Stereo overview

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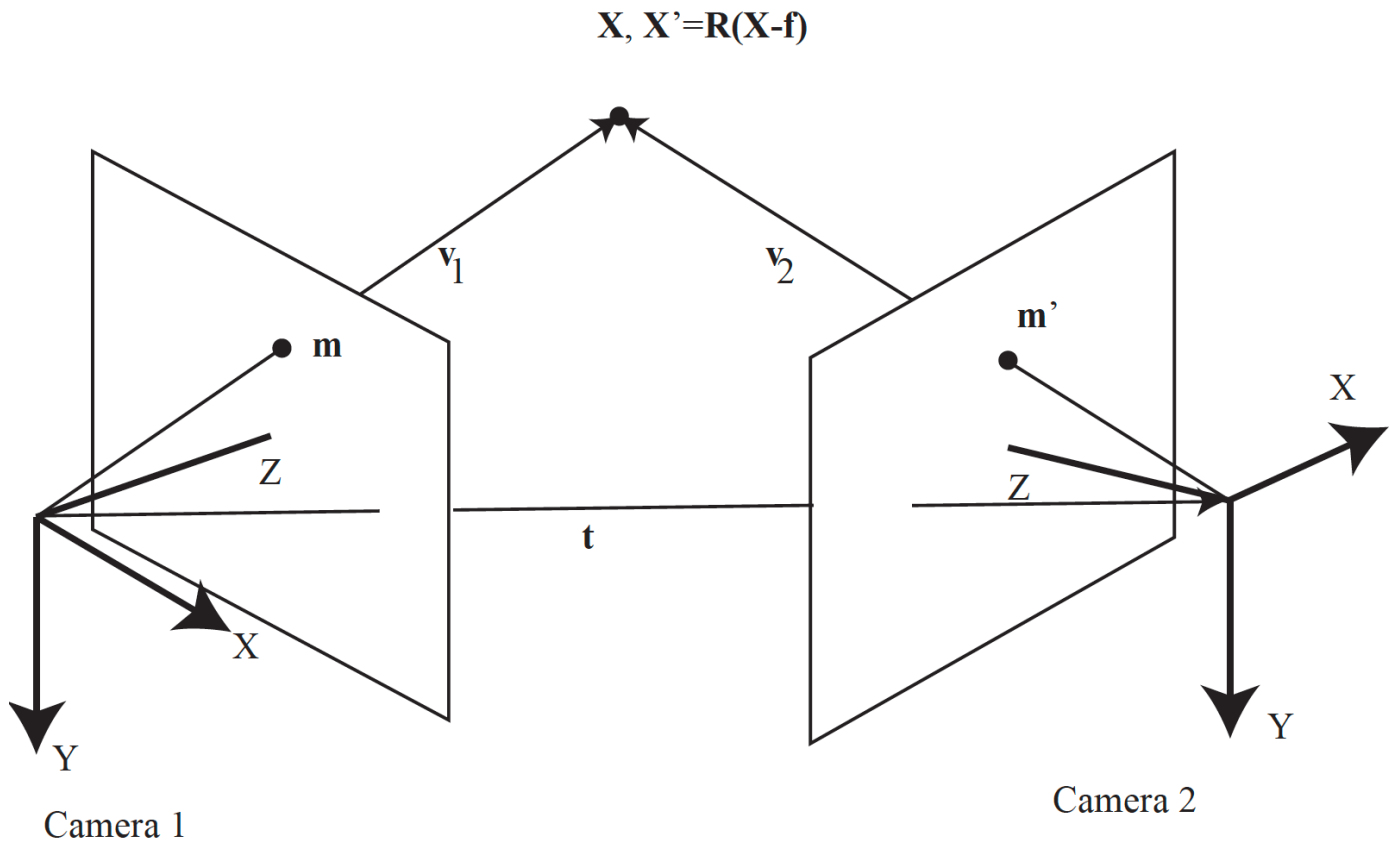
Recall triangulation

- IF you know m, m’ correspond
  - you can get X



Setup

- Two cameras
- Images
  - at the same time
  - OR static scene
- Issue:
  - what m’ corresponds to m?
- Already know:
  - epipoles, etc.

