CS325 Artificial Intelligence
Computer Vision II – 3D Vision (Ch. 24)

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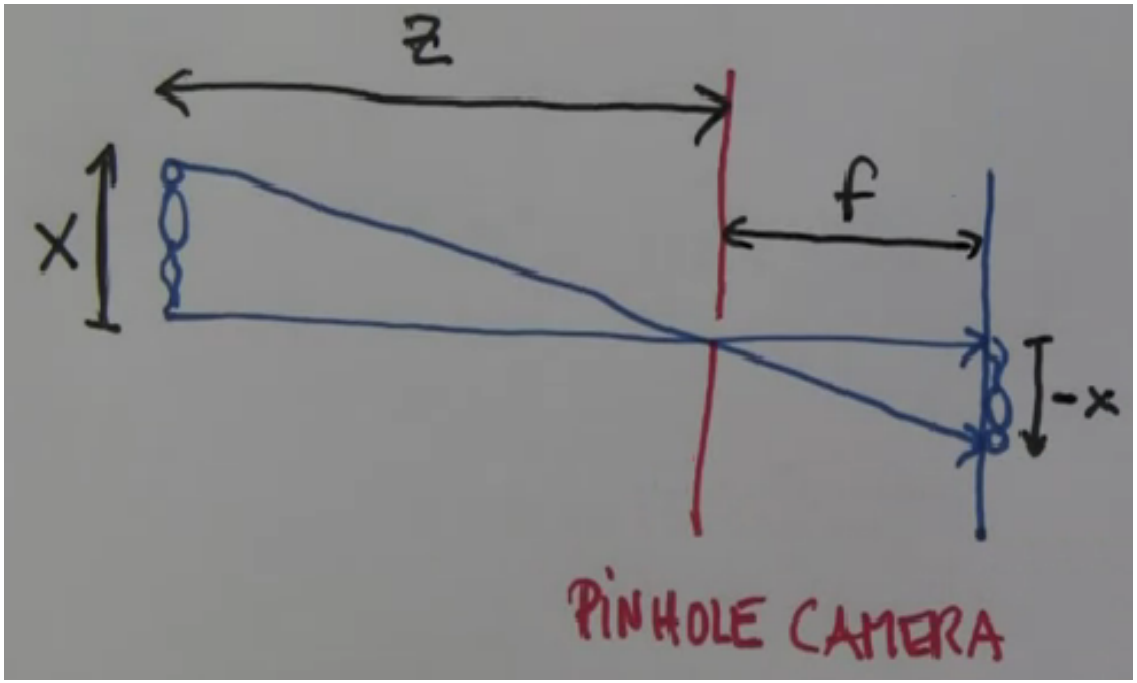
Spring 2013

Limits of 2D Projection



- 3D world is projected onto 2D image
- What happens to depth information?

Getting the Depth from Perspective Projection

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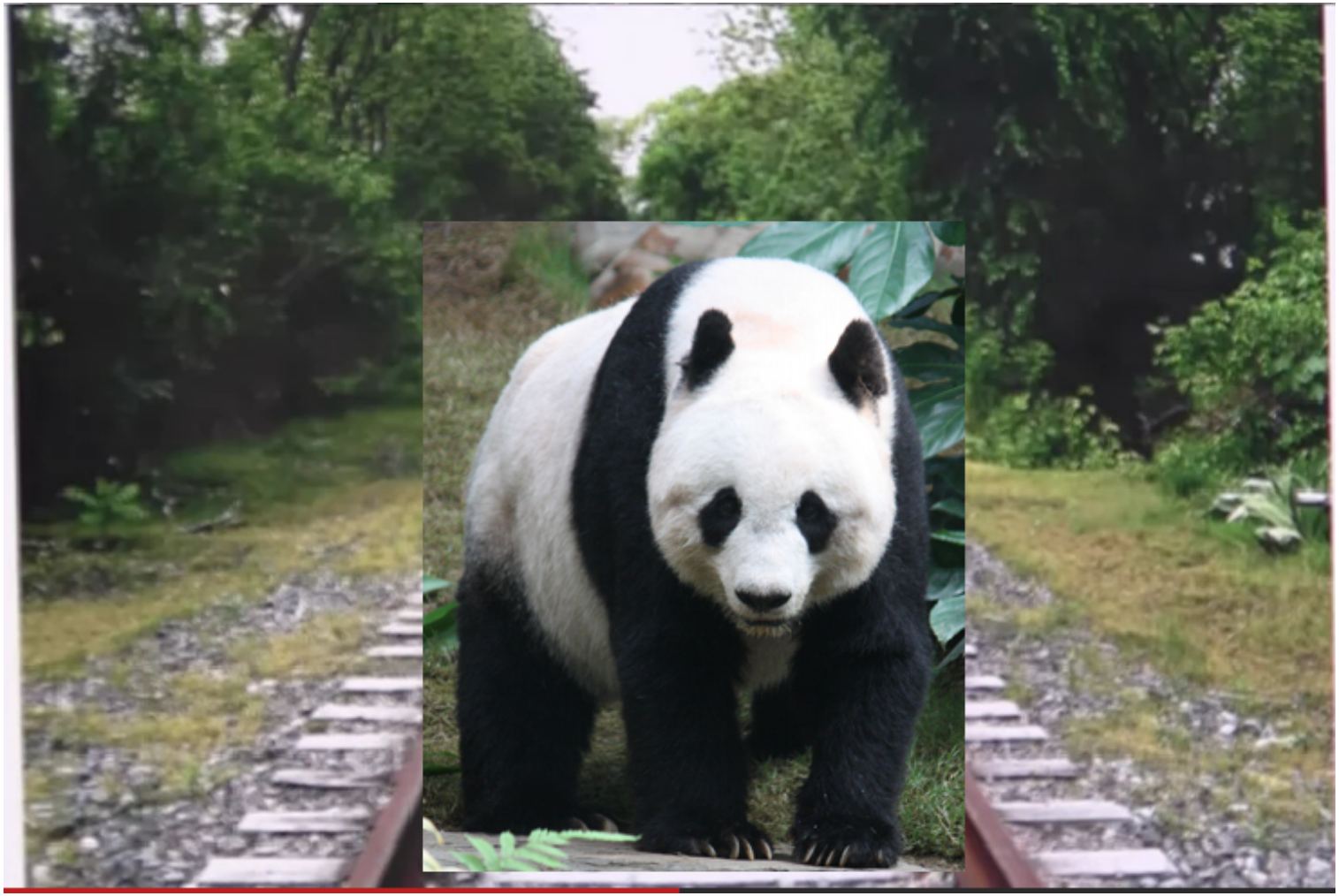

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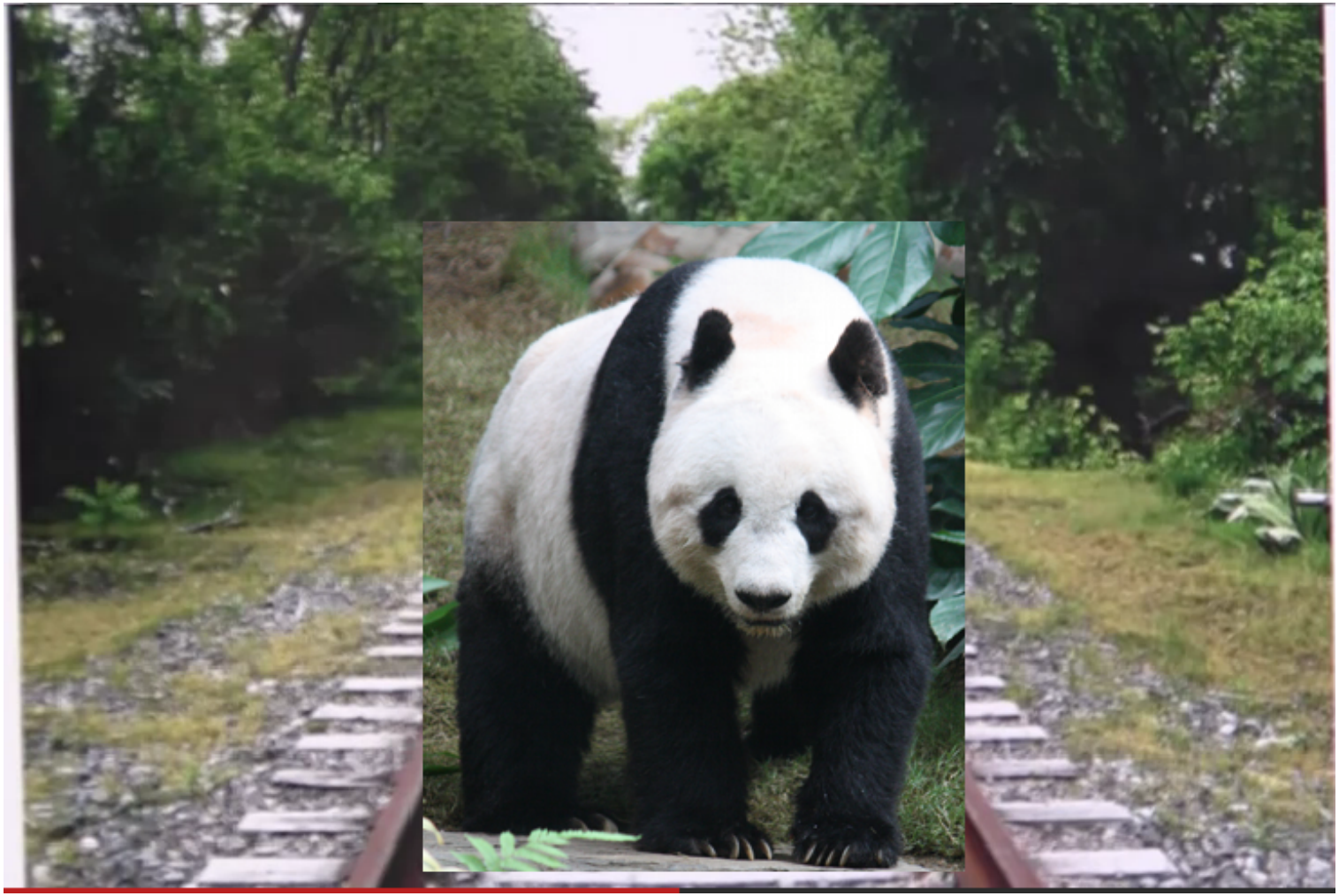
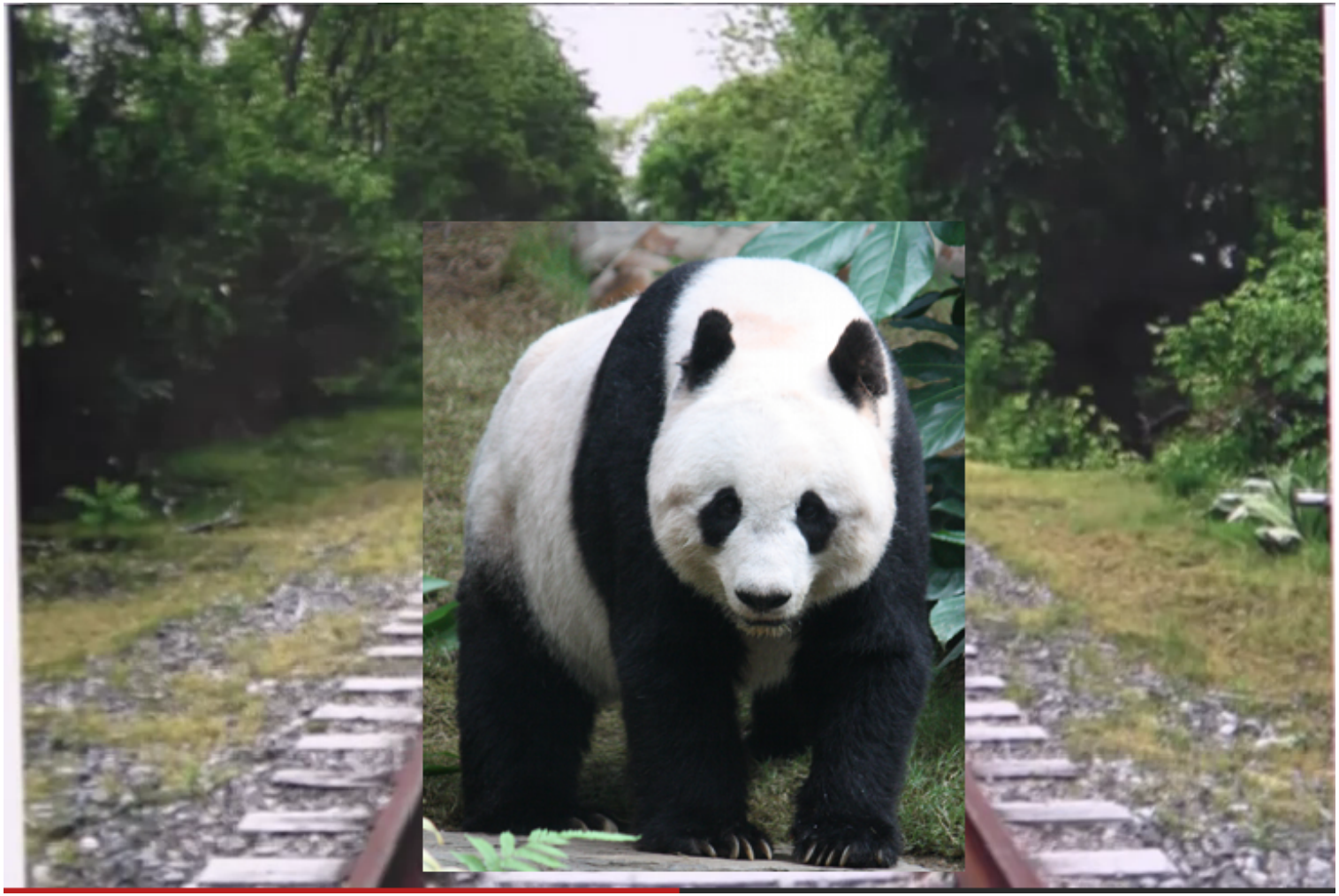


- Giant panda, or just close?

Getting the Depth from Perspective Projection



- Giant panda, or just close?
- Can only tell if we know exactly the size.

Alternative?

Alternative?

