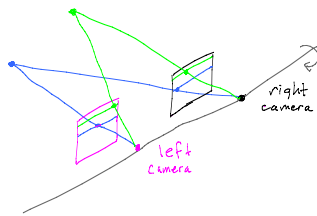


# lecture 23

## Stereo correspondence



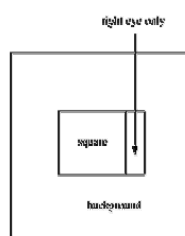
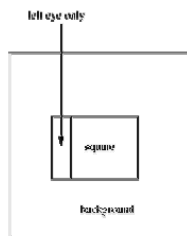
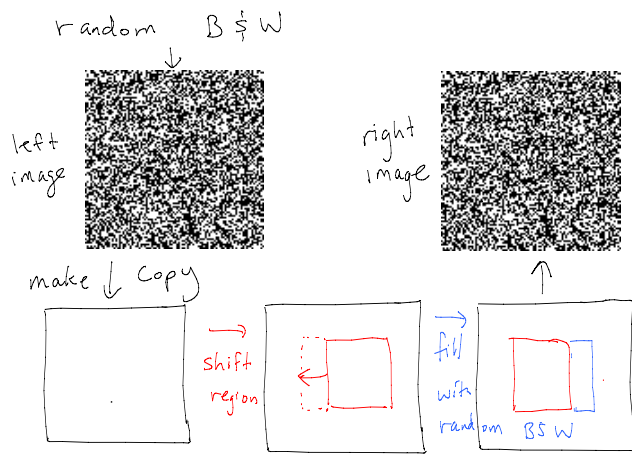
$$x_l = f \cdot \frac{X}{Z}$$

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

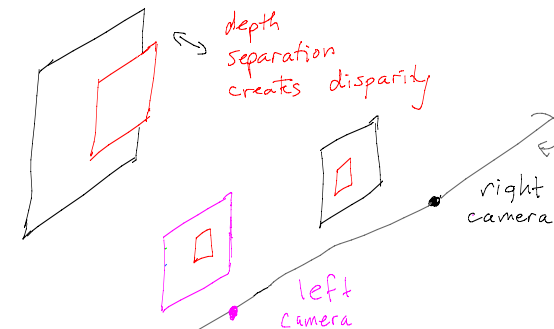
$$x_l - x_r = f \frac{T}{Z}$$

"binocular disparity"

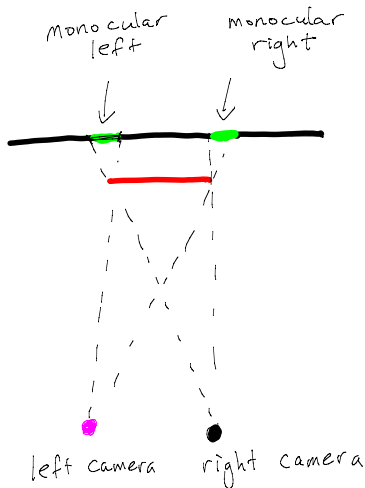
History - Bela Julesz's the random dot stereogram



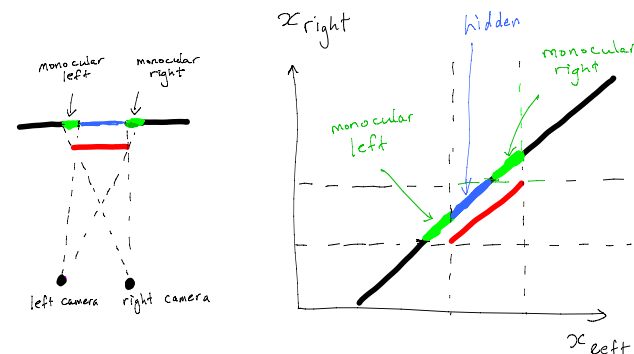
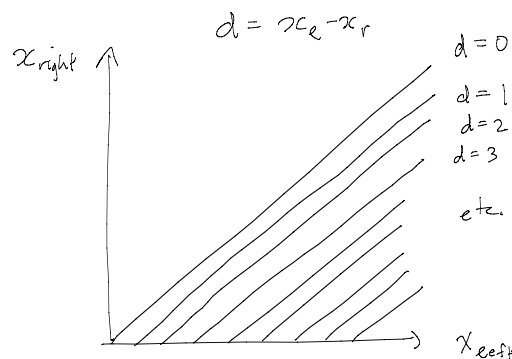
perception