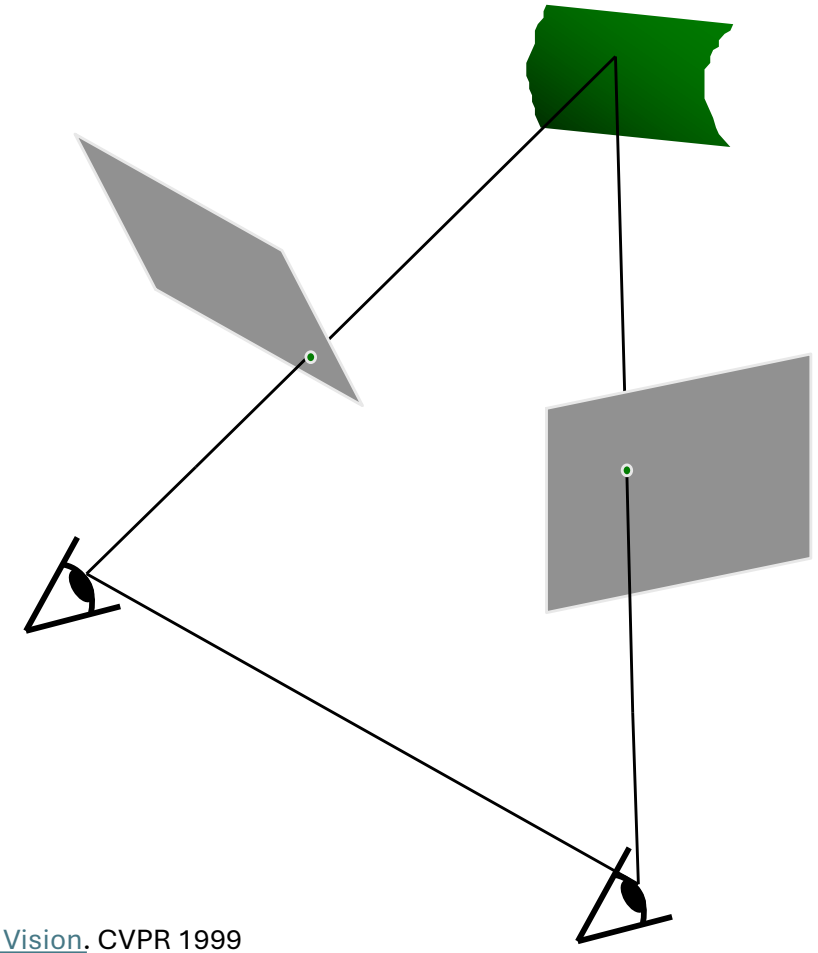
Strategy

- Matching procedures for ”easy” camera pair
  - camera translated along the x-axis

- Rectify other pairs into that frame

Stereo image rectification

- If the image planes are not parallel, we can find homographies to project each view onto a common plane parallel to the baseline



•C. Loop and Z. Zhang. Computing Rectifying Homographies for Stereo Vision. CVPR 1999

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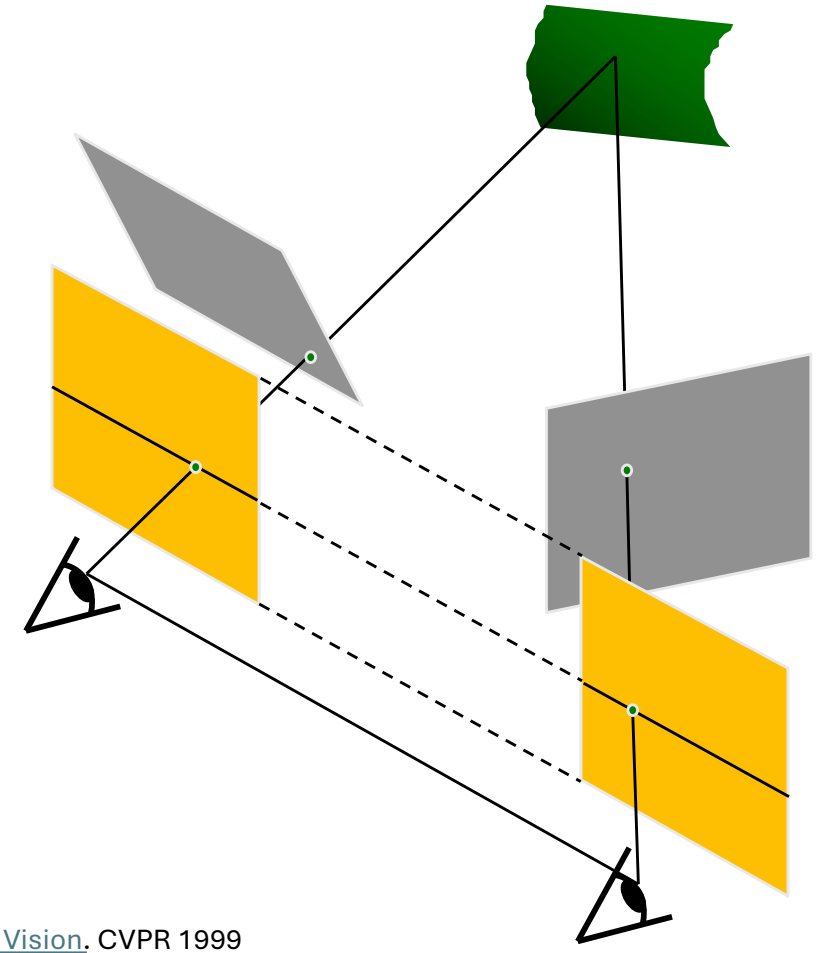

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Stereo image rectification

- Before rectification:

Image source

Stereo image rectification

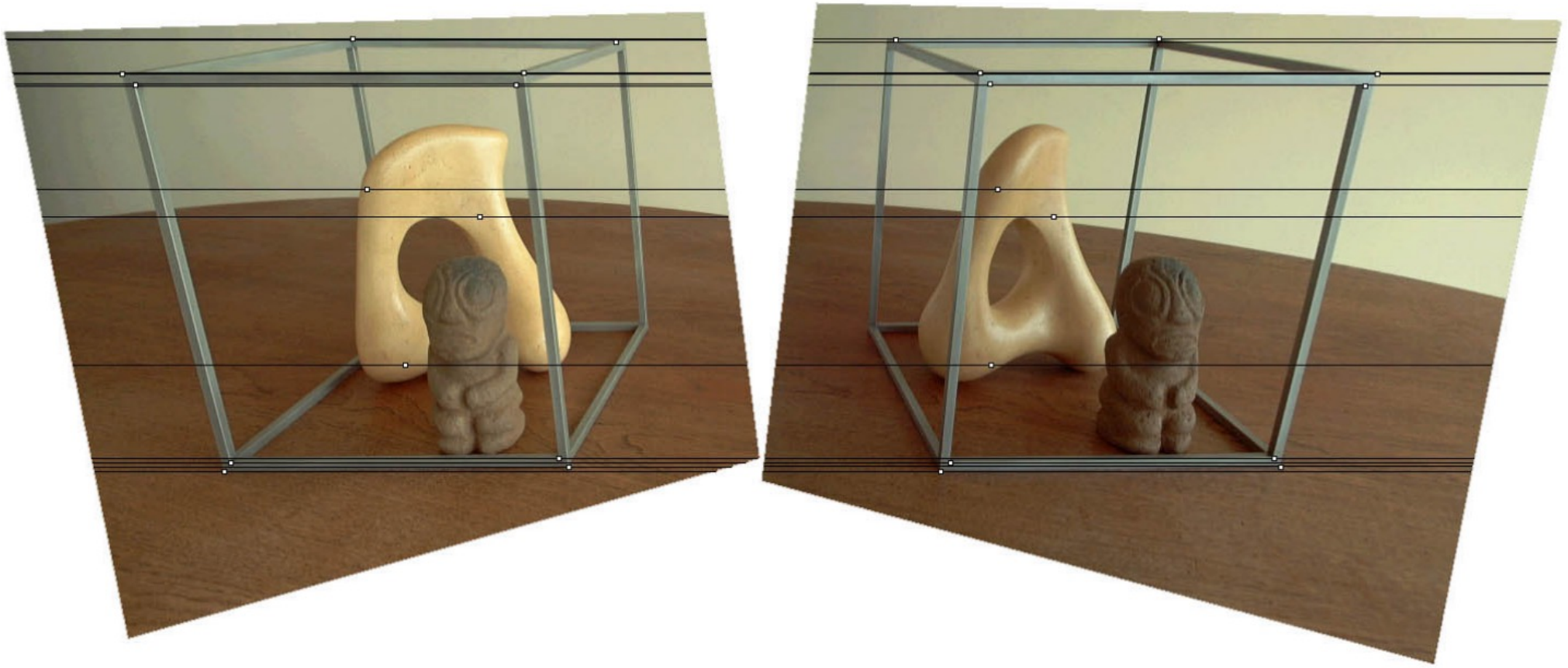
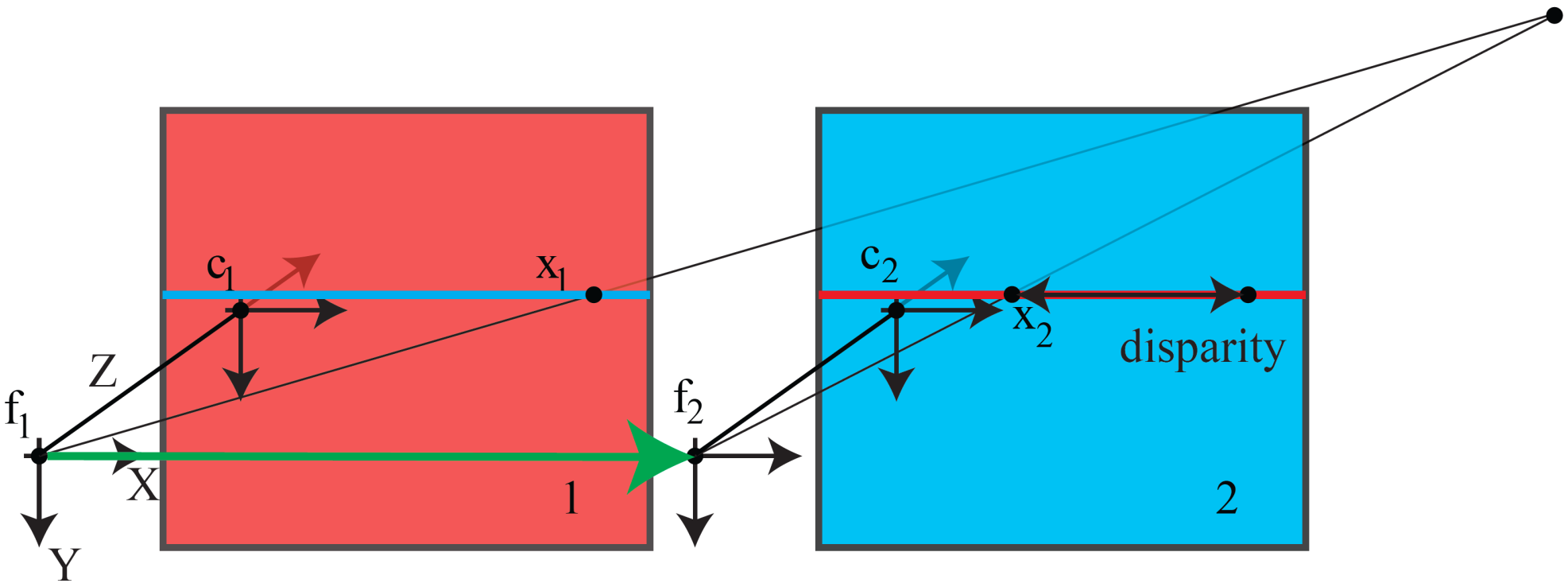


