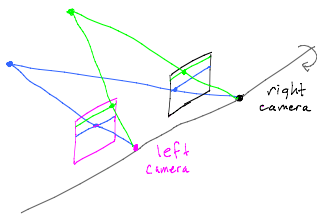
lecture 23

Stereo correspondence

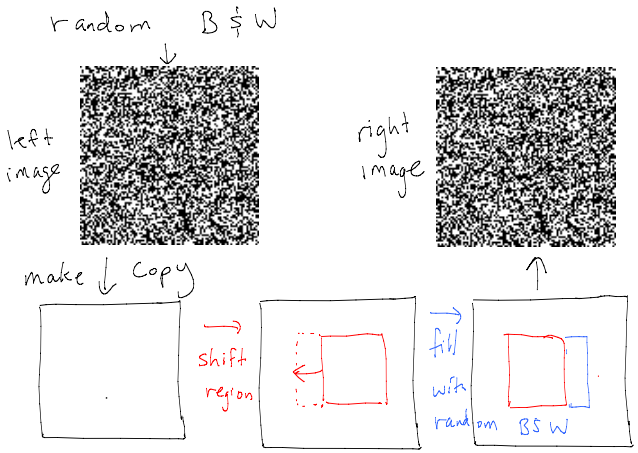


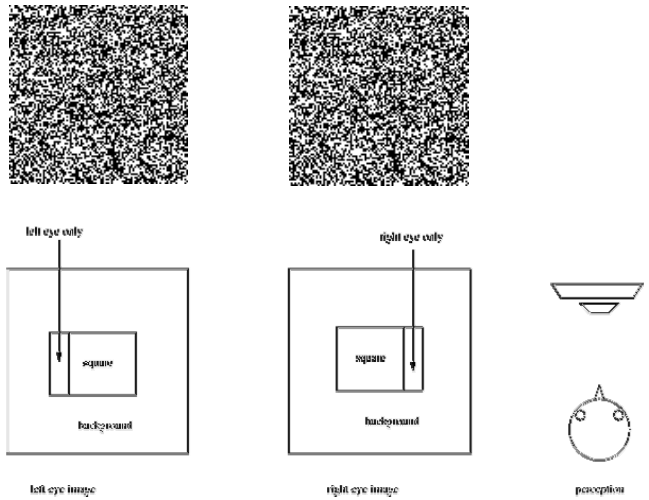
$$x_l = f \cdot \frac{X}{Z} \qquad x_r = f \cdot \frac{X - T}{Z}$$

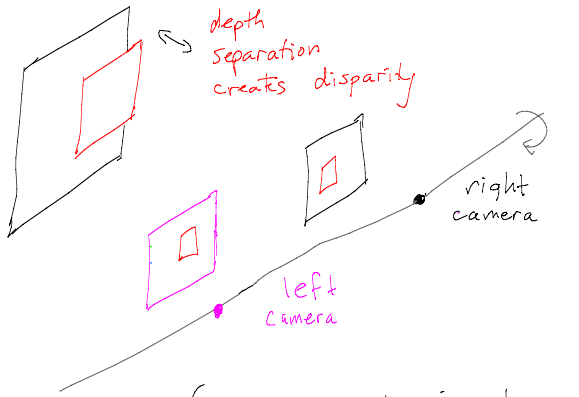
$$x_l - x_r = f \frac{T}{Z}$$

"binocular disparity"

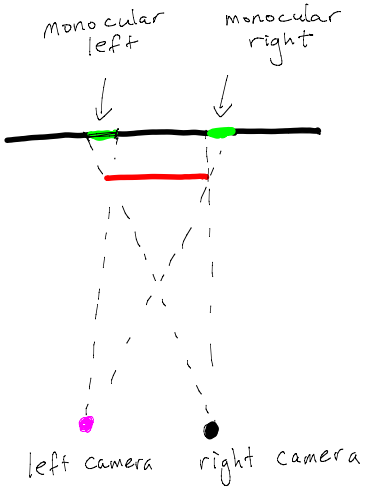
History - Bela Julesz & the random dot stereogram







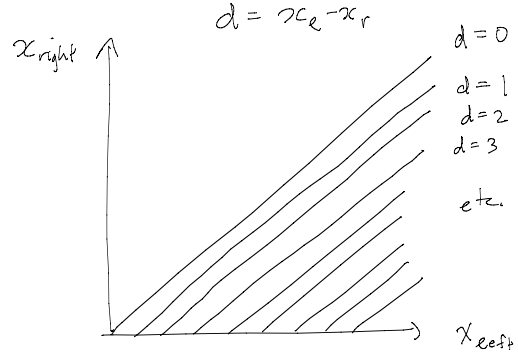
(apologies for atrocious drawing)

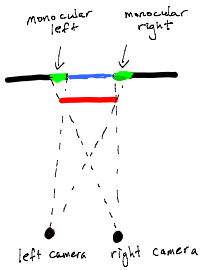


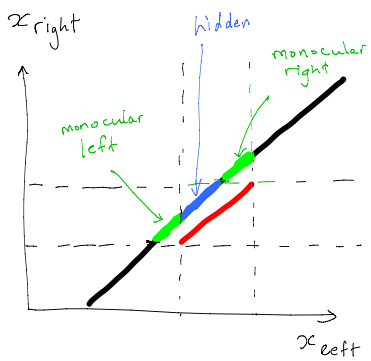
Disparity Space

(for a pair of epipolar lines)