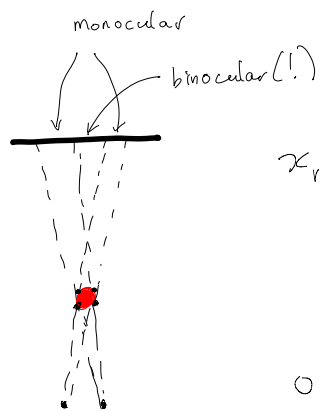
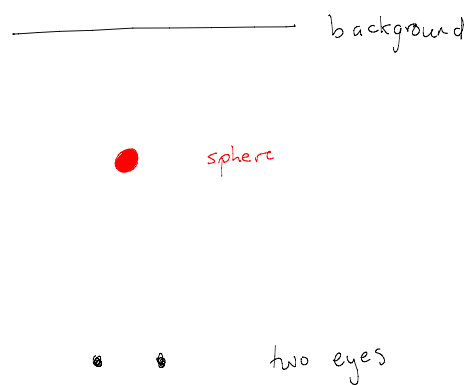
(apologies for atrocious drawing)



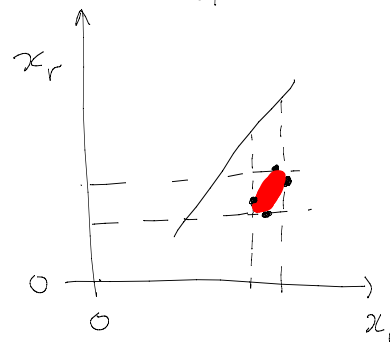
Disparity Space  
(for a pair of epipolar lines)



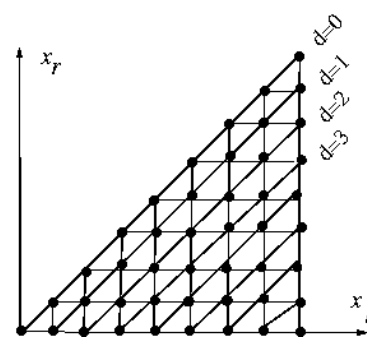
## Another Example



There are also monocular points on the sphere.

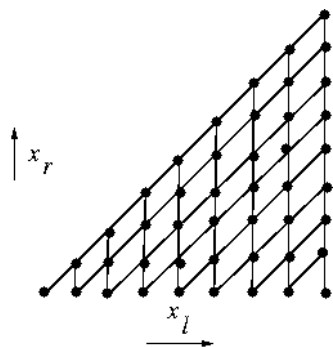


## Graph representation



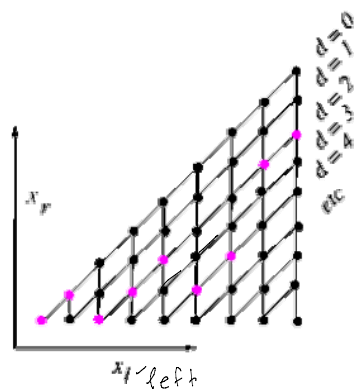
- Vertices (how to label?)
- Edges - (mean what?)

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?

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

$$\text{i.e. } x_l - x_r = d$$

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

What makes a good match?

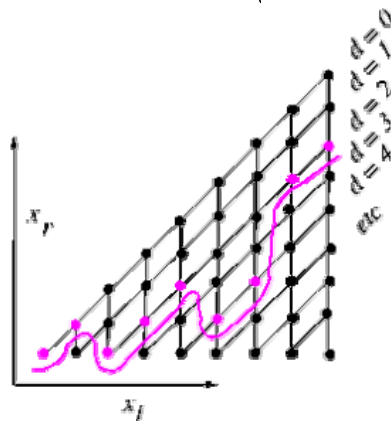
2.) Depth (and thus disparity) should be piecewise smooth.

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

binocular disparity

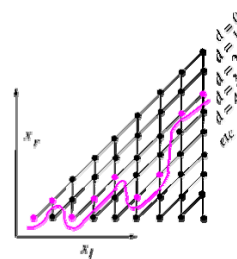
(For simplicity, require disparity to be piecewise constant.)

## Graph cut



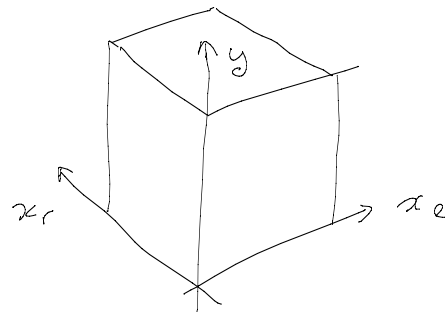
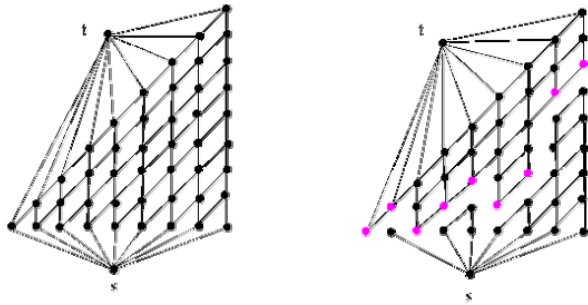
Idea: assign penalties to edges and find the "minimum cut"

## Graph cut



- Diagonal edge cost is constant  $\Rightarrow$  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