Image source

Another rectification example

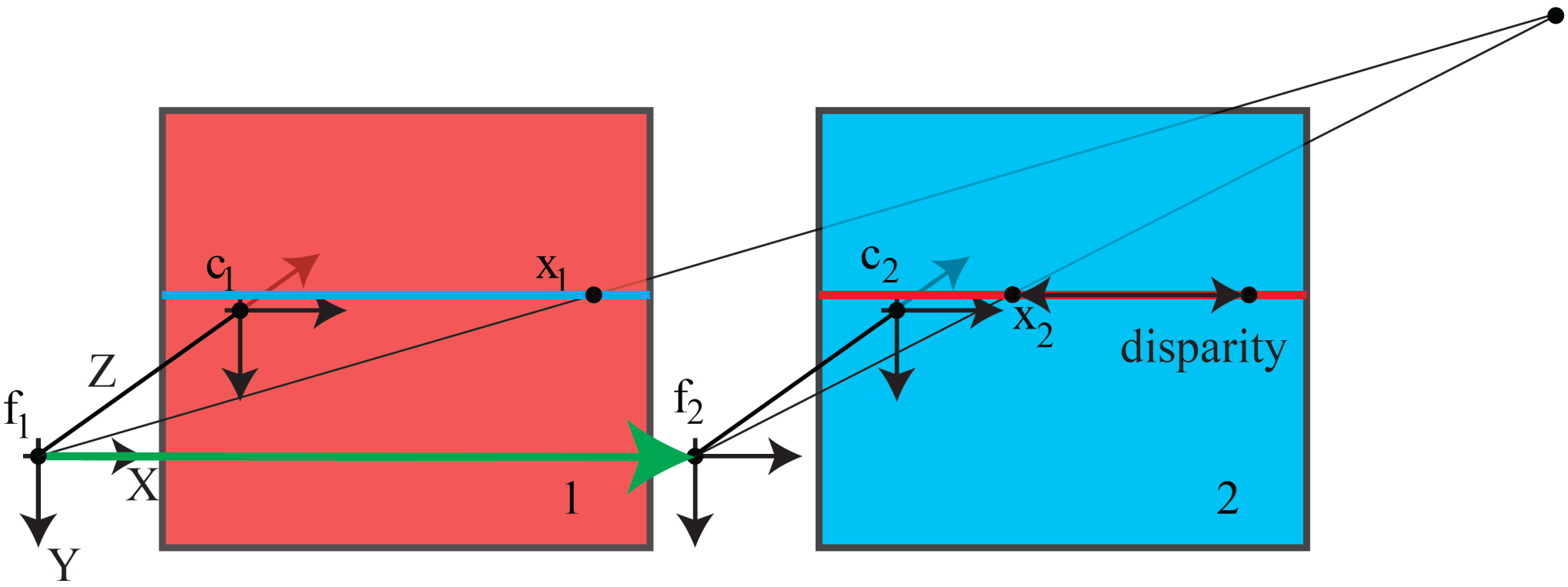
Easy cameras



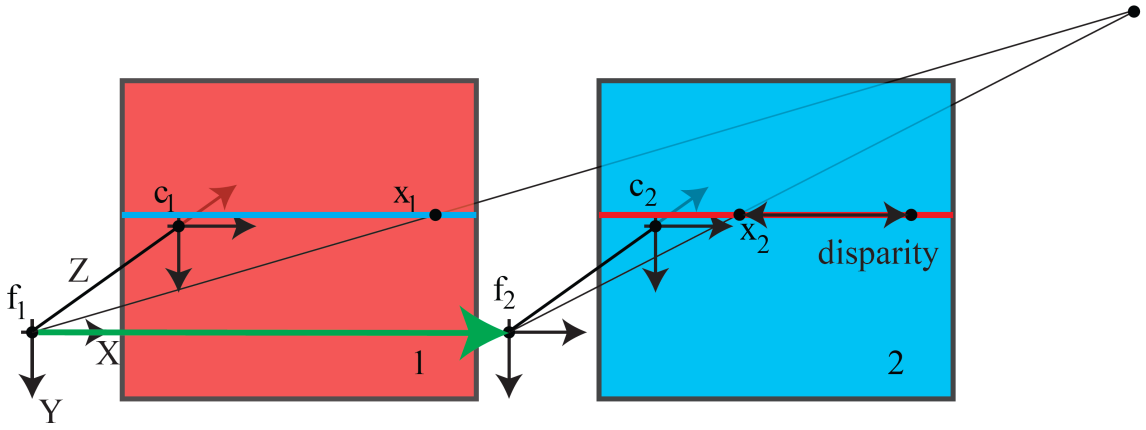
$(X, Y, Z) \rightarrow (X/Z, Y/Z)$

$(X', Y', Z') \rightarrow (X'/Z', Y'/Z')$

Easy cameras



Easy cameras

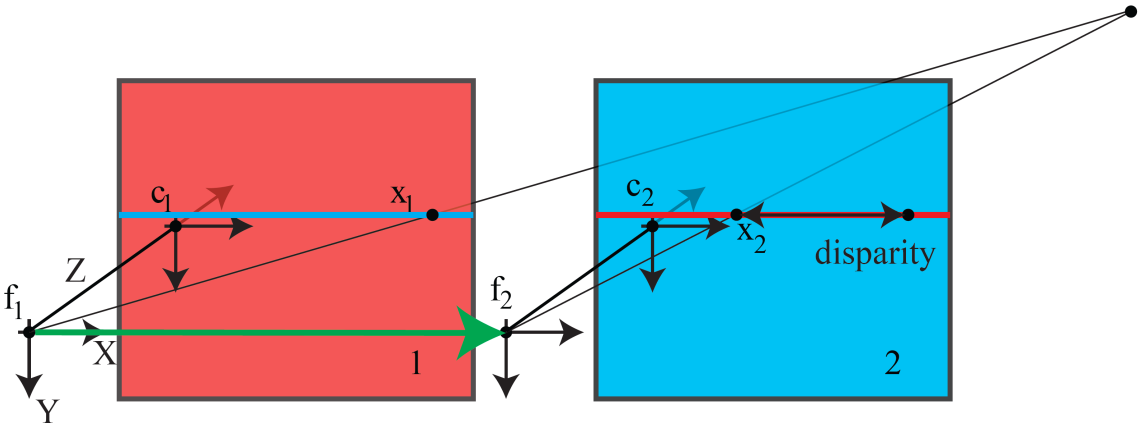


$$(X', Y', Z') = (X - B, Y, Z) \rightarrow (X'/Z', Y'/Z') = (X/Z - B/Z, Y/Z)$$

$$\delta = -B/Z$$

Disparity – the difference in position in the red and blue cameras

Easy cameras



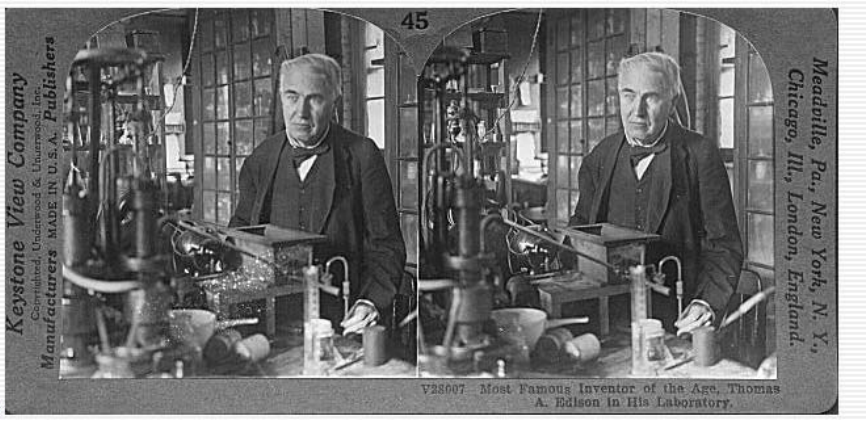
$$\delta = -B/Z$$

Bigger baseline == better depth resolution

Key question: which x2 matches x1?