Use your two eyes: Stereo Vision

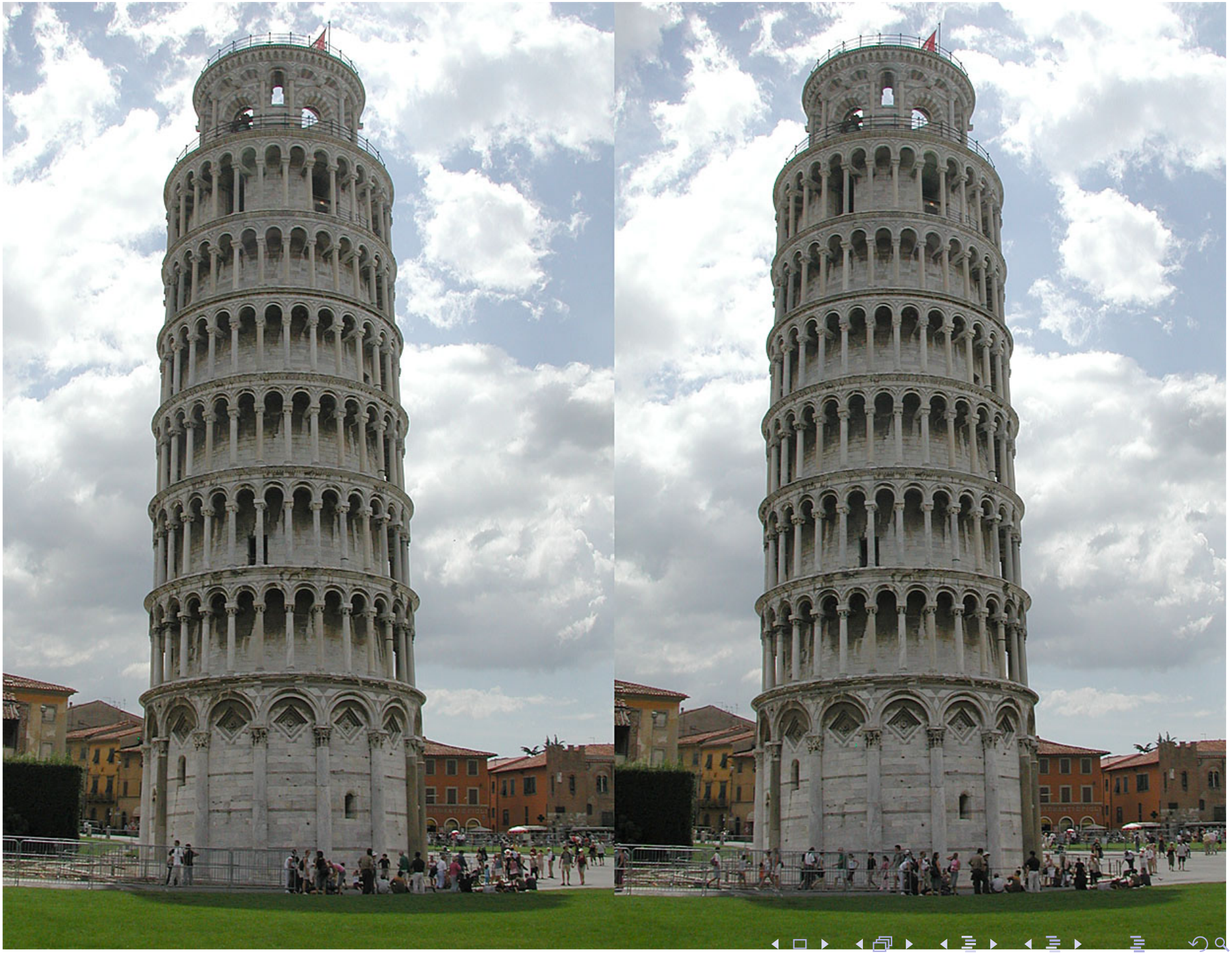
Entry/Exit Surveys

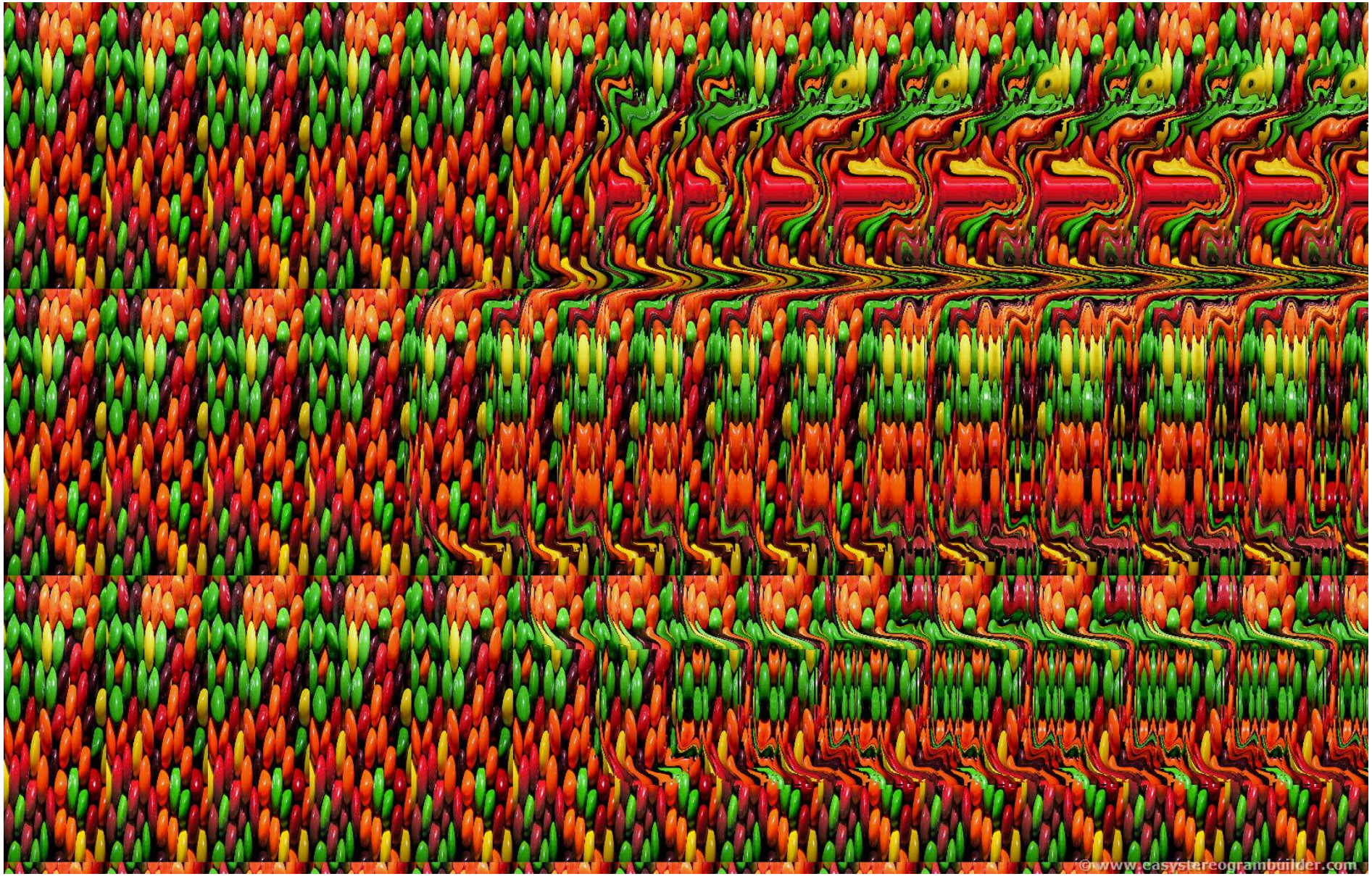
Exit survey: Computer Vision I – Object Recognition

- List some problematic states of objects for which an object recognition algorithm must be invariant for.
- What kind of a filter mask would you convolve with an image to detect *diagonal* lines?

Entry survey: Computer Vision II – 3D Vision (0.25 points)

- What tasks would you find difficult if you had only one eye open?
- How do you think stereograms are made?

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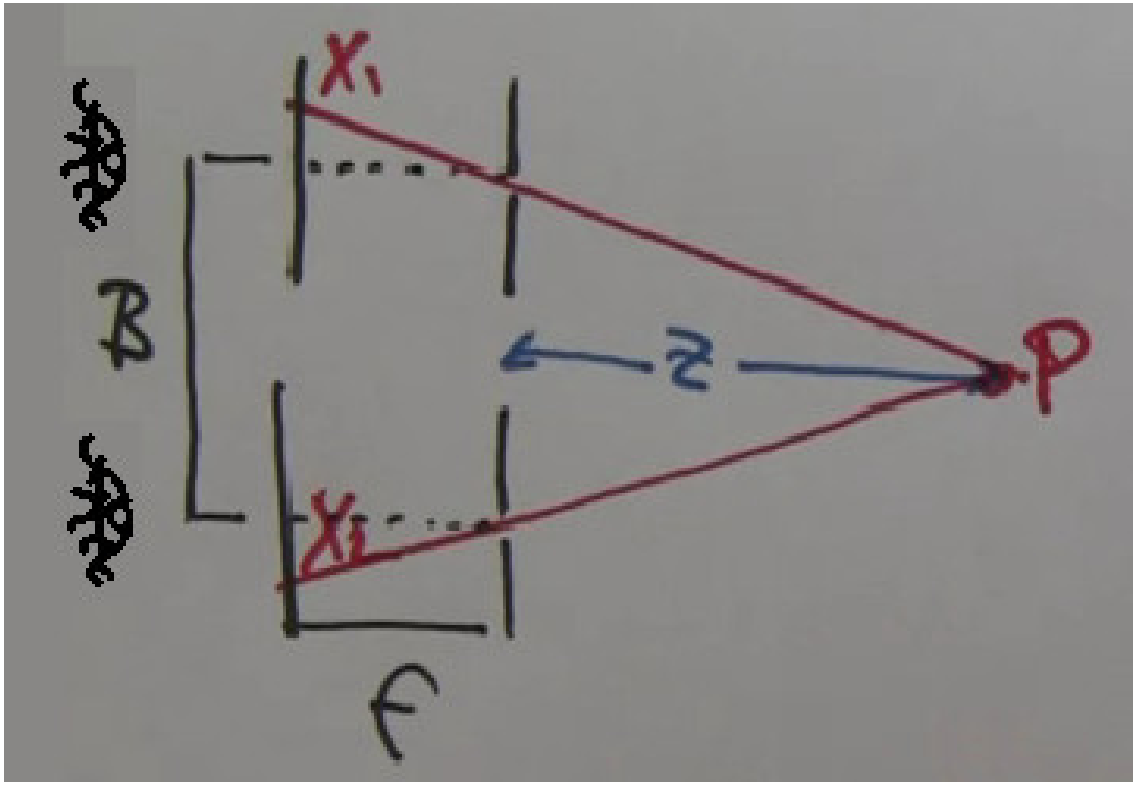
Stereo Vision



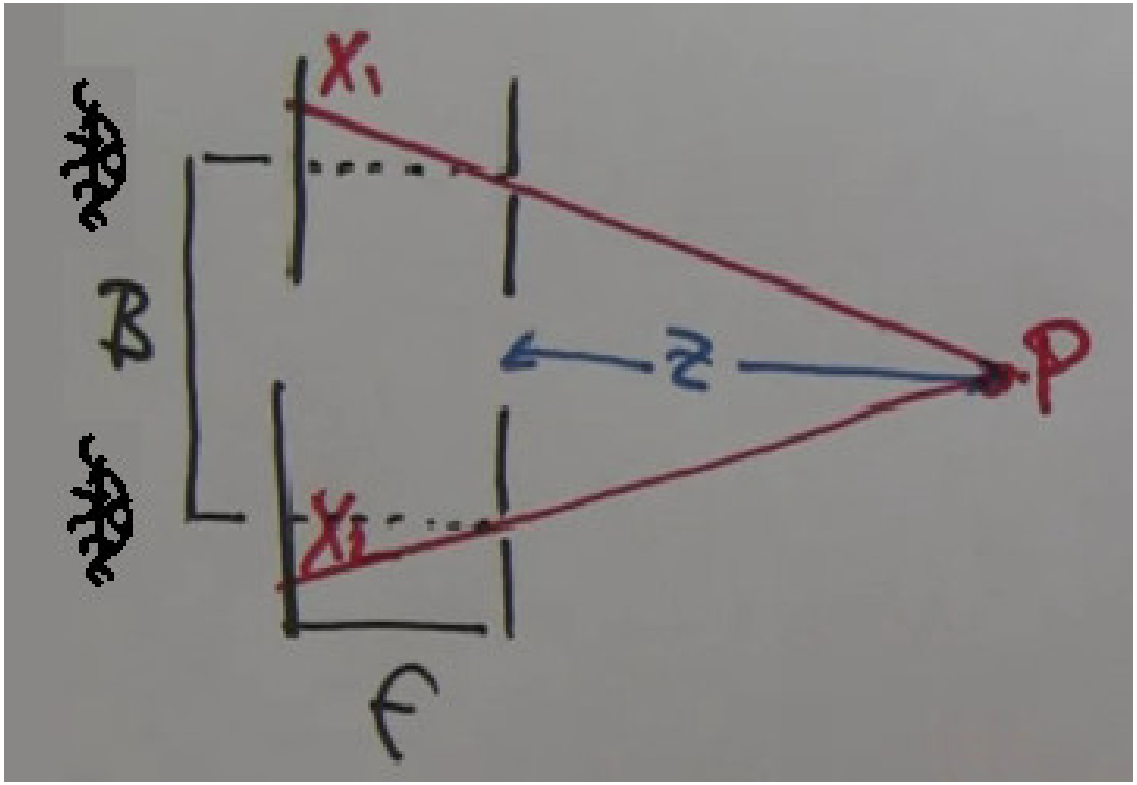
P: Target object.

Z: Distance to object.

B: Baseline; separation between eyes.

x_1, x_2 : Disparity or parallax; different offsets at each eye.

Stereo Vision



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Can we always find depth of P?