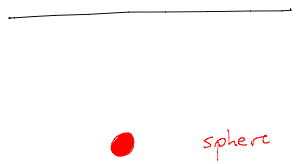
$$d = x_e - x_r$$

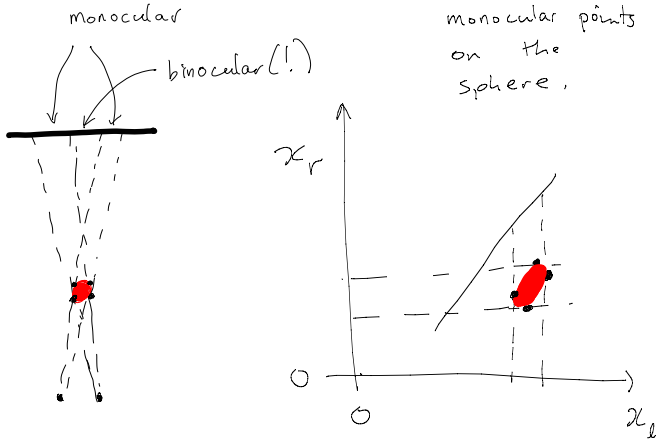






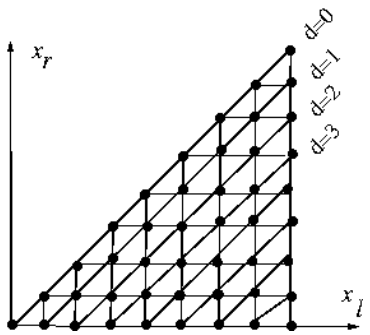
Another Example





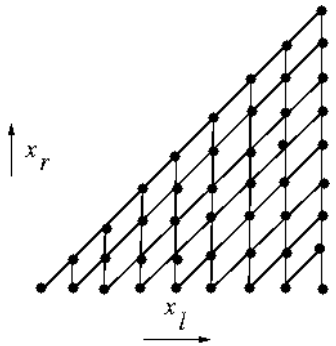
There are also monocular points on the sphere.

Graph representation



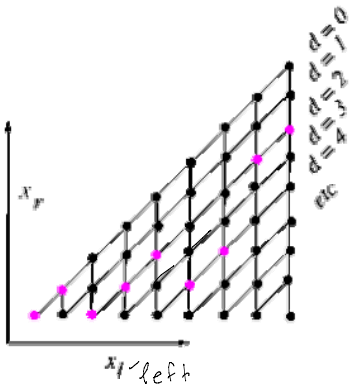
- Vertices (how to label?)
- Edges - (mean what?)

Alternative graph representation (used in "graph cut" method below).



note: asymmetry x_l vs. x_r

Problem formulation:



For each x_l, choose a disparity d i.e. $x_r = x_l - d$ such that (x_l, x_r) is a "good match."

What makes a good match?

1.) $I_l(x_l) \approx I_r(x_r)$

i.e. $x_l - x_r = d$

i.e. same as requirement that $I(x+h) \approx J(x)$ in image registration

What makes a good match?

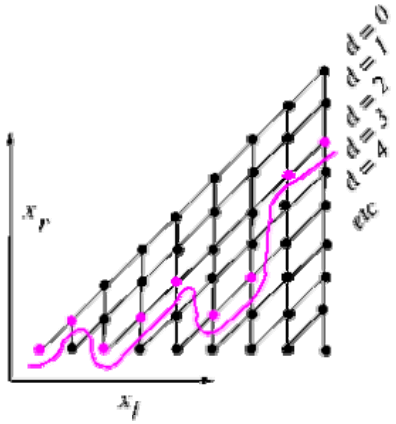
2.) Depth (and thus disparity) should be piecewise smooth.

$x_l - x_r = \frac{I}{Z}$

binocular disparity

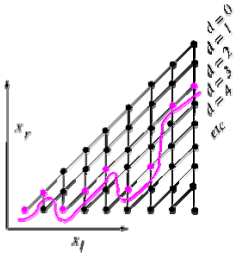
(For simplicity, require disparity to be piecewise constant.)

Graph cut



Idea: assign penalties to edges and find the "minimum cut"

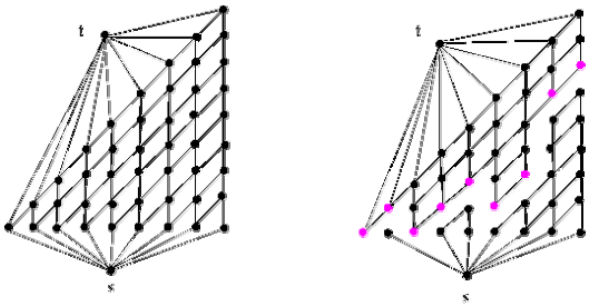
Graph cut

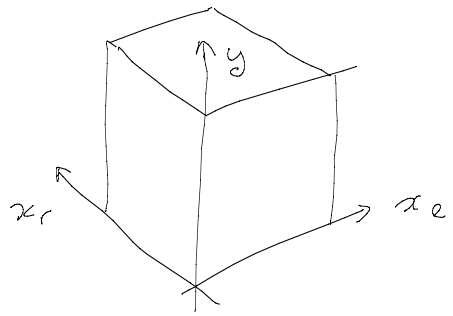


- Diagonal edge cost is constant
  - ⇒ large disparity discontinuities cost more
- Vertical Edge cost depends on intensity match of upper vertex.

Use "max-flow = min-cut" methods

(Details omitted here.)





Better results are obtained by stacking all epipolar lines and enforcing "smoothness" across y

See Middlebury stereo database

(You cannot publish a new stereo algorithm without running it on these images.)

- Friday - review for final exam (who will be there?)
- Bonus marks for significant typos.
- Course evaluations