Stereograms

- Humans can fuse pairs of images to get a sensation of depth

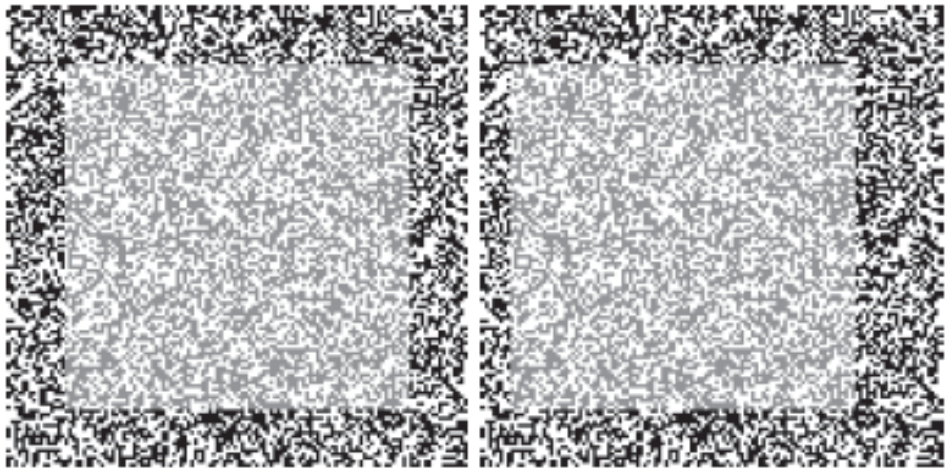


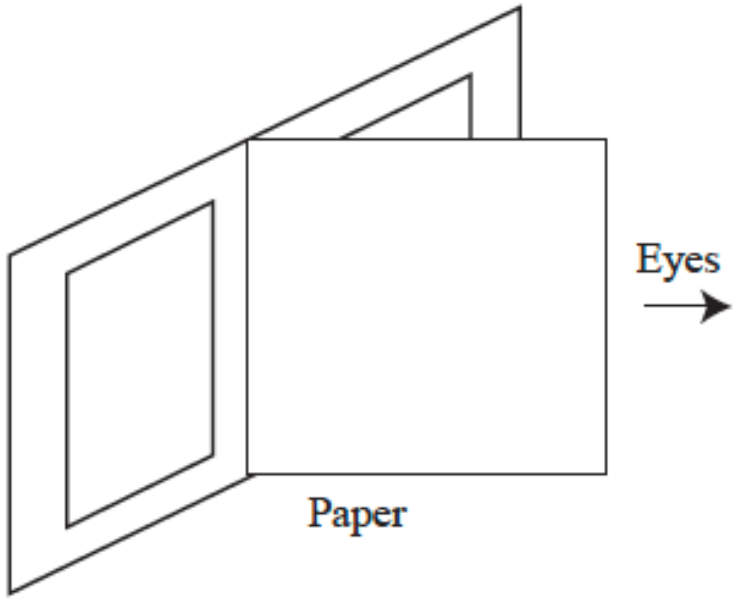
Stereograms: Invented by Sir Charles Wheatstone, 1838