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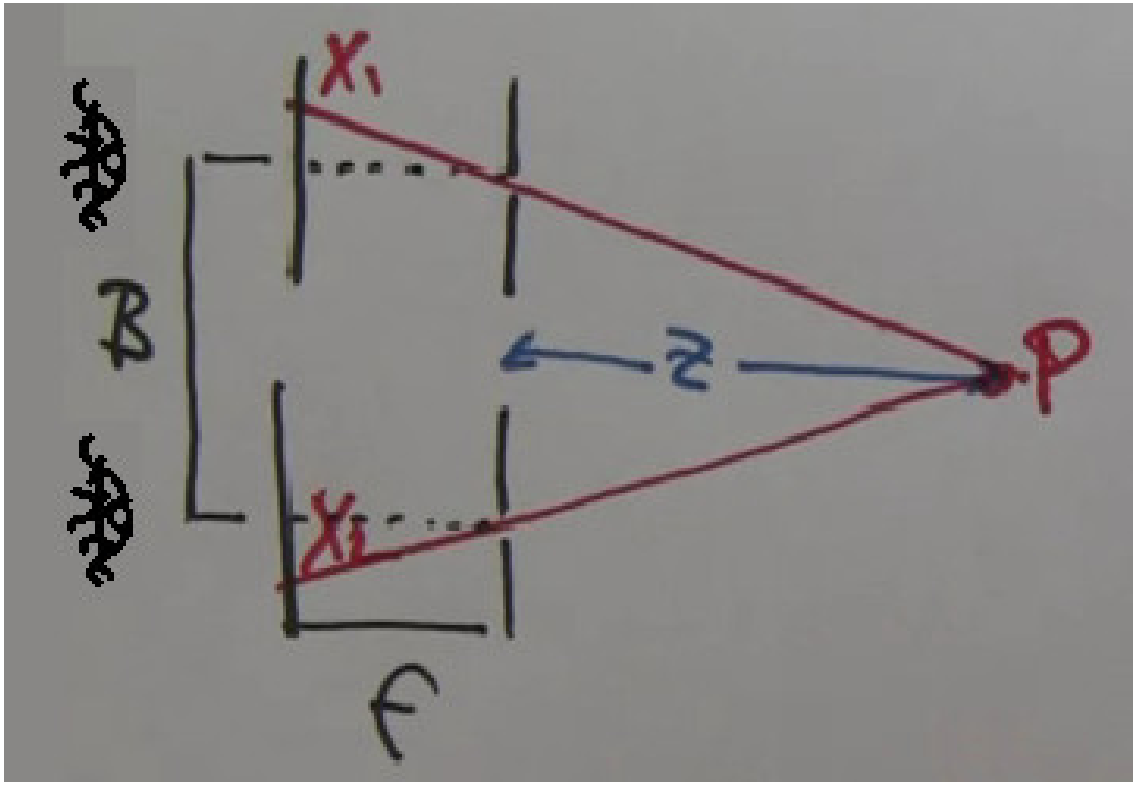

P: Target object.

Z: Distance to object.

B: Baseline; separation between eyes.

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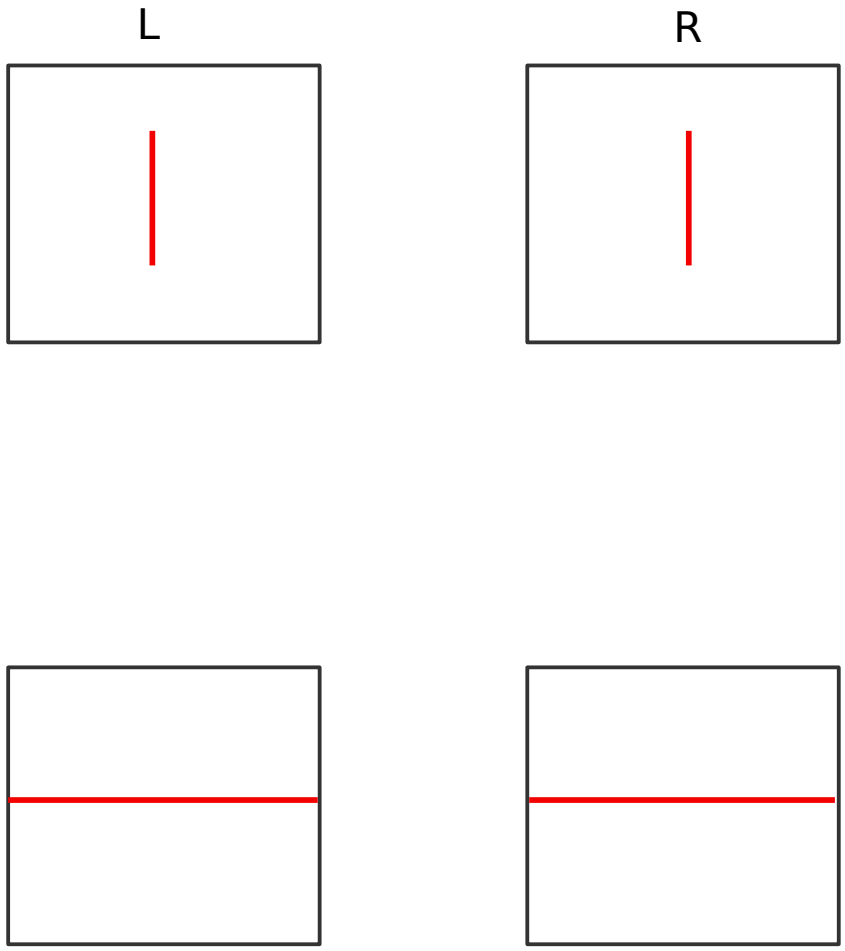
Can we always find depth of P? No, only sometimes.

Stereo Vision: Which One is Easier?



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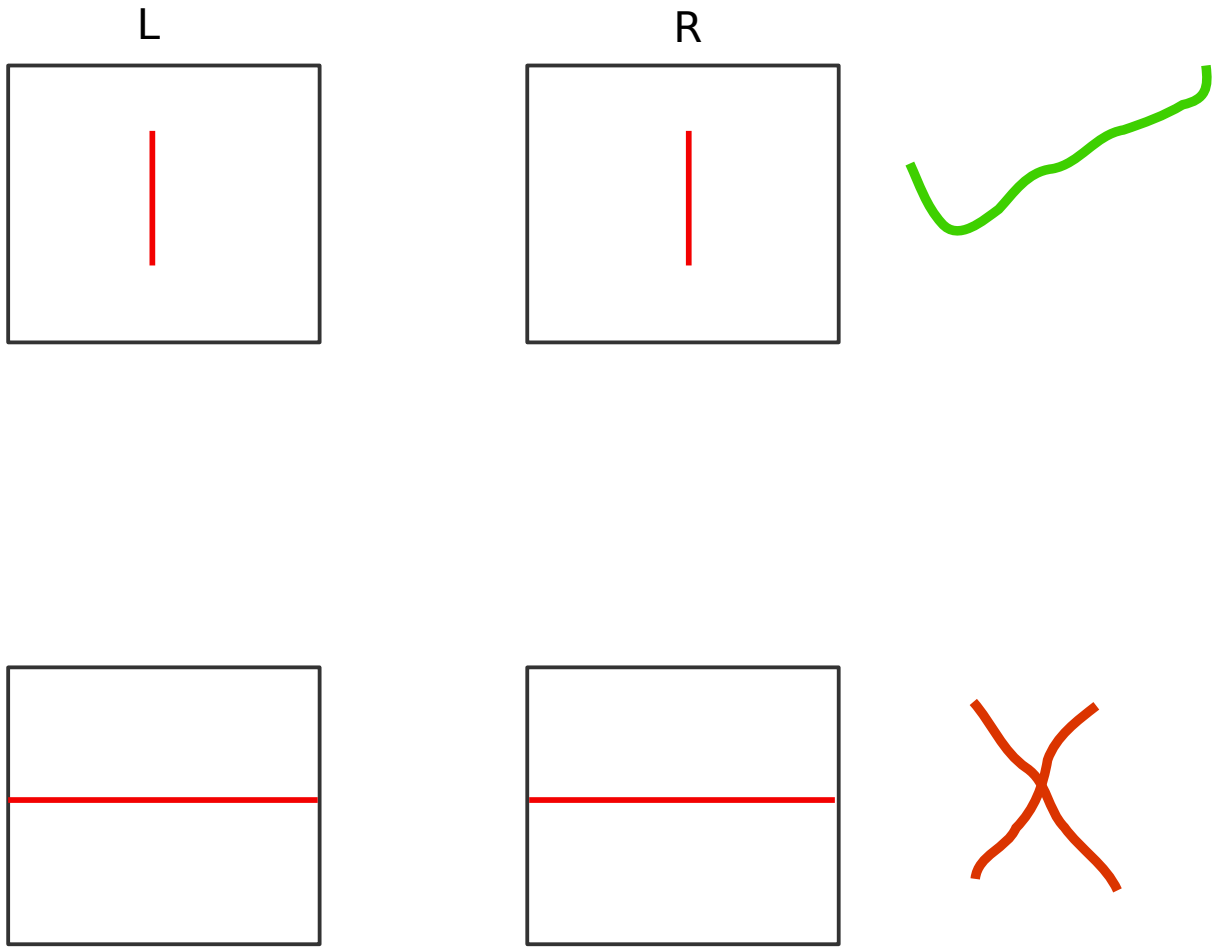
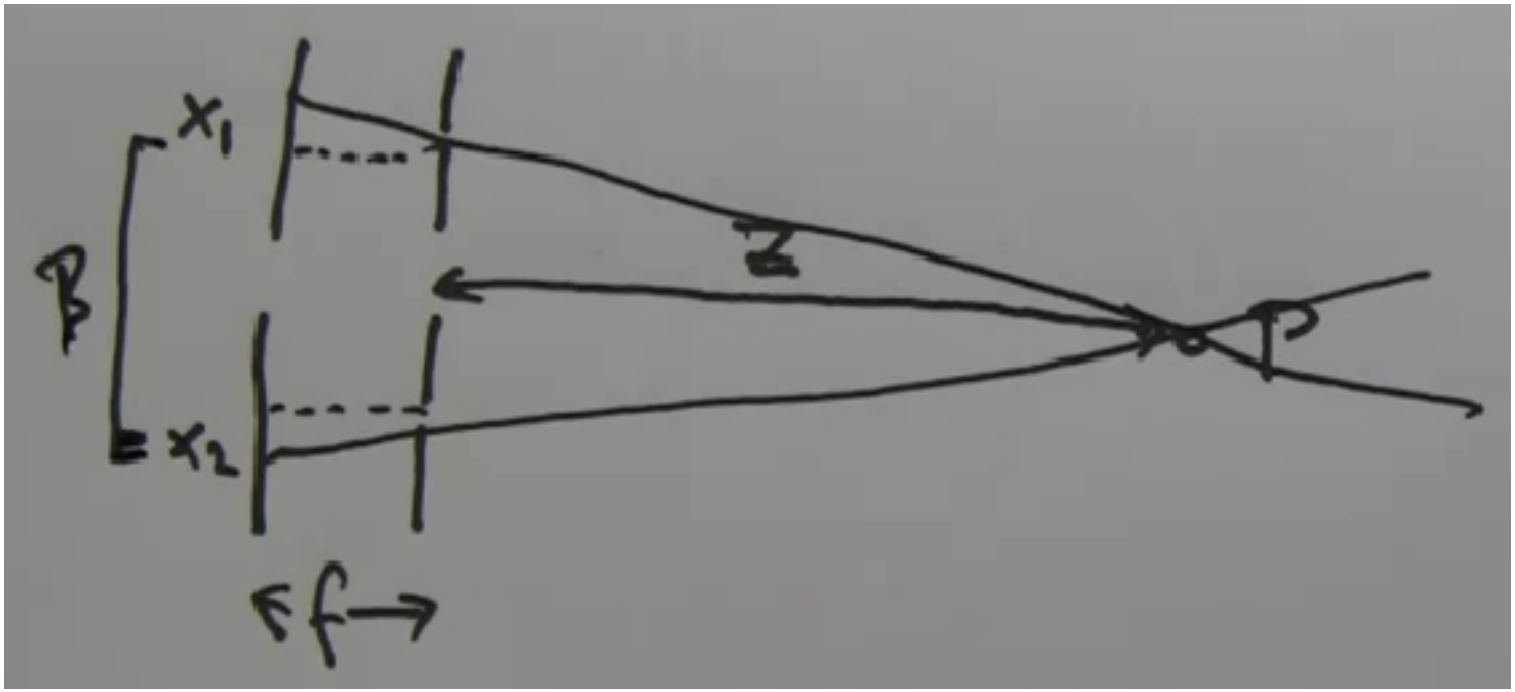


Stereo Vision: How to Find Depth?



