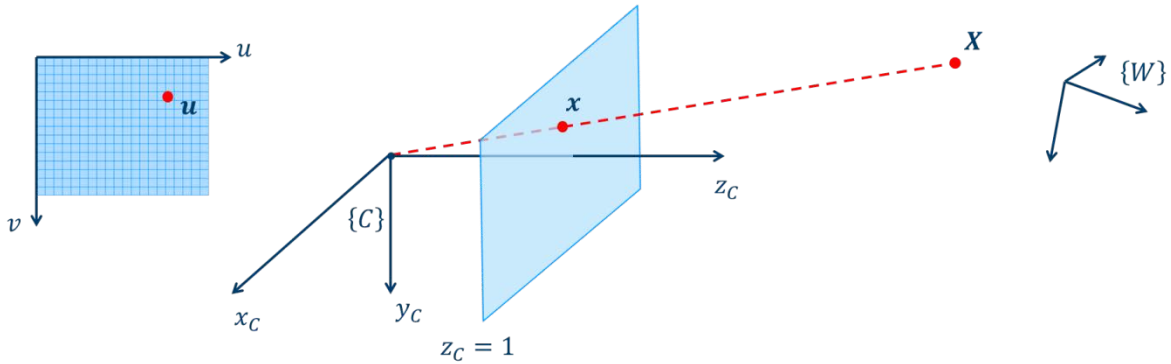
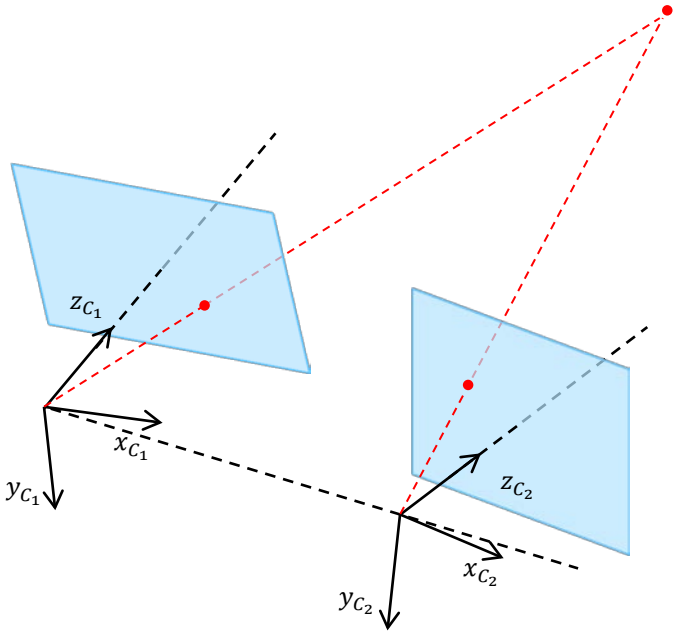


- Two-view geometry
  - Epipolar geometry is the geometric relationship between two perspective cameras
  - Two camera models $P_1\widetilde{\boldsymbol{X}} = \widetilde{\boldsymbol{u}}_1$, $P_2\widetilde{\boldsymbol{X}} = \widetilde{\boldsymbol{u}}_2$
  - Next week - General two-view



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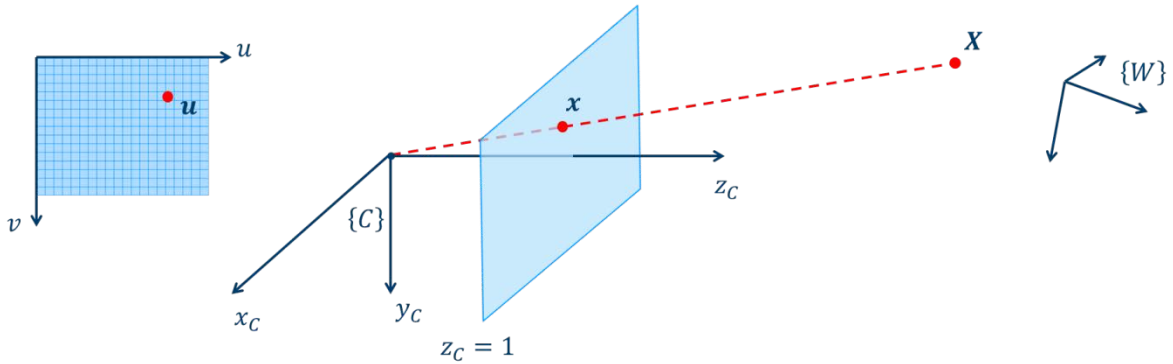