https://en.wikipedia.org/wiki/Stereoscopy

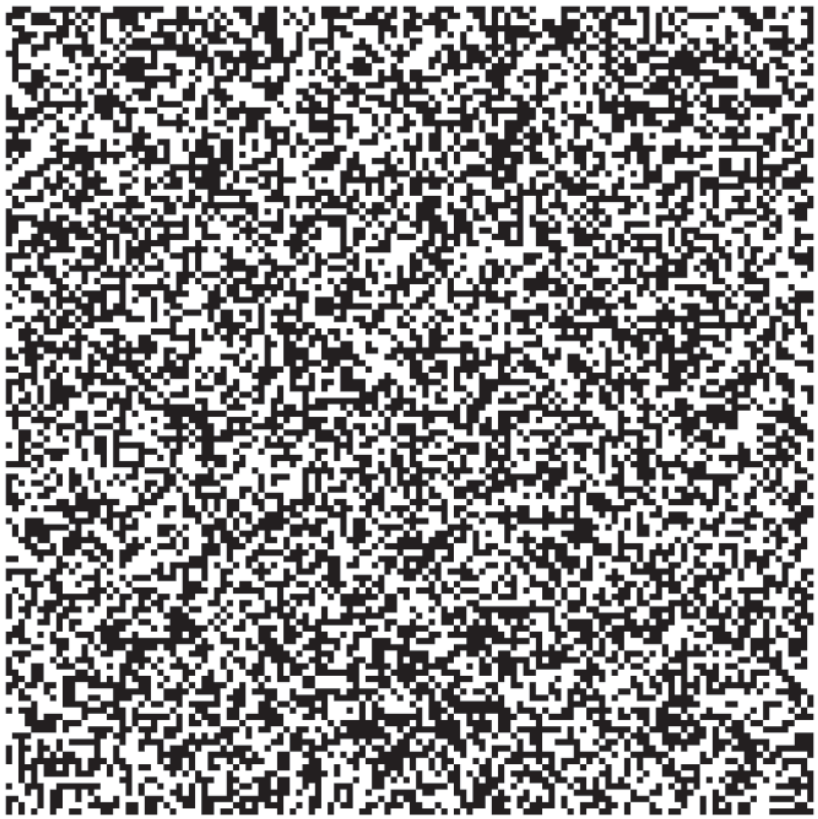
Stereo in people

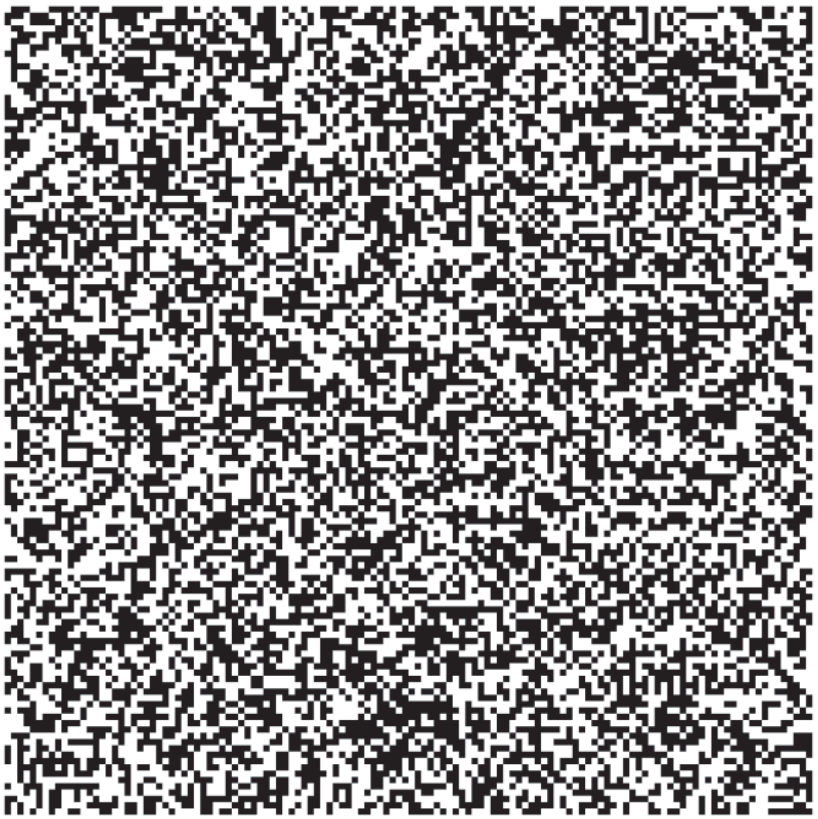
- Not everyone has it
- It has nothing to do with semantics
  - Random Dot Stereogram, due to Julesz