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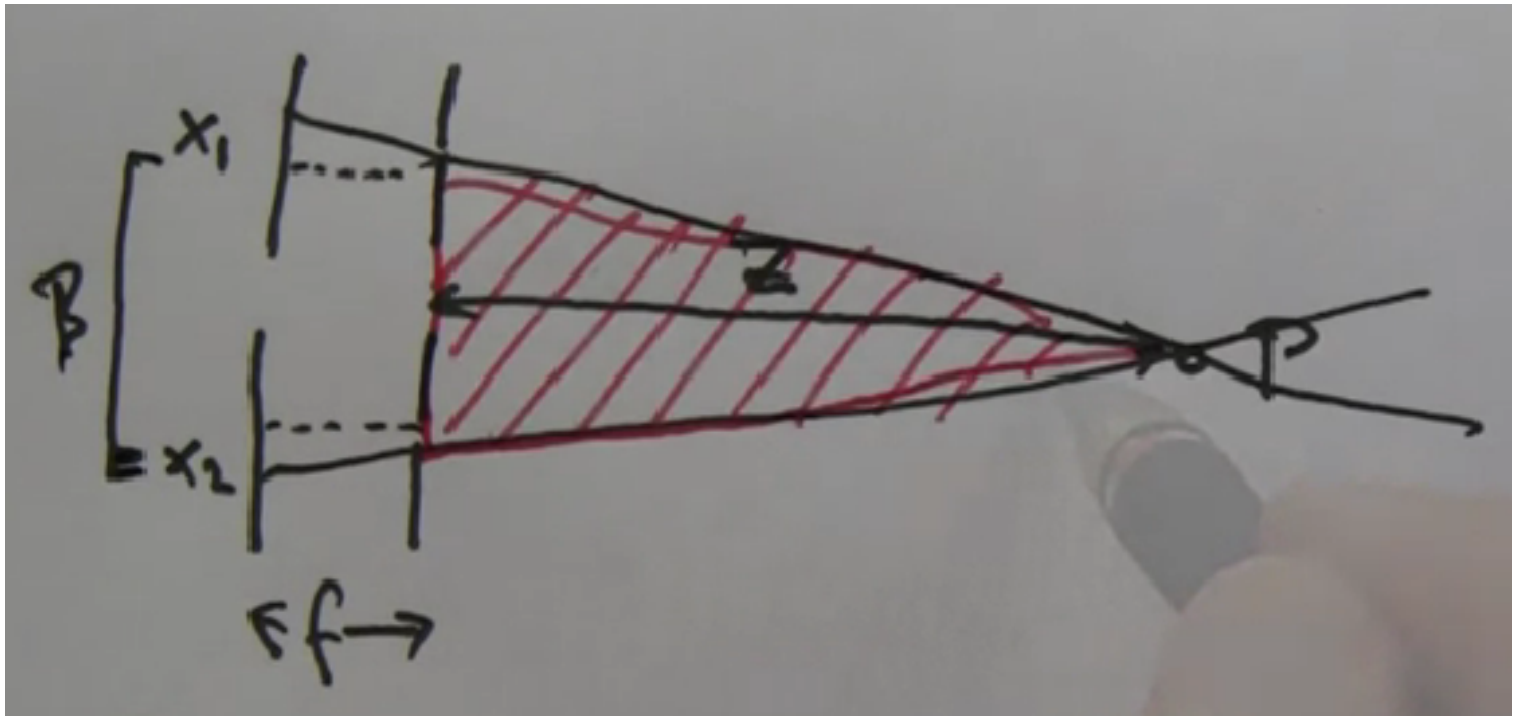

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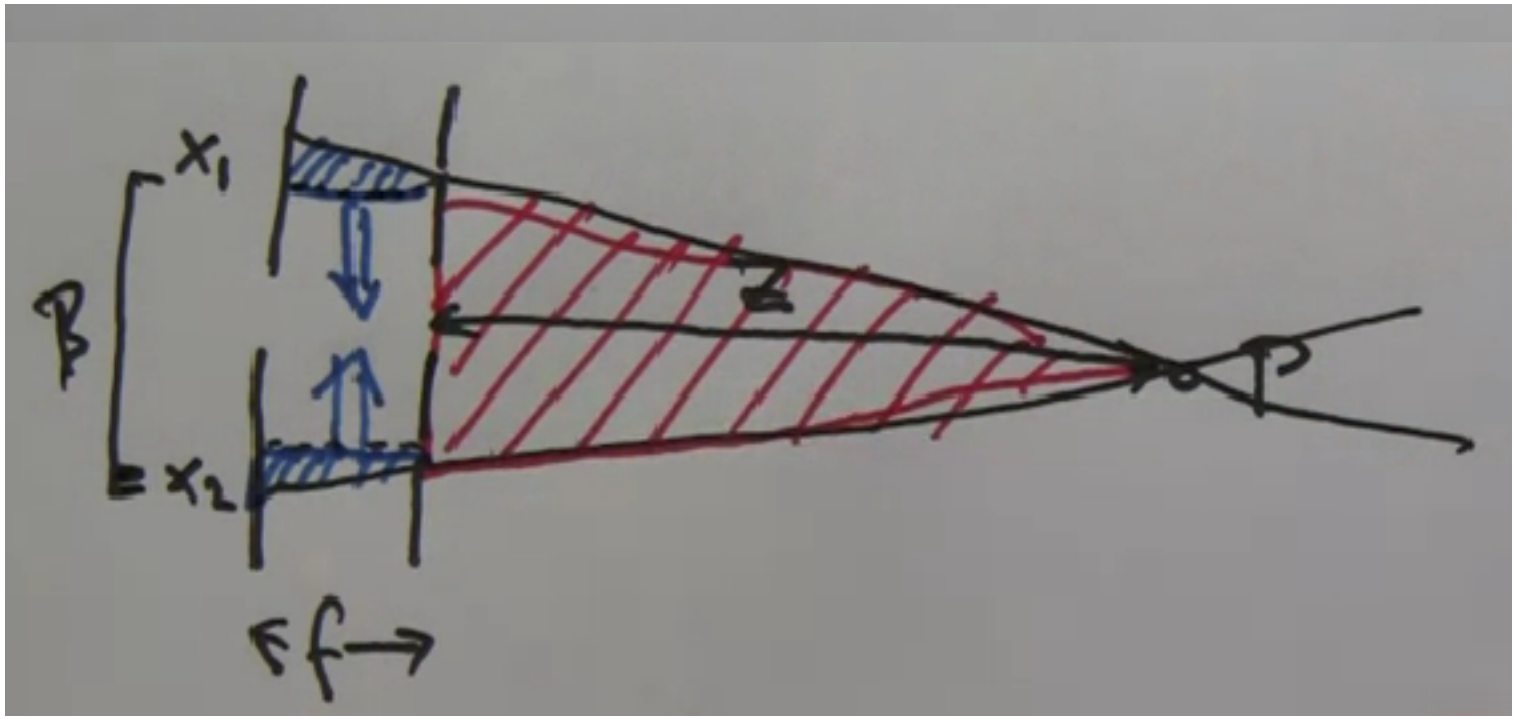

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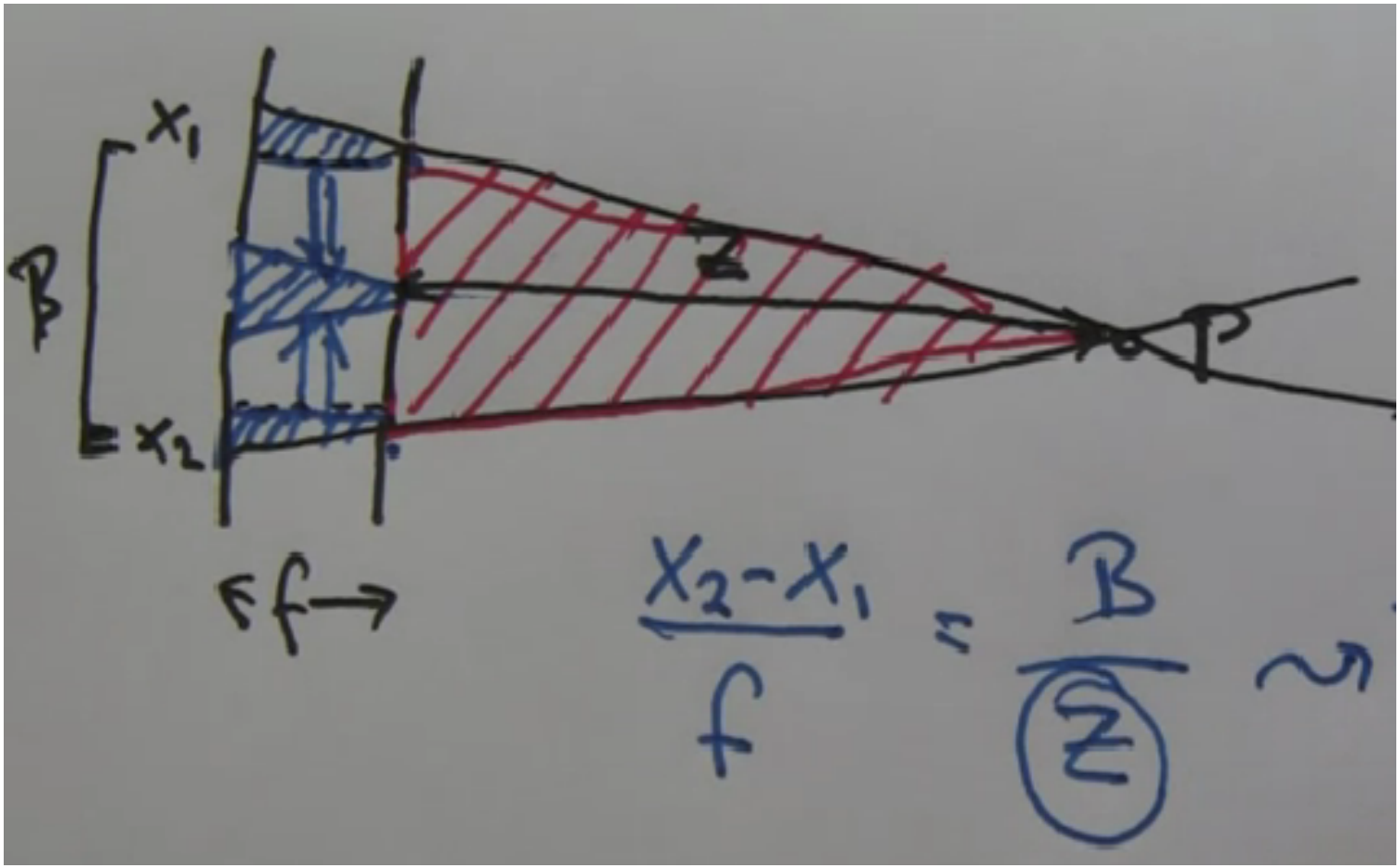

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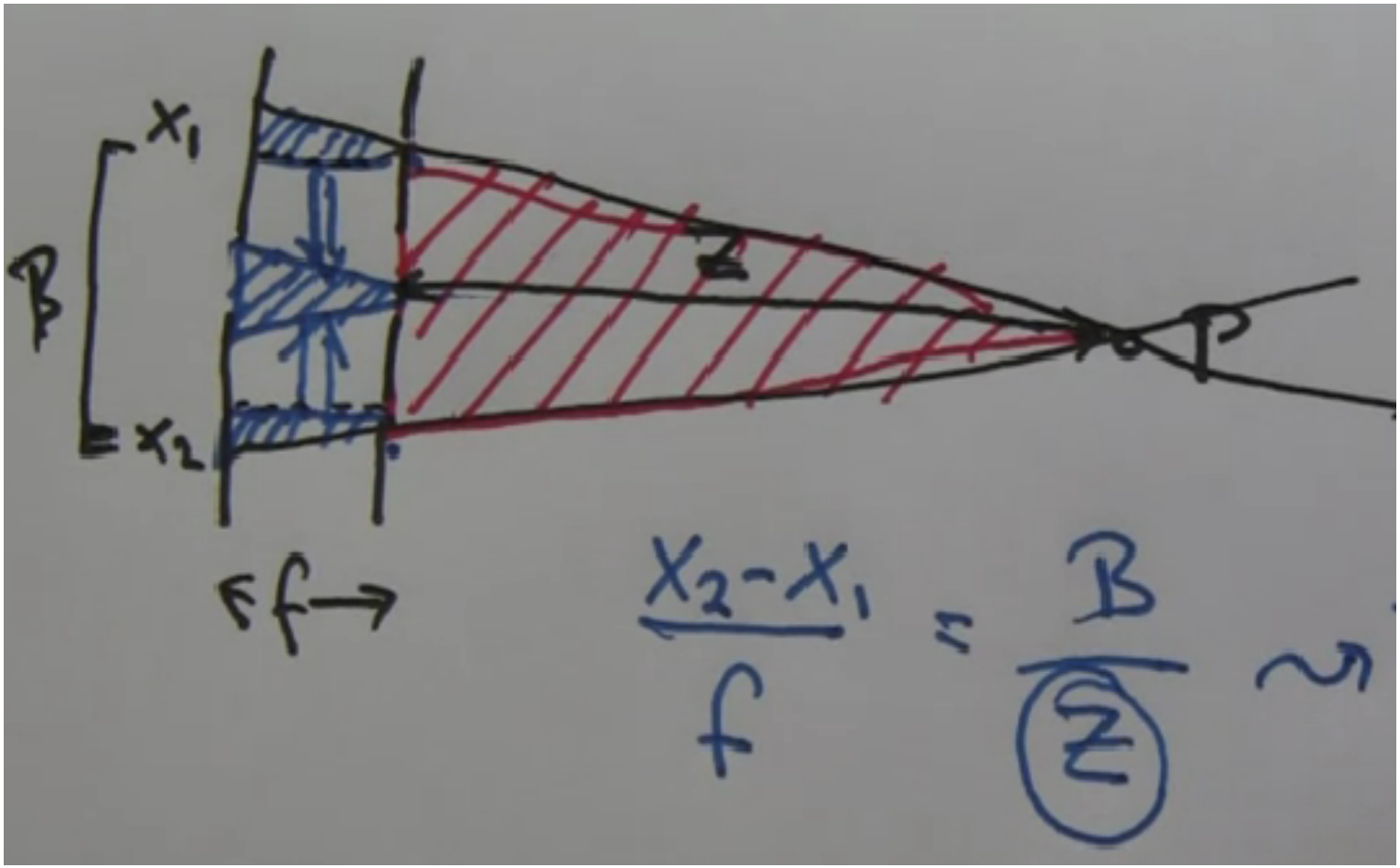

What's different here? What don't we need to find depth?