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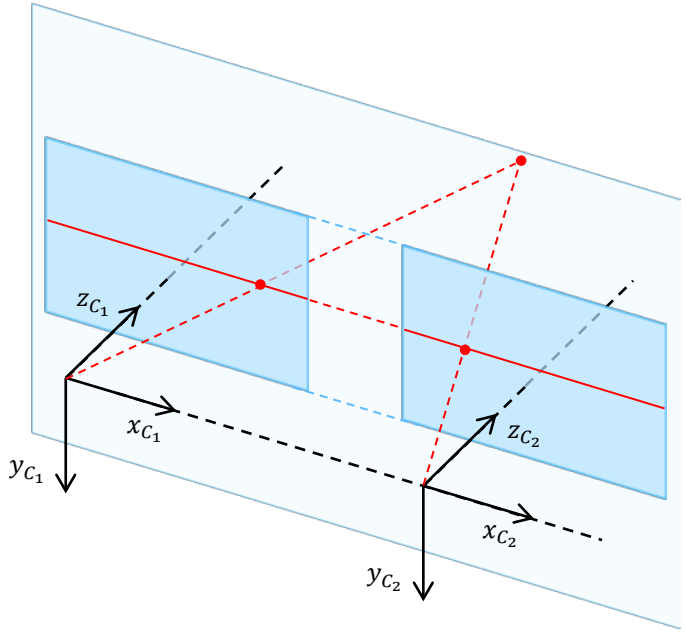
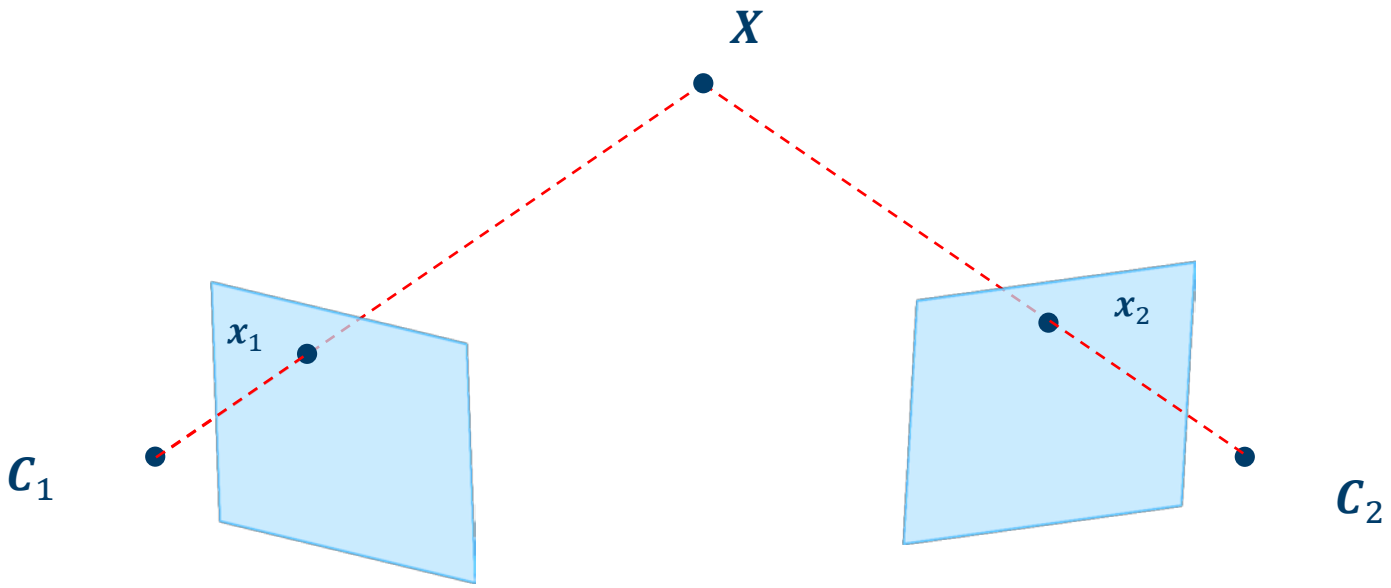
  - Next week - General two-view
  - This week - Stereo view