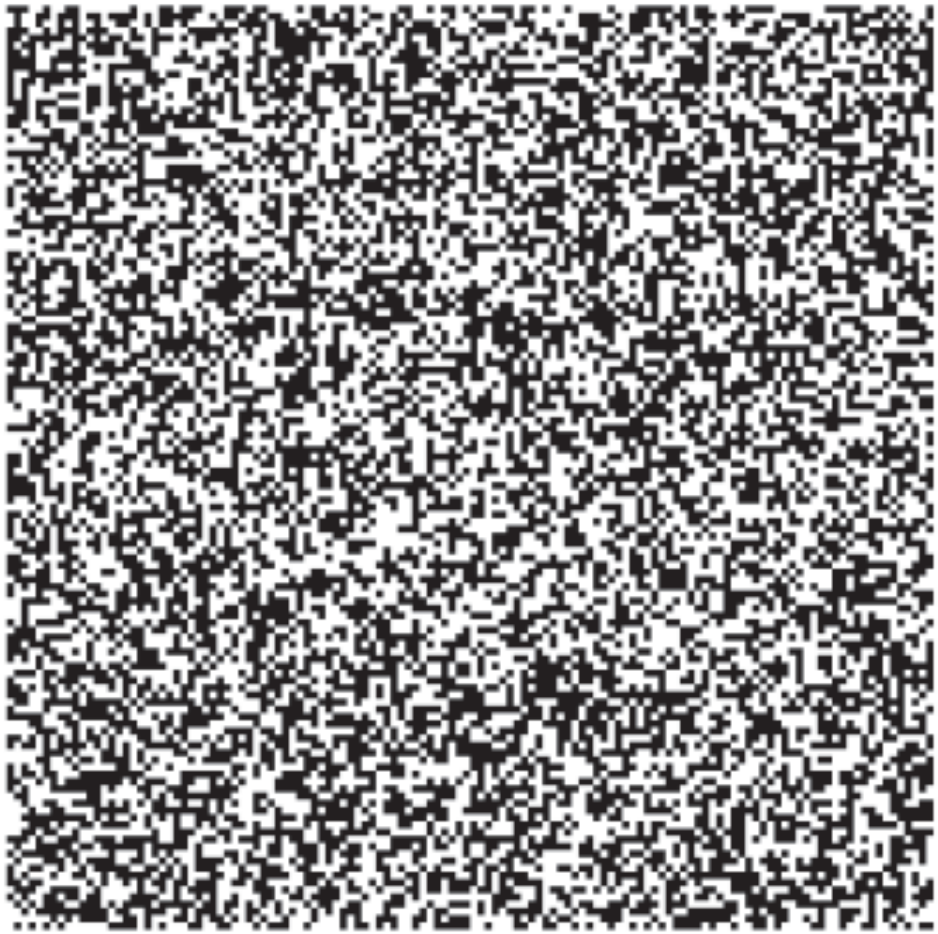


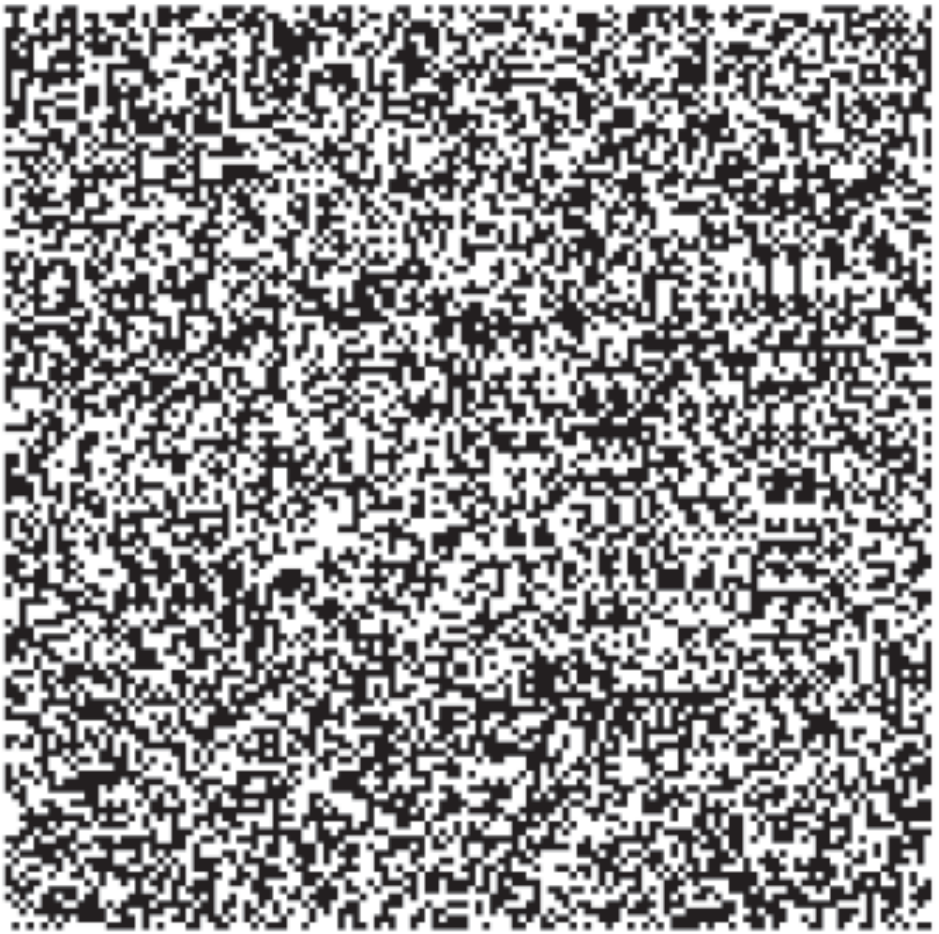
RDS-II



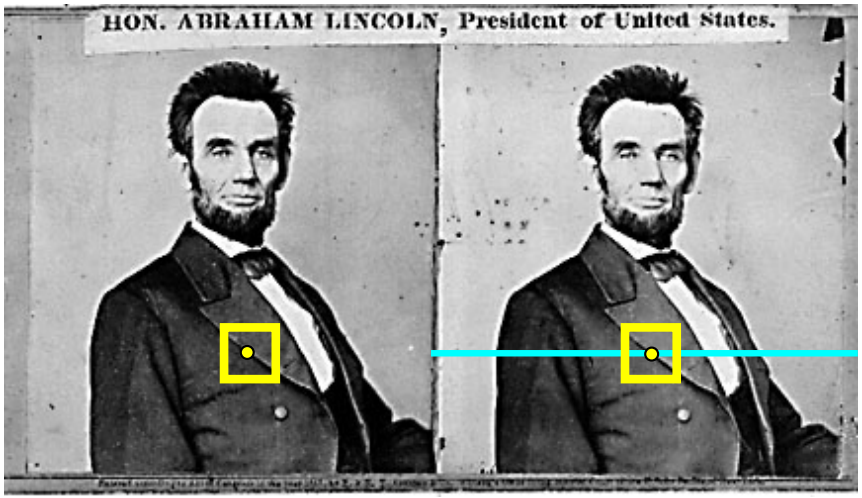


RDS-III





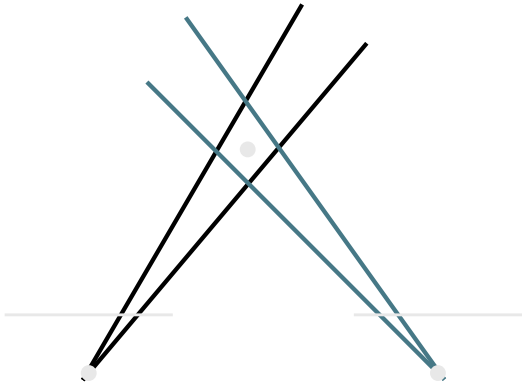
Basic stereo recipe



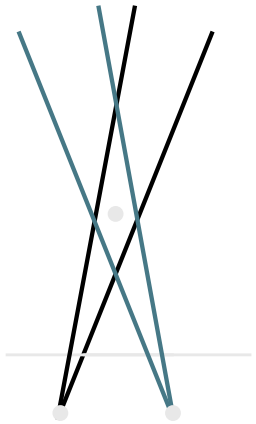
- If necessary, rectify the two stereo images to transform epipolar lines into scanlines
- For each pixel x in the first image
  - Find corresponding epipolar scanline in the right image
  - Examine all pixels on the scanline and pick the best match x'
  - Triangulate the matches to get depth information