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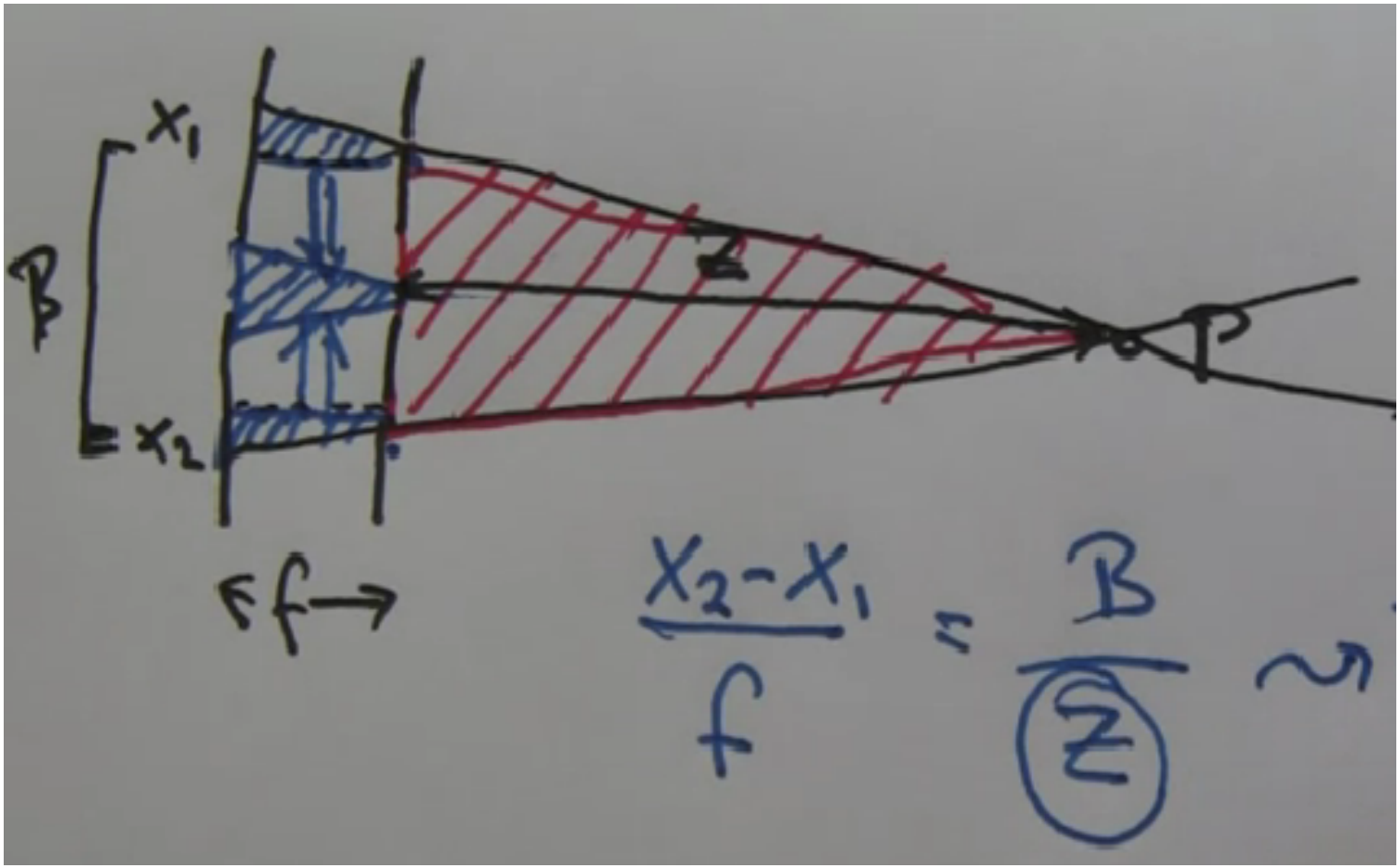
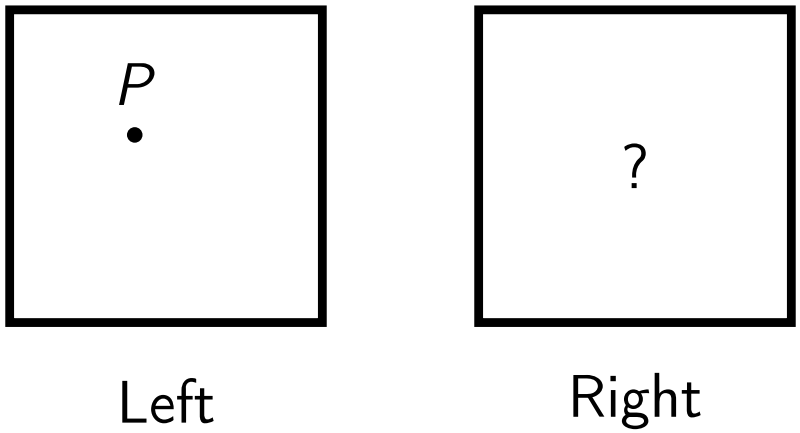


What's different here? What don't we need to find depth? **Original size**.

Finding Correspondence Between Left and Right Images



Where do we search on the right image?

1. 2D: everywhere
2. 1D: on a line
3. 0D: we know the point

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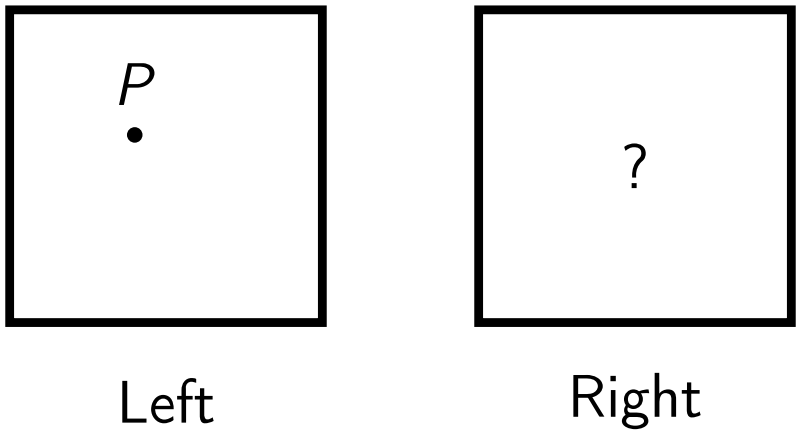

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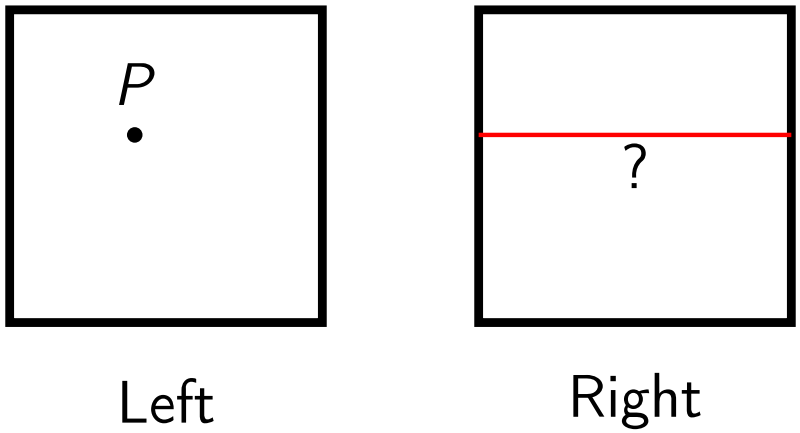

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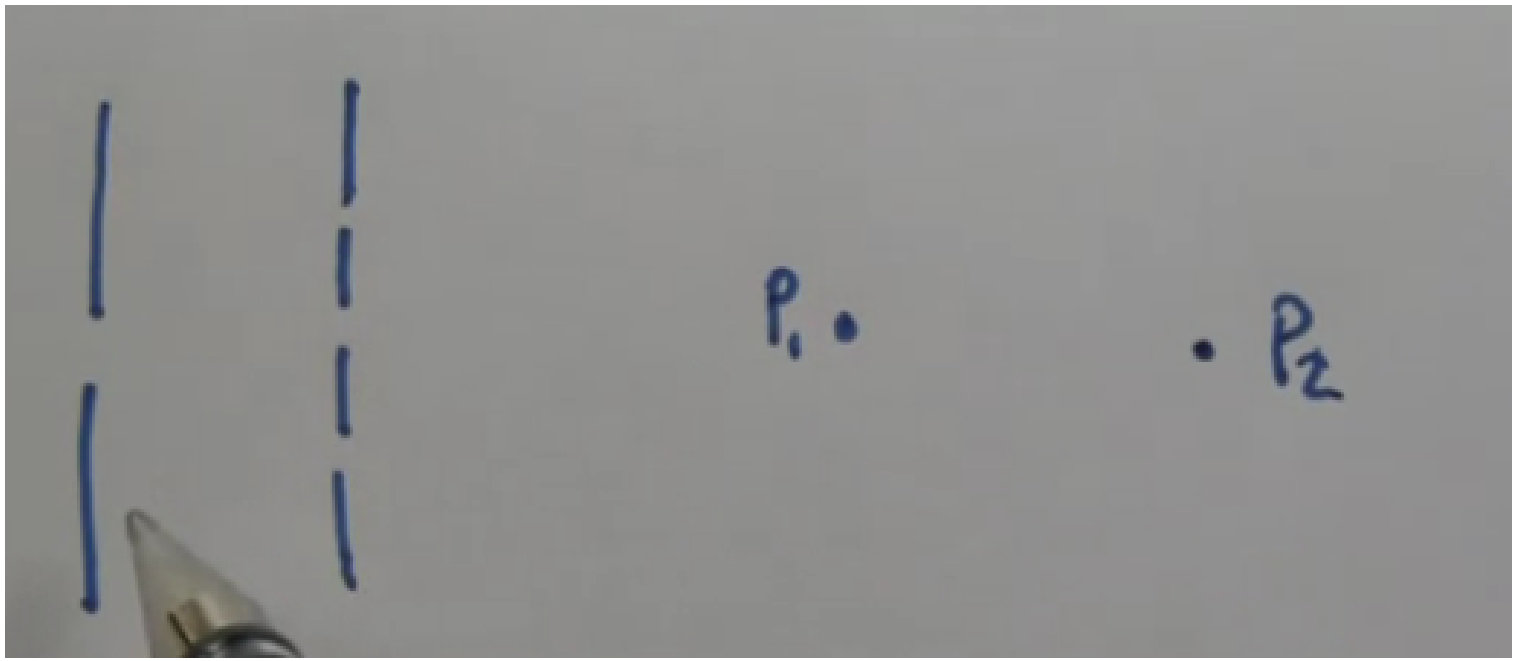
Correspondence Problems



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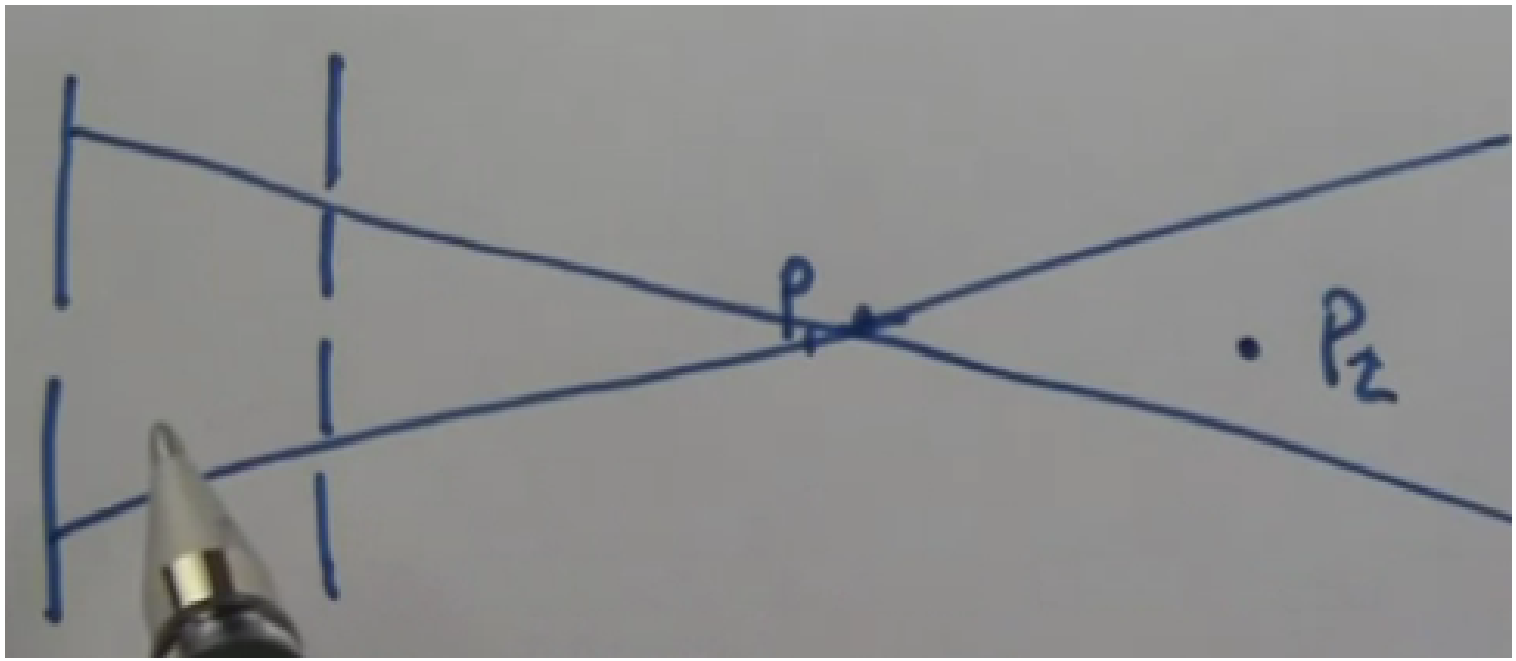

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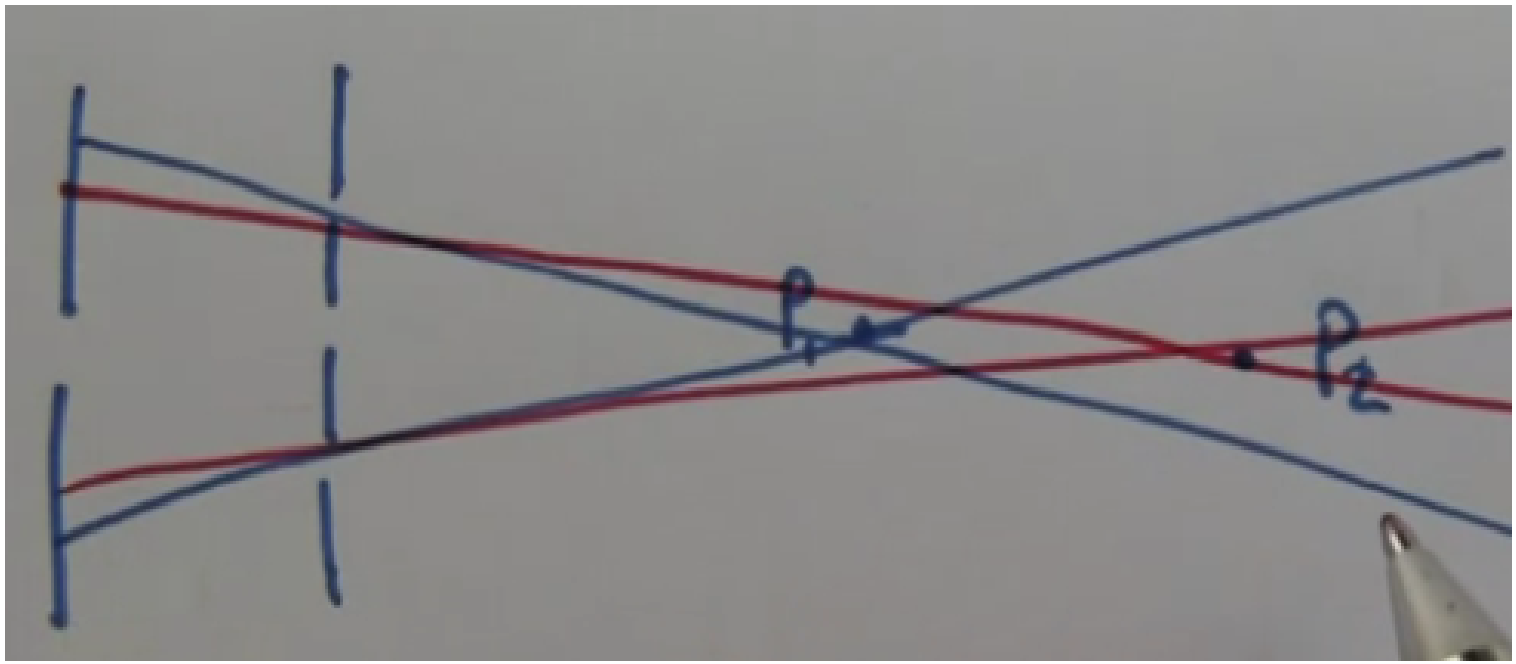

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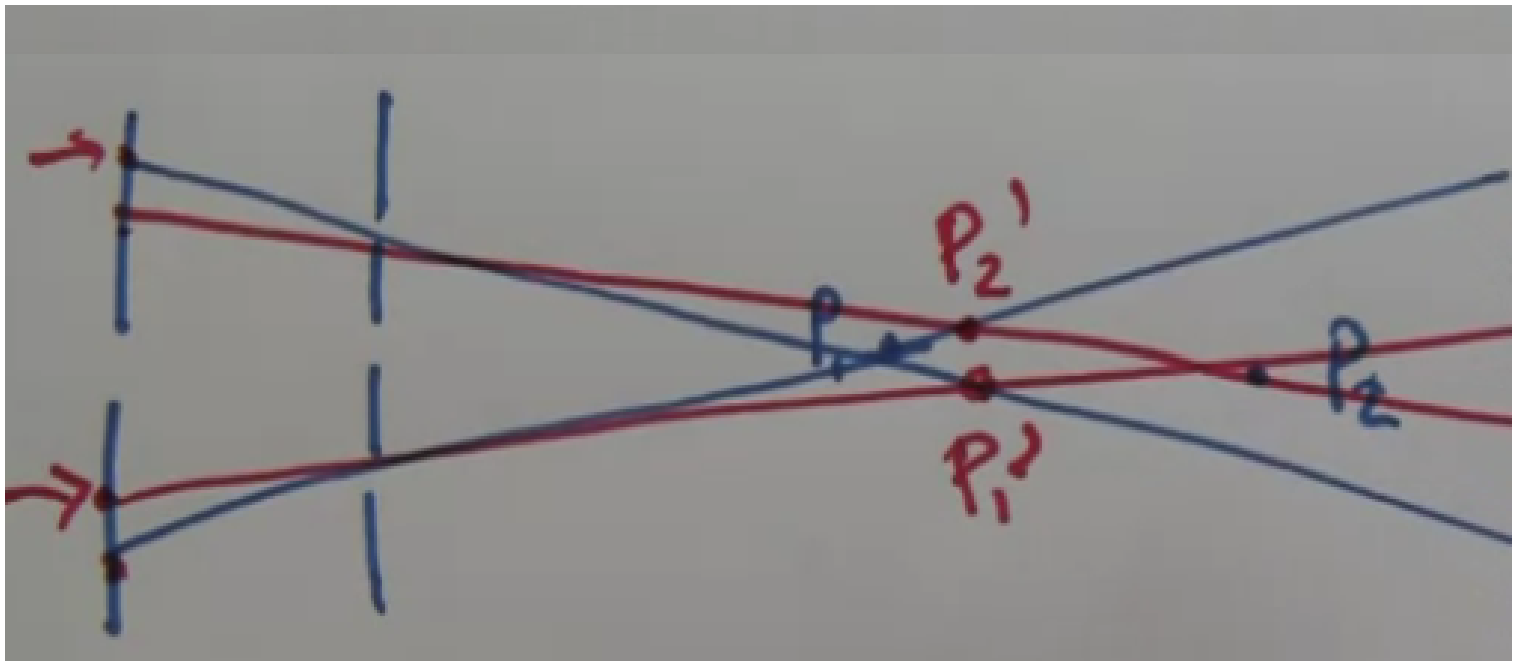

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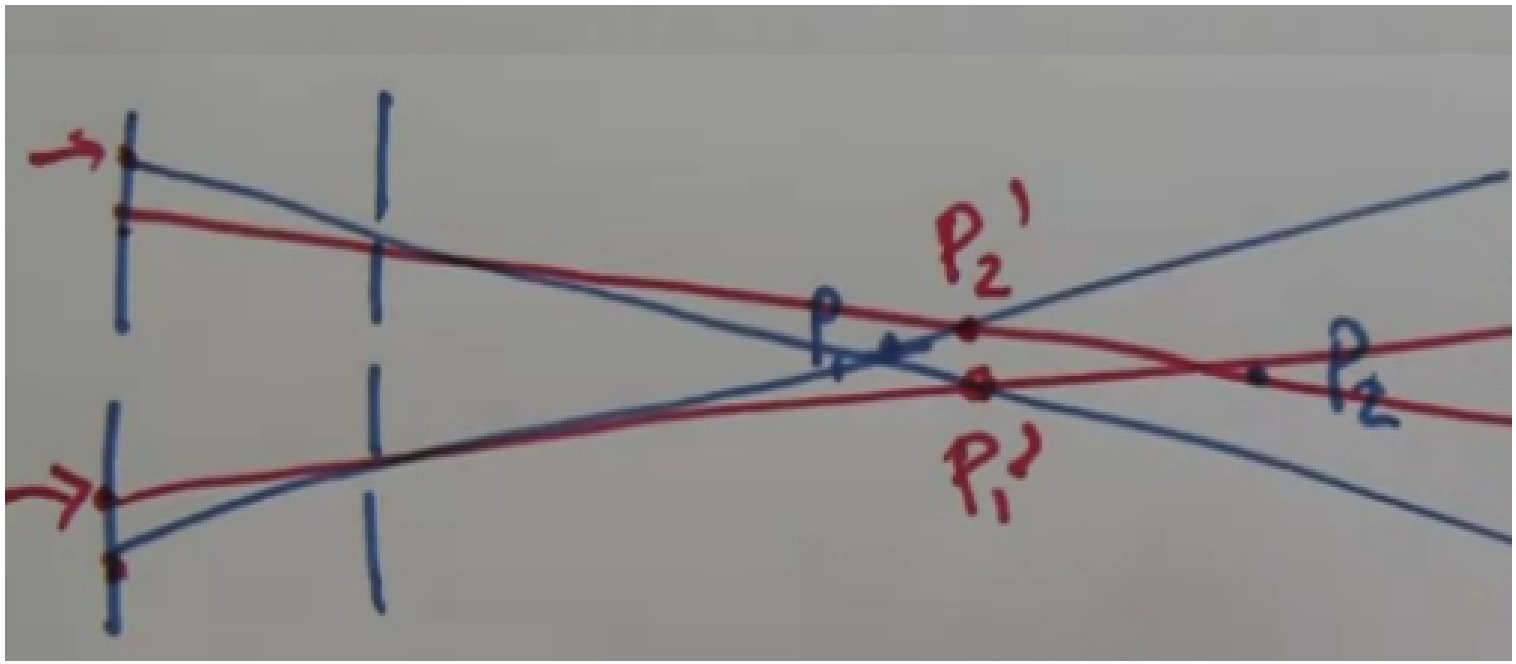

You get **Phantom Points** if you get the correspondence wrong.

A Real Correspondence Example

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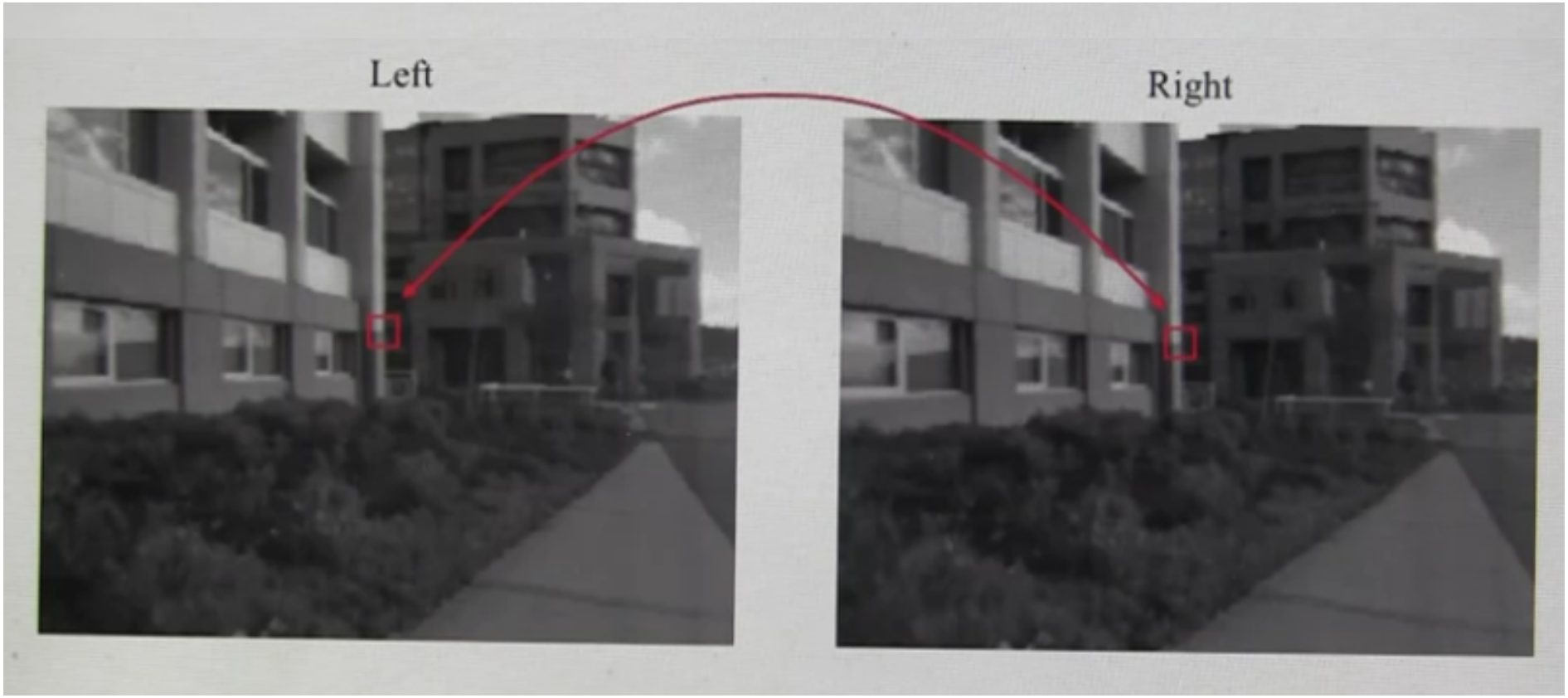

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Can we find correspondence with any of:

1. Texture match?
2. Feature match?

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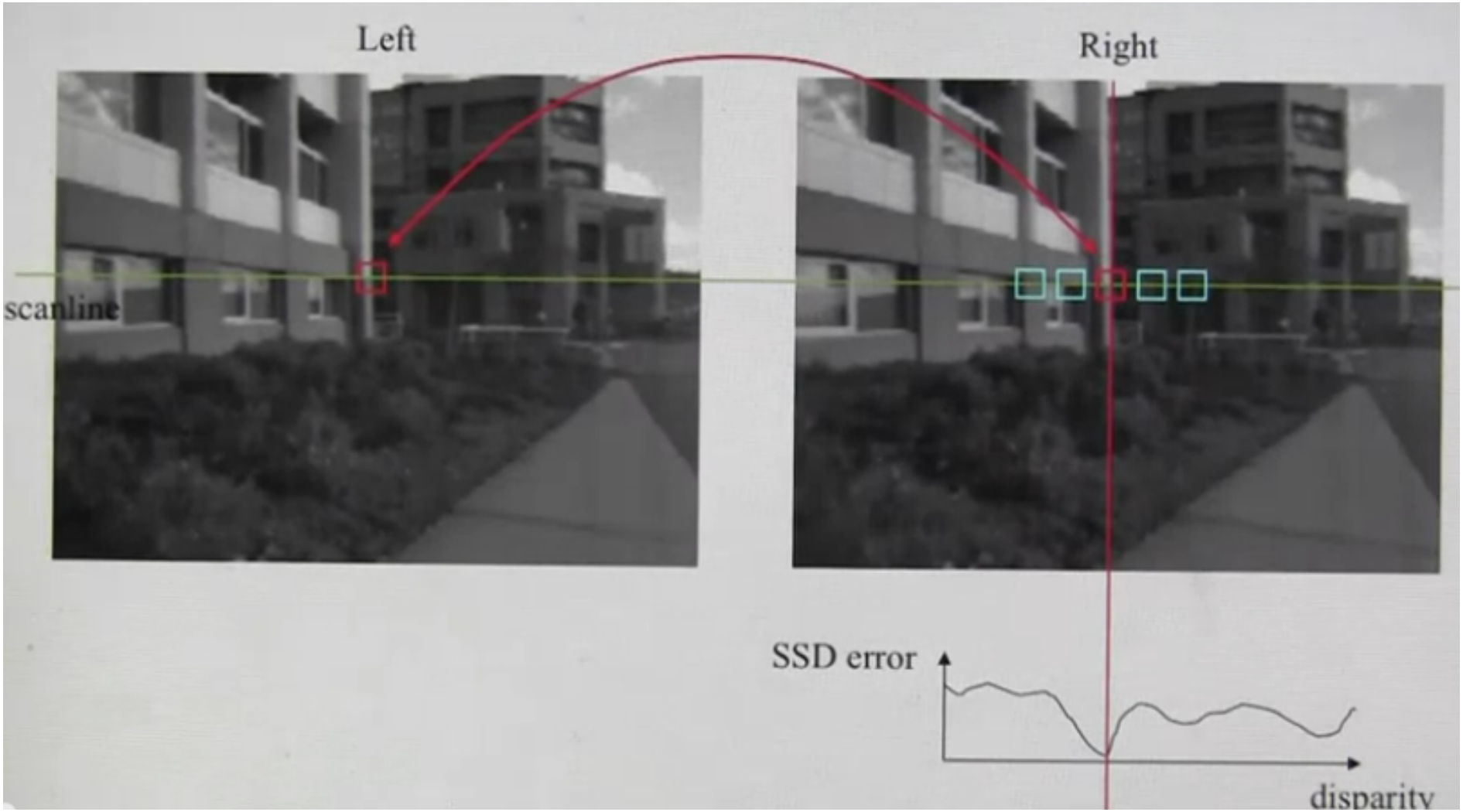
Can we find correspondence with any of:

1. Texture match?
2. Feature match?

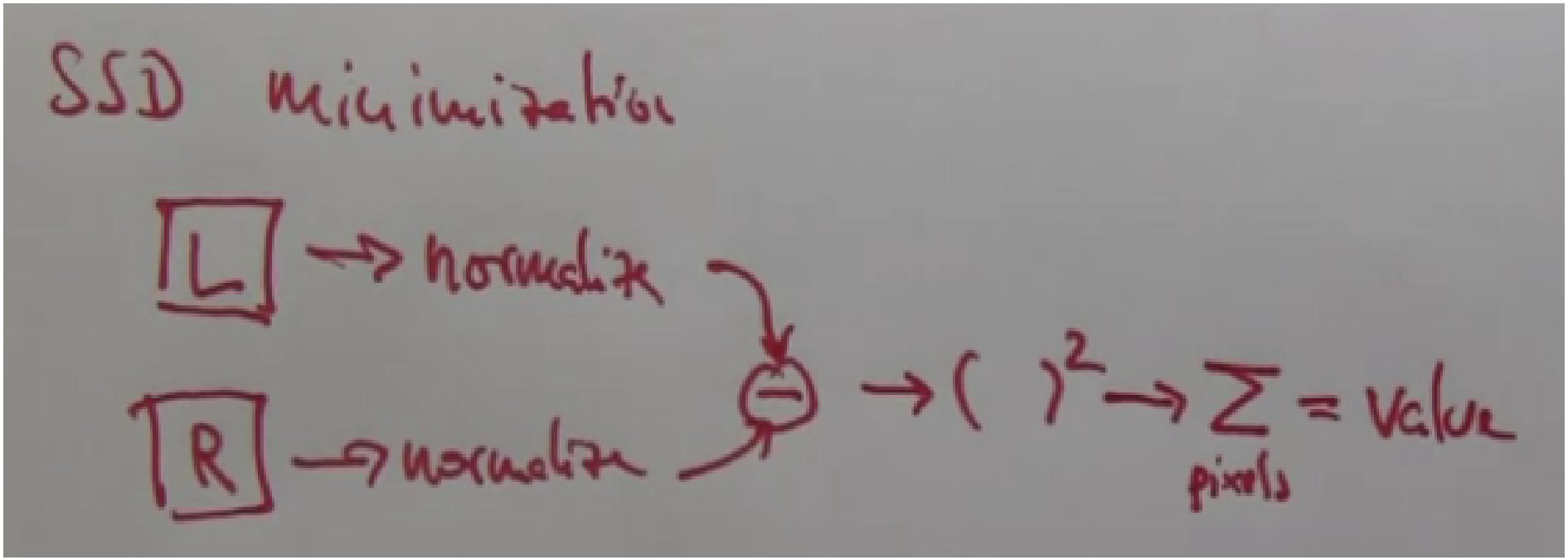
Both, actually.

Texture Match with SSD

SSD is not **solid state drive**, but it is **sum of squared distance**



Sum of Squared Distance (SSD)



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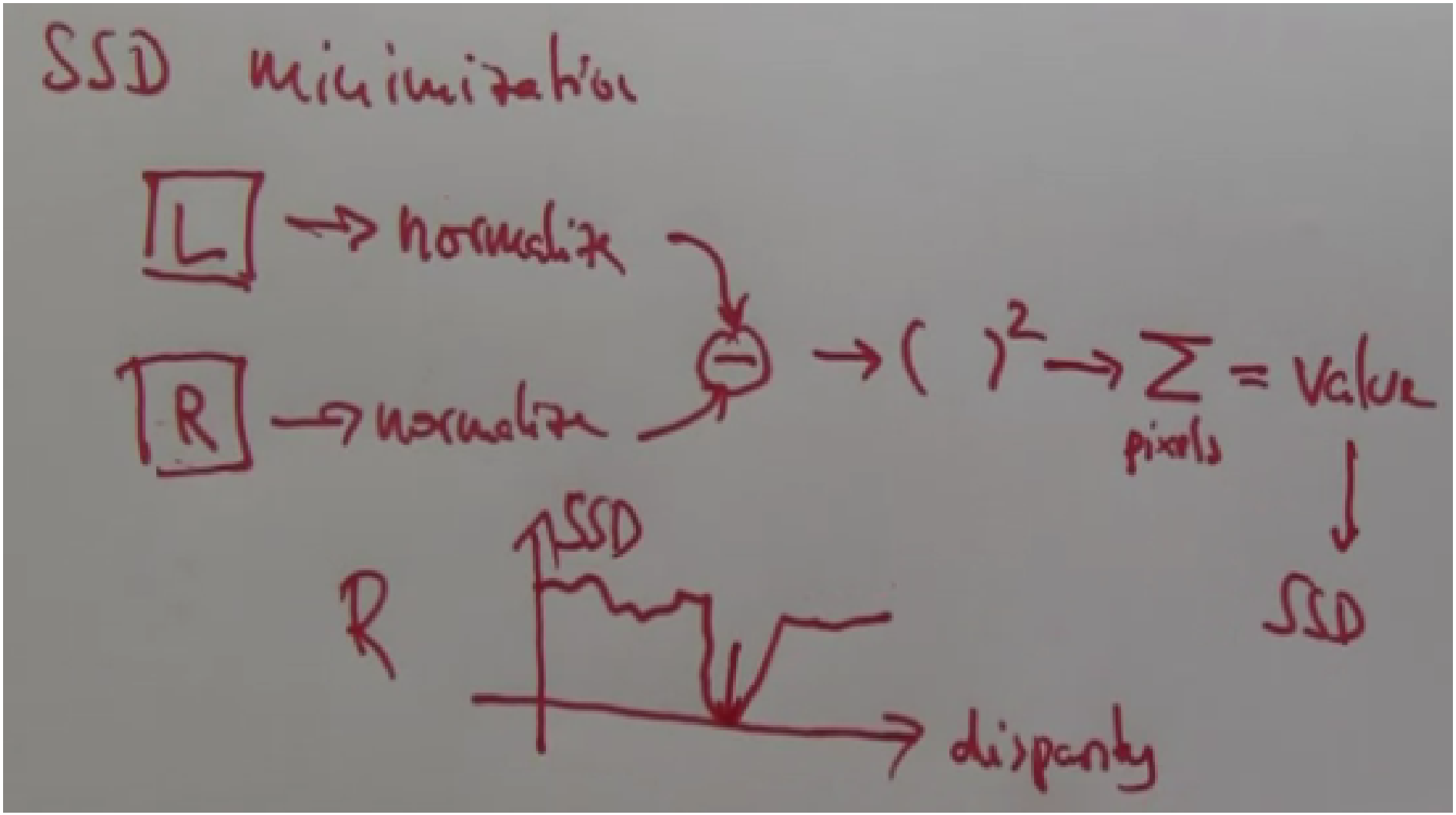
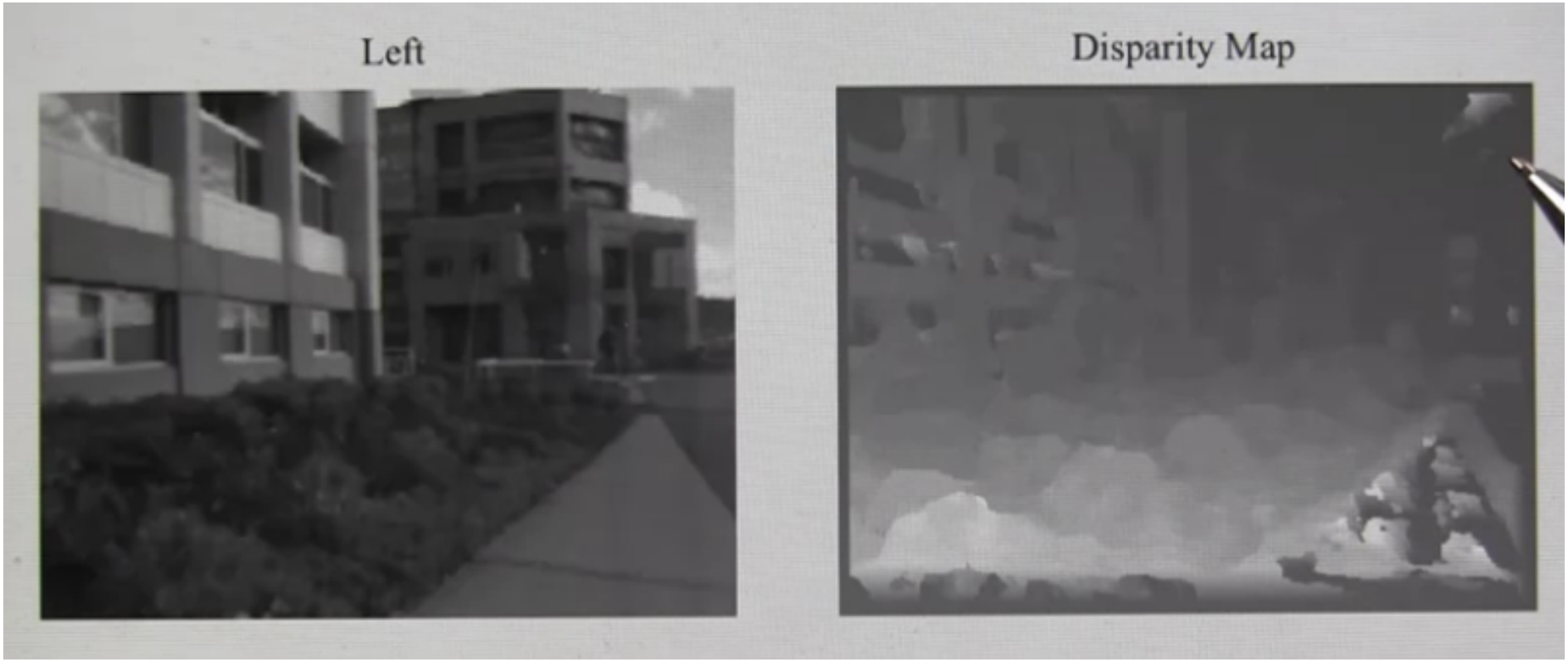
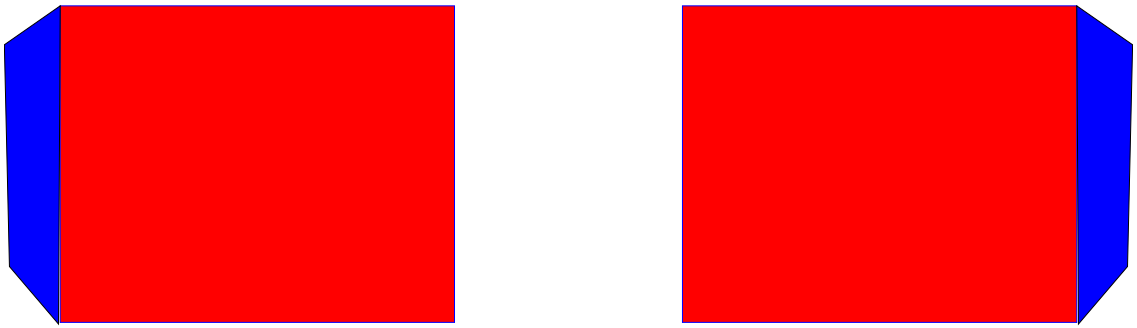


The Result: Disparity Maps

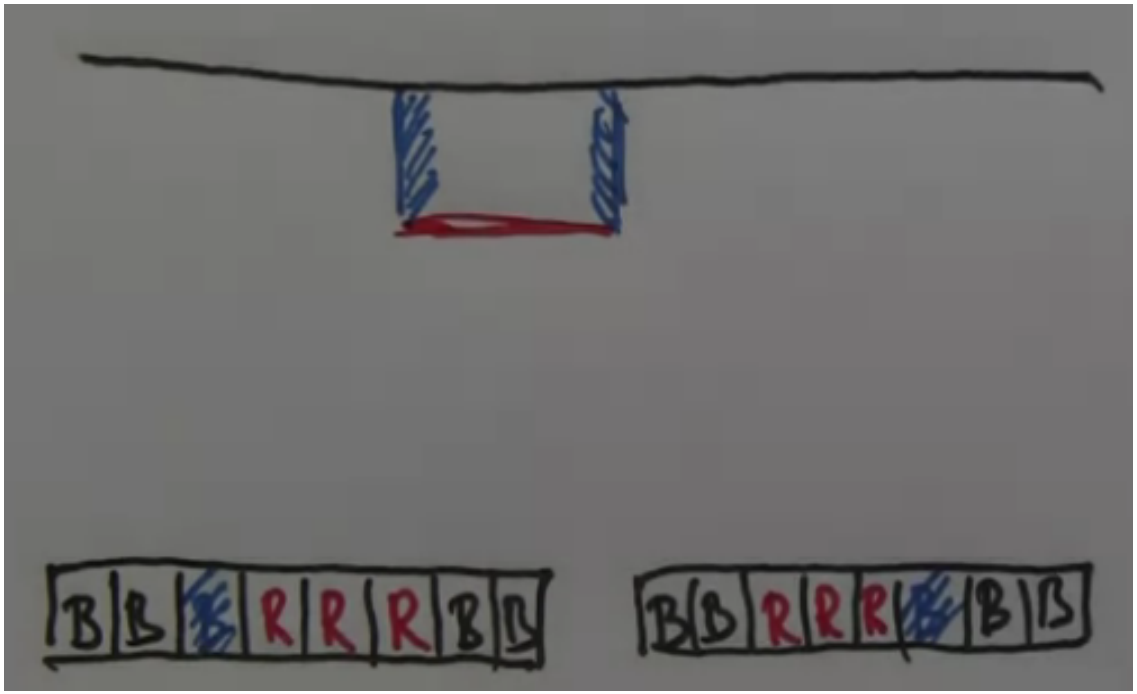


How About Occlusions?



Left

Right



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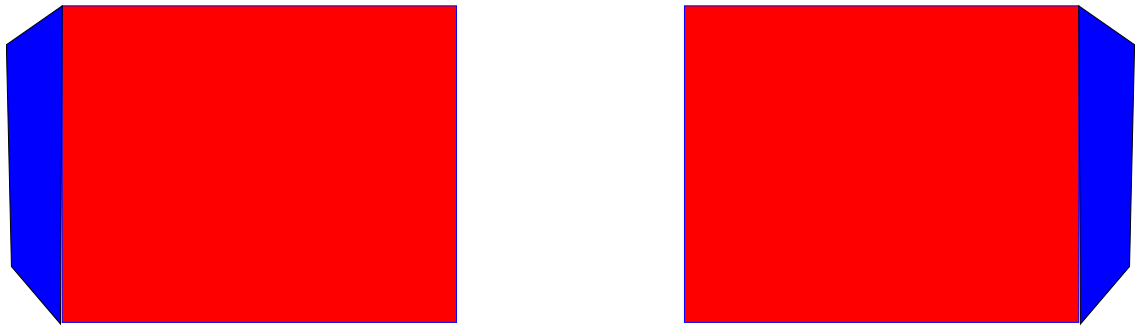

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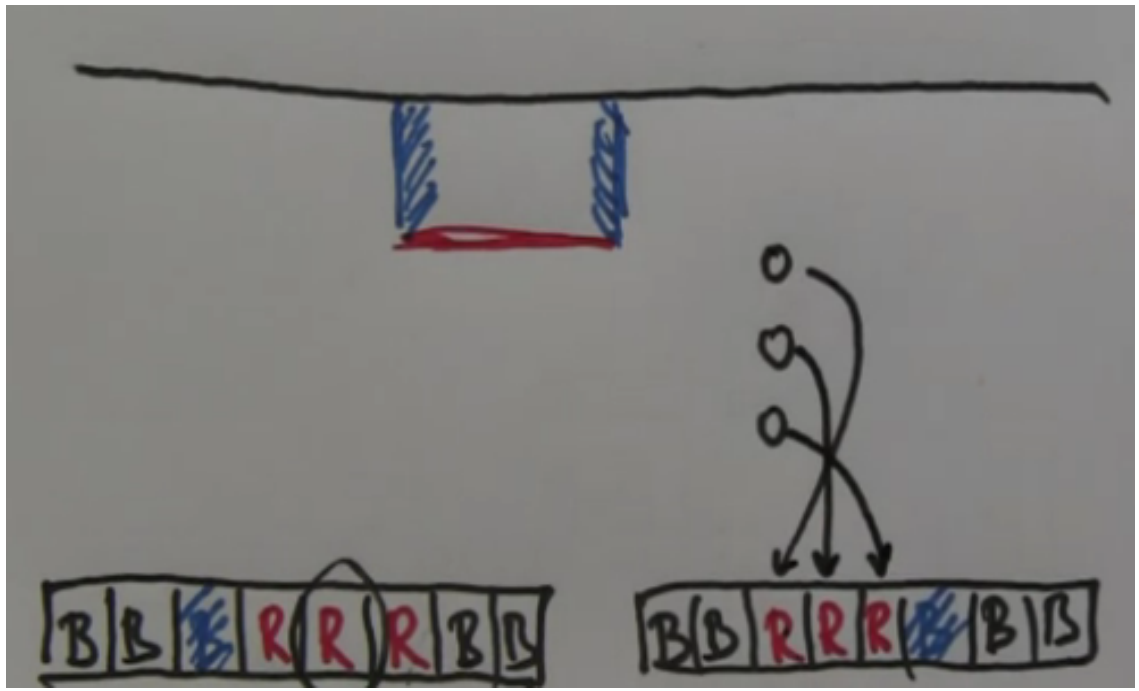

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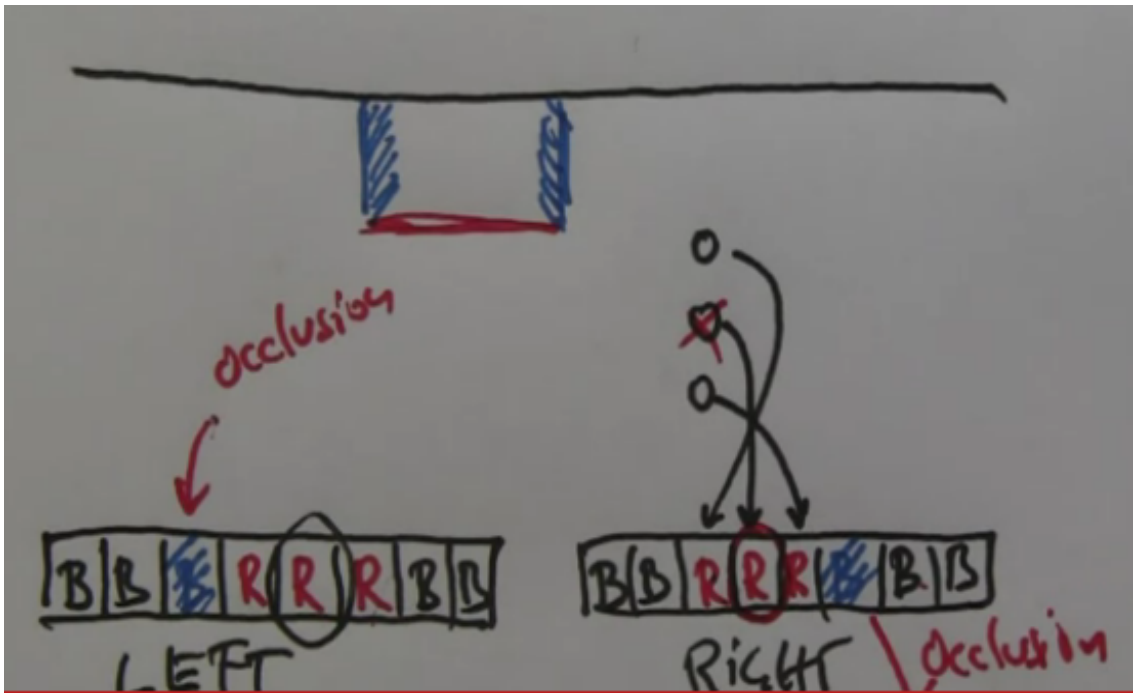
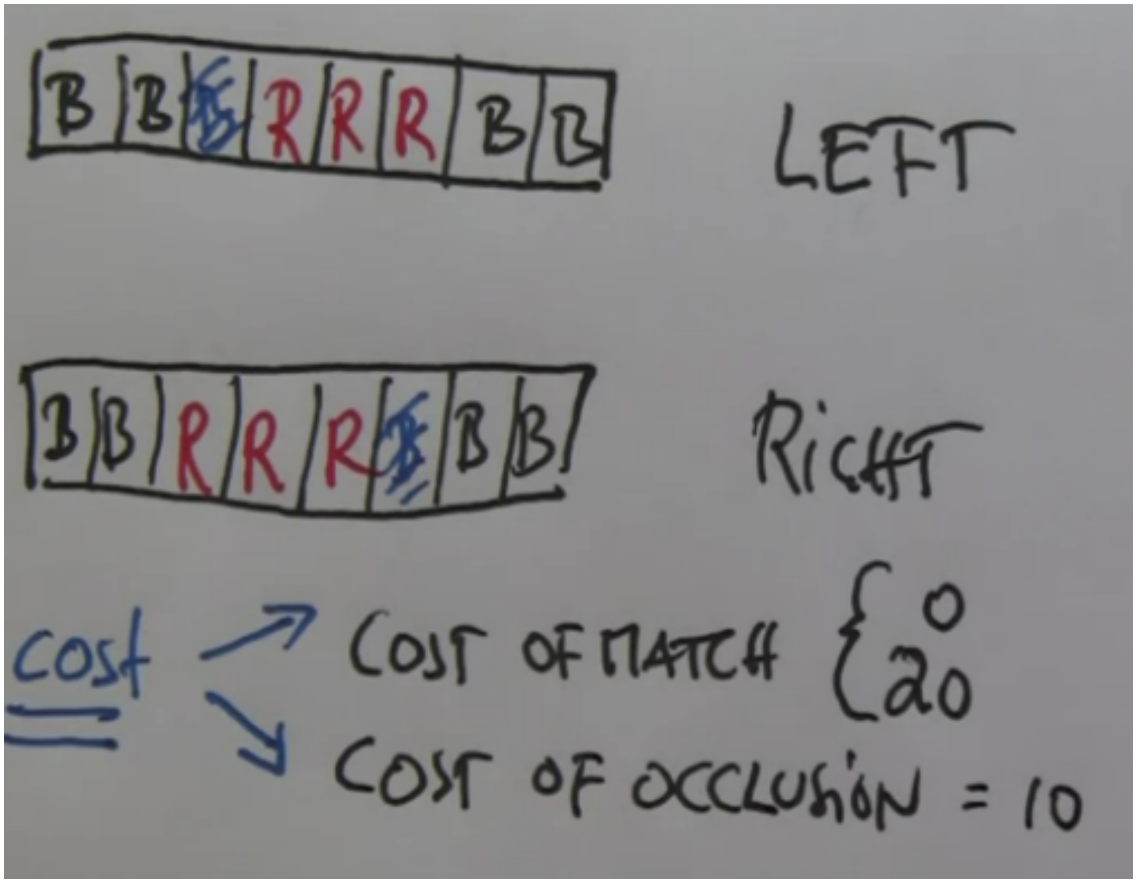


Using Cost to Optimize Correspondence



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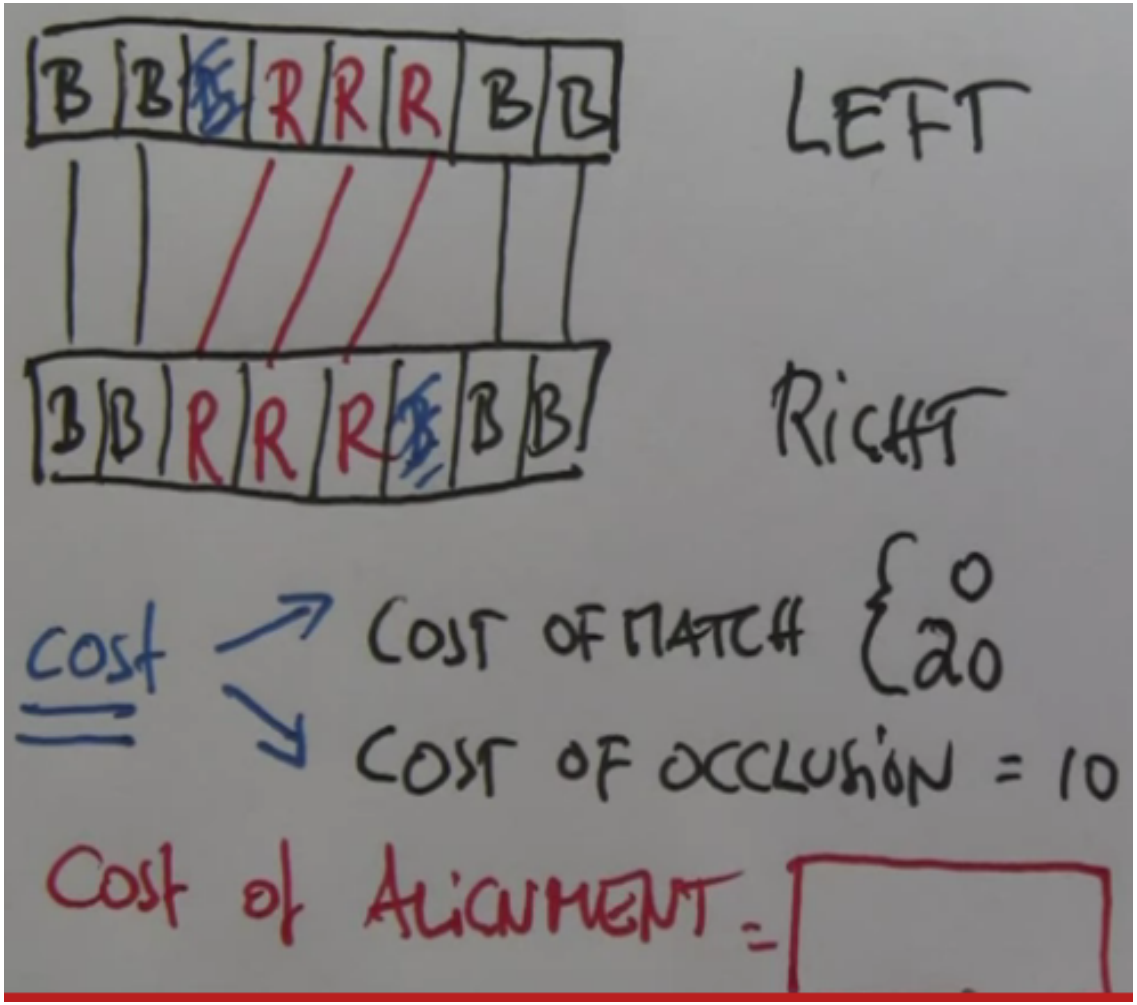

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