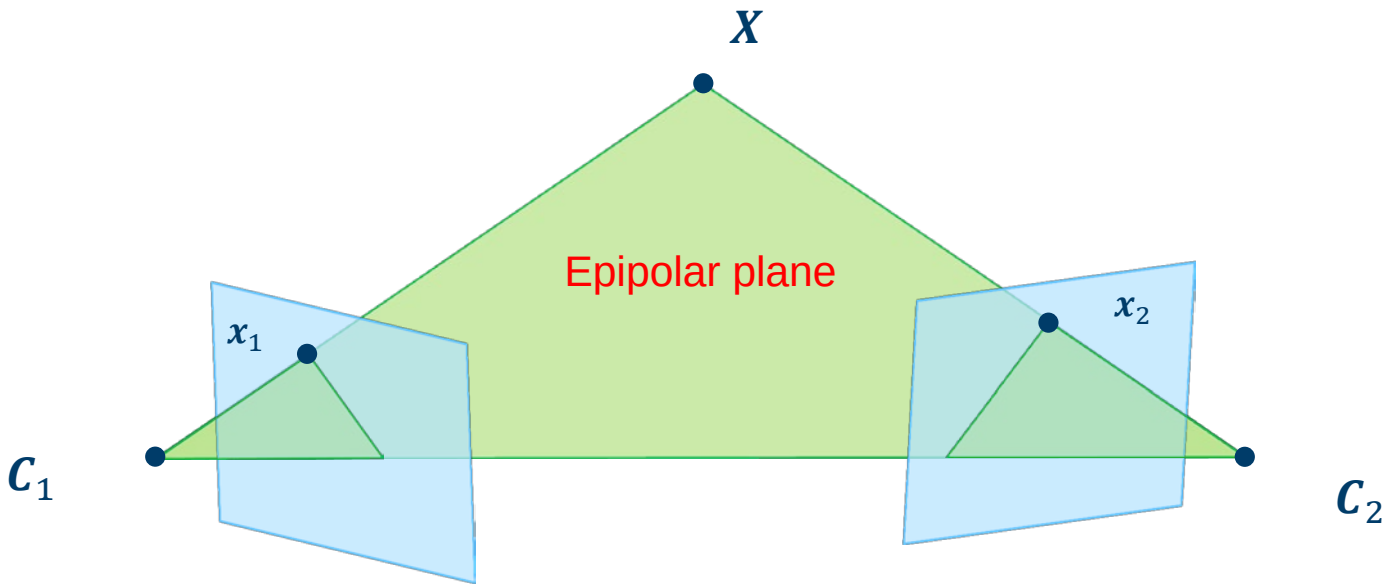
Epipolar geometry

- Two-view geometry involve several new geometrical entities compared to single-view geometry



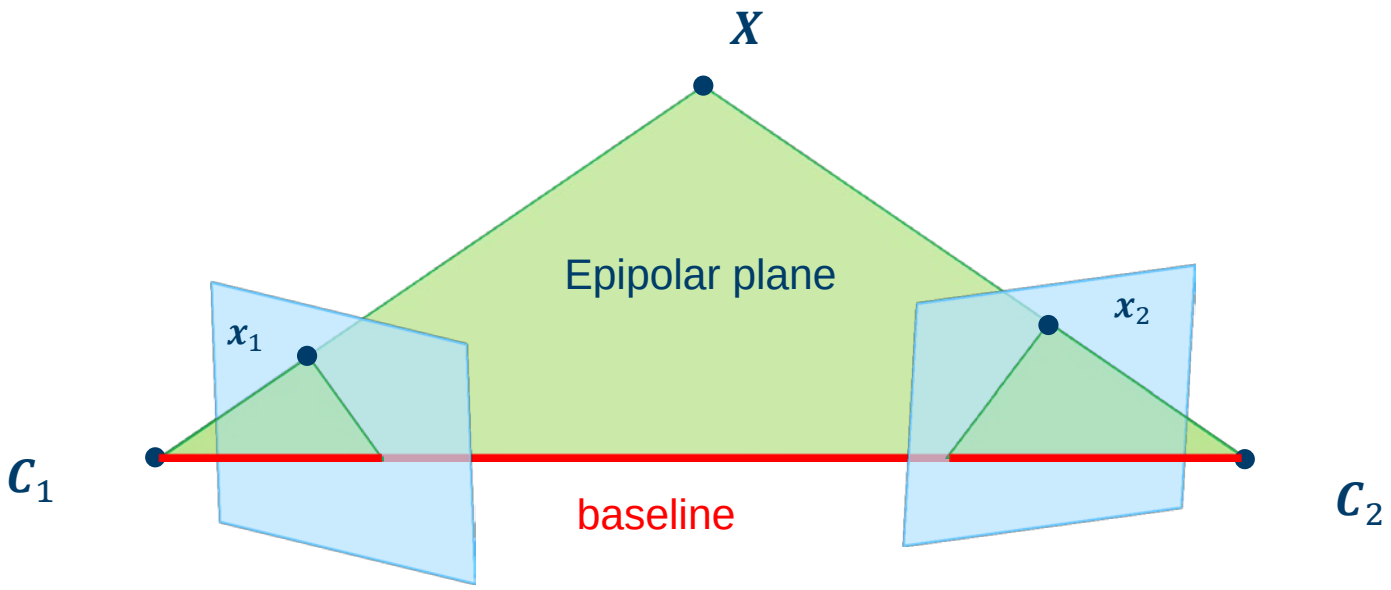
Epipolar geometry

- Two-view geometry involve several new geometrical entities compared to single-view geometry
- The **epipolar plane** is the plane containing $\boldsymbol{X}$ and the two camera centers $\boldsymbol{C}_1$ and $\boldsymbol{C}_2$



Epipolar geometry

- Two-view geometry involve several new geometrical entities compared to single-view geometry
- The **epipolar plane** is the plane containing $\boldsymbol{X}$ and the two camera centers $\boldsymbol{C}_1$ and $\boldsymbol{C}_2$
- The **baseline** is the line joining the two camera centers



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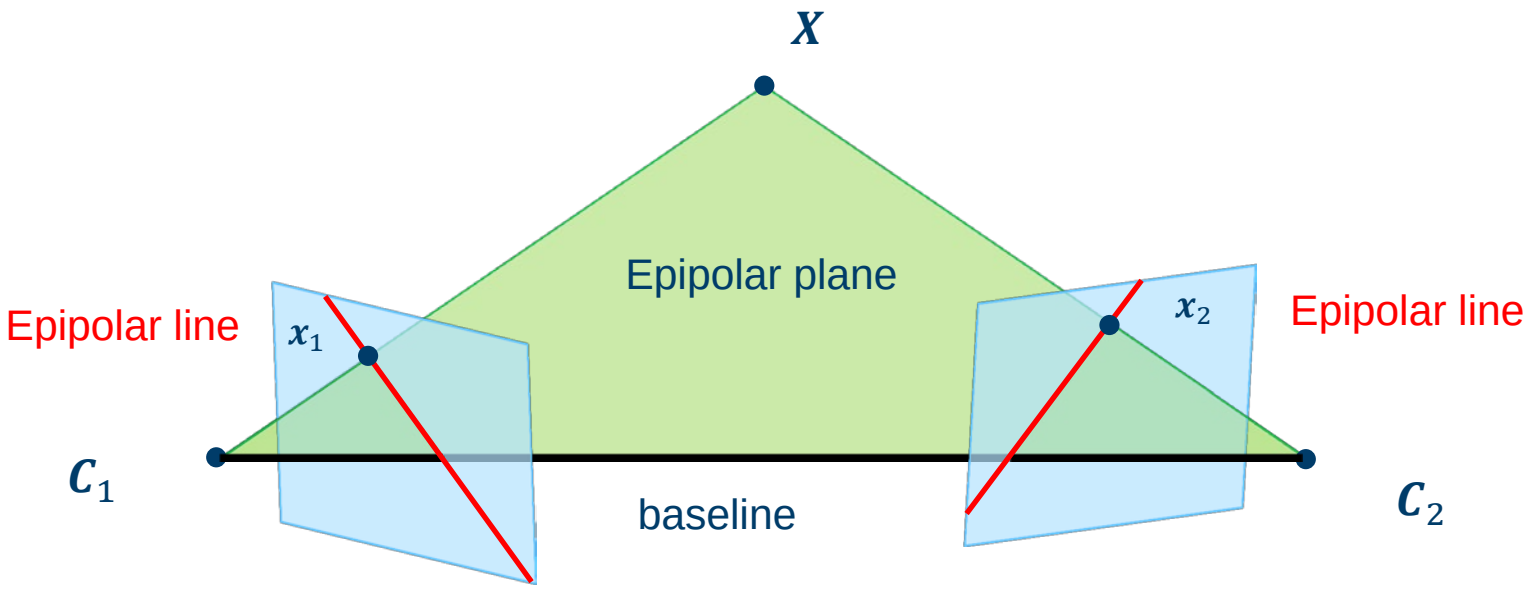
- Two-view geometry involve several new geometrical entities compared to single-view geometry
- The **epipolar plane** is the plane containing $\boldsymbol{X}$ and the two camera centers $\boldsymbol{C}_1$ and $\boldsymbol{C}_2$
- The **baseline** is the line joining the two camera centers
- The **epipolar lines** are where the epipolar plane intersect the image planes



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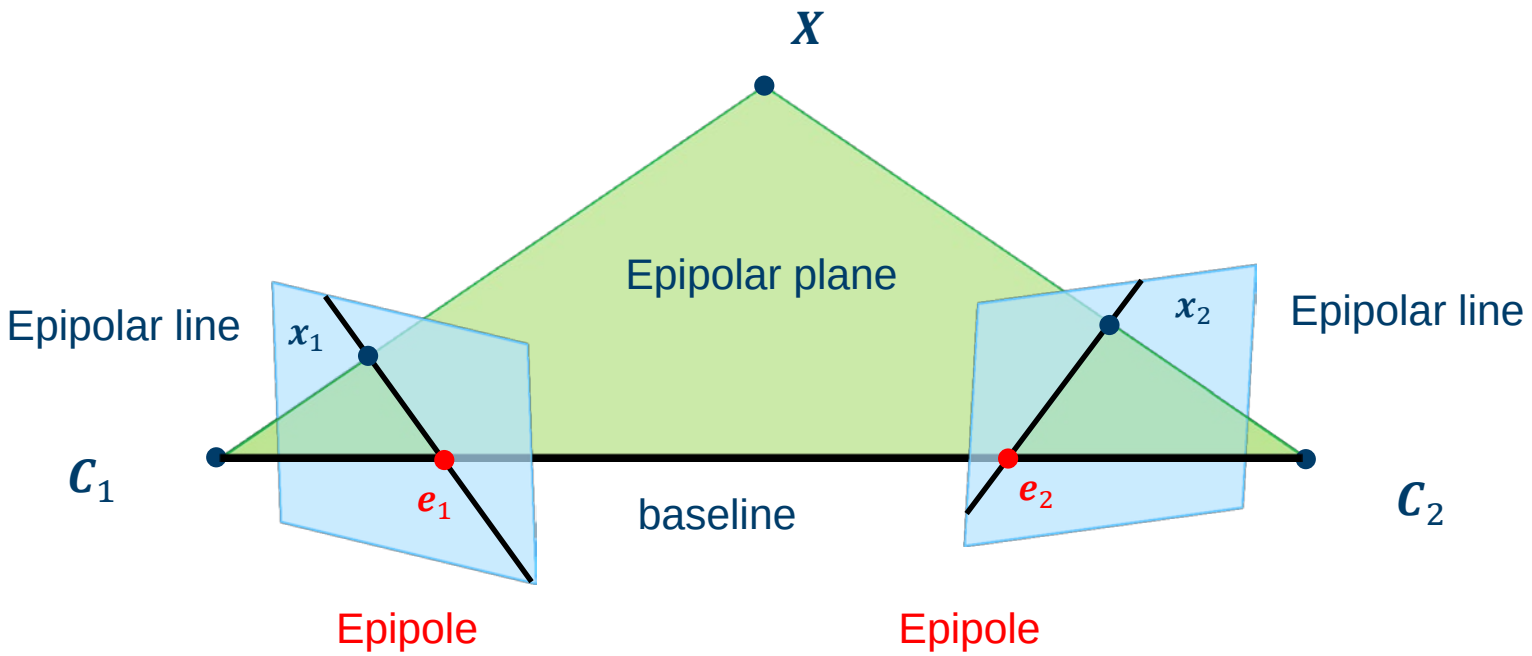
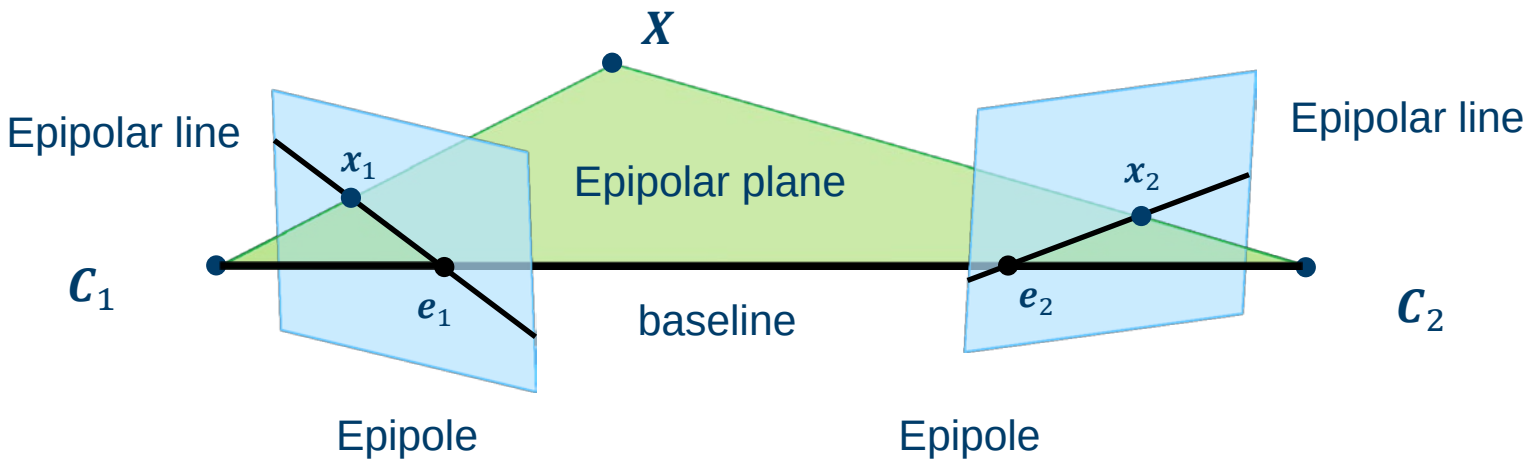
- The **epipolar plane** is the plane containing $\boldsymbol{X}$ and the two camera centers $\boldsymbol{C}_1$ and $\boldsymbol{C}_2$
- The **baseline** is the line joining the two camera centers
- The **epipolar lines** are where the epipolar plane intersect the image planes
- The **epipoles** are where the baseline intersects the two image planes



Epipolar geometry

- Two-view geometry involve several new geometrical entities compared to single-view geometry
- The **epipolar plane** is the plane containing $\boldsymbol{X}$ and the two camera centers $\boldsymbol{C}_1$ and $\boldsymbol{C}_2$
- The **baseline** is the line joining the two camera centers
- The **epipolar lines** are where the epipolar plane intersect the image planes
- The **epipoles** are where the baseline intersects the two image planes
- The baseline and epipoles are uniquely defined by the two camera matrices P_1 and P_2
- The epipolar plane and epipolar lines depends on the observed point $\boldsymbol{X}$



Example

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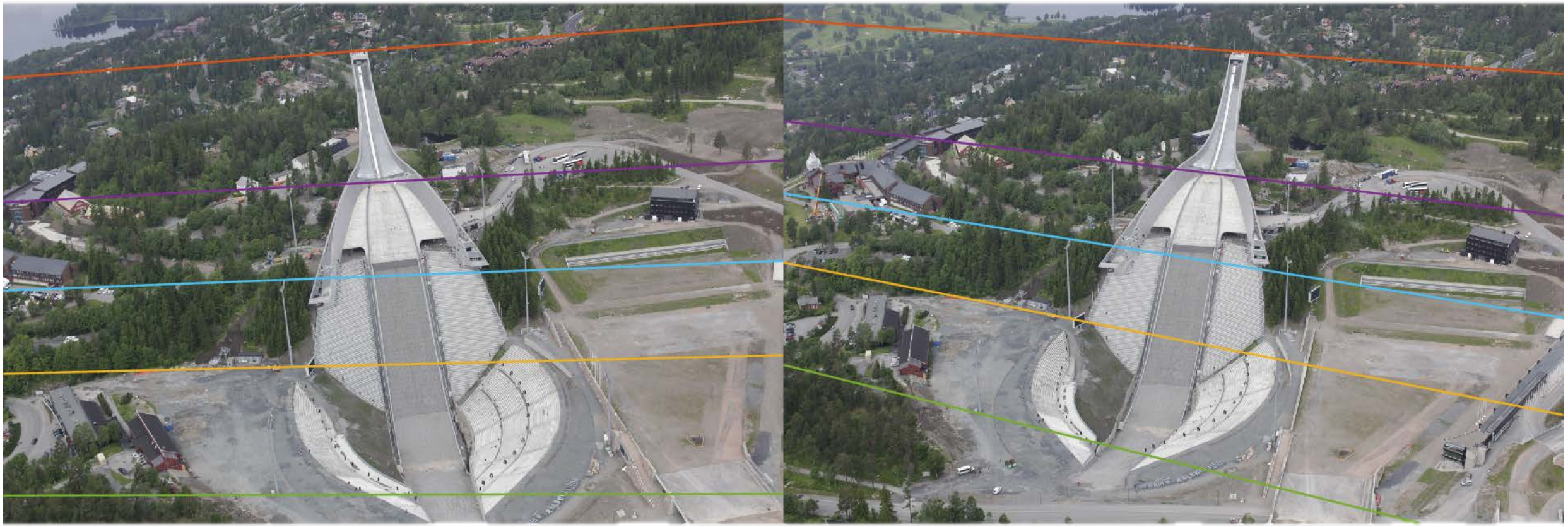
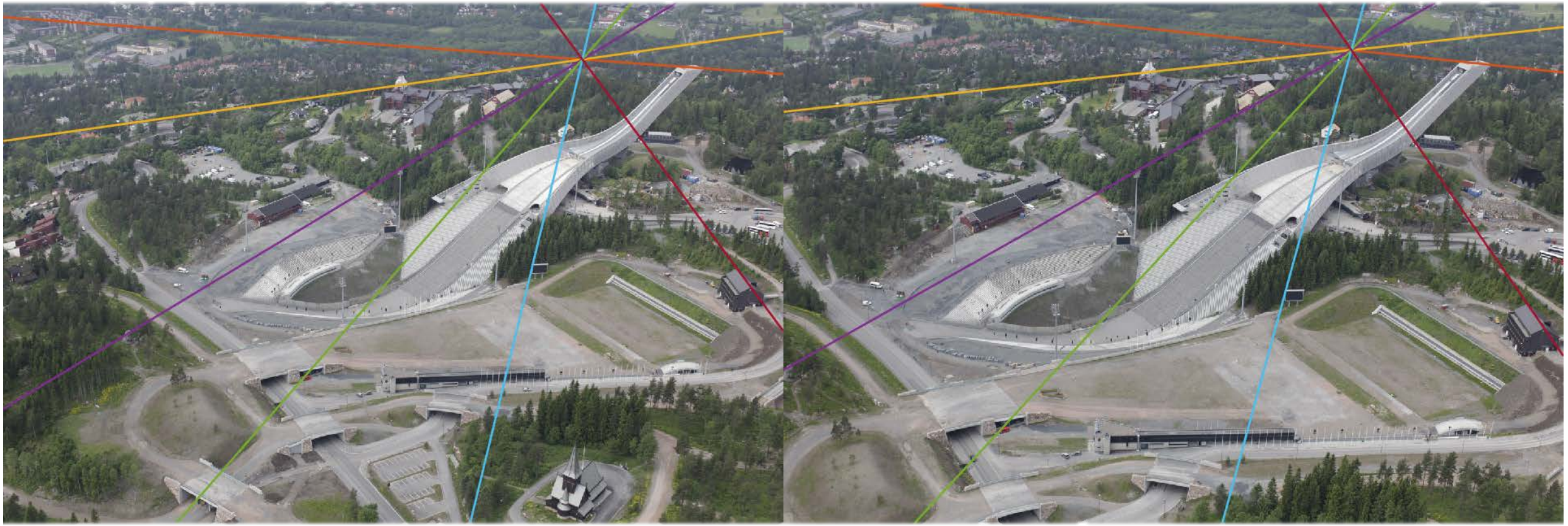


- Corresponding points lie on corresponding epipolar lines
- Both epipoles are outside of the visible part of the image planes

Example

Example



- Corresponding points lie on corresponding epipolar lines
- Both epipoles are visible as the intersection of epipolar lines

Summary

- Epipolar geometry
  - Epipolar planes
  - Epipolar lines
  - Epipoles
- Topics ahead
  - Stereo imaging
  - Representing epipolar geometry
  - Estimating epipolar geometry
  - 3D from epipolar geometry
  - Relative pose from epipolar geometry
  - More views…

- Additional reading:
  - Szeliski: 11 introduction & 11.1