Hard to pick the best match
--might be far away
– some points don't have matches

Effect of baseline on stereo results

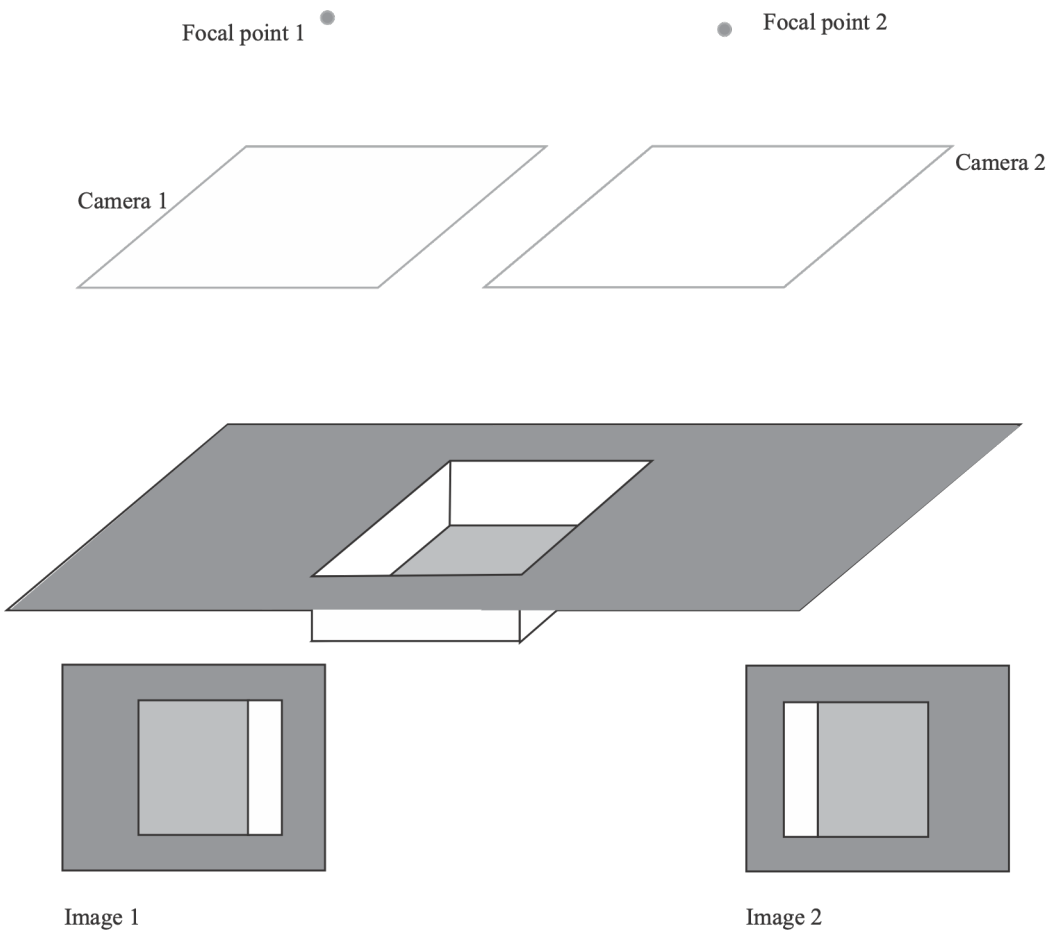


- Larger baseline
  - \+ Smaller triangulation error
  - – Matching is more difficult



- Smaller baseline
  - – Higher triangulation error
  - \+ Matching is easier

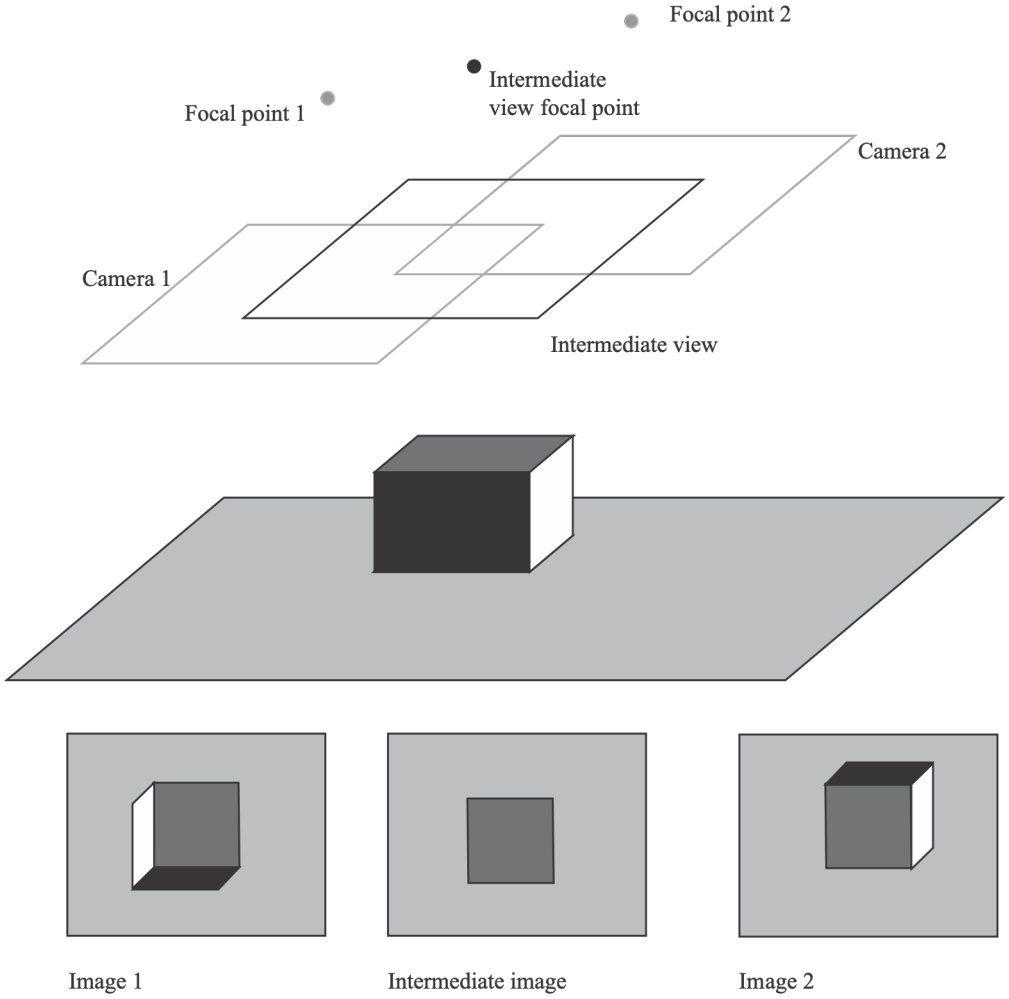
Some points don’t have matches



This is a depth cue, though not much used directly

Effect sometimes known as
Da Vinci stereopsis

Some points don’t have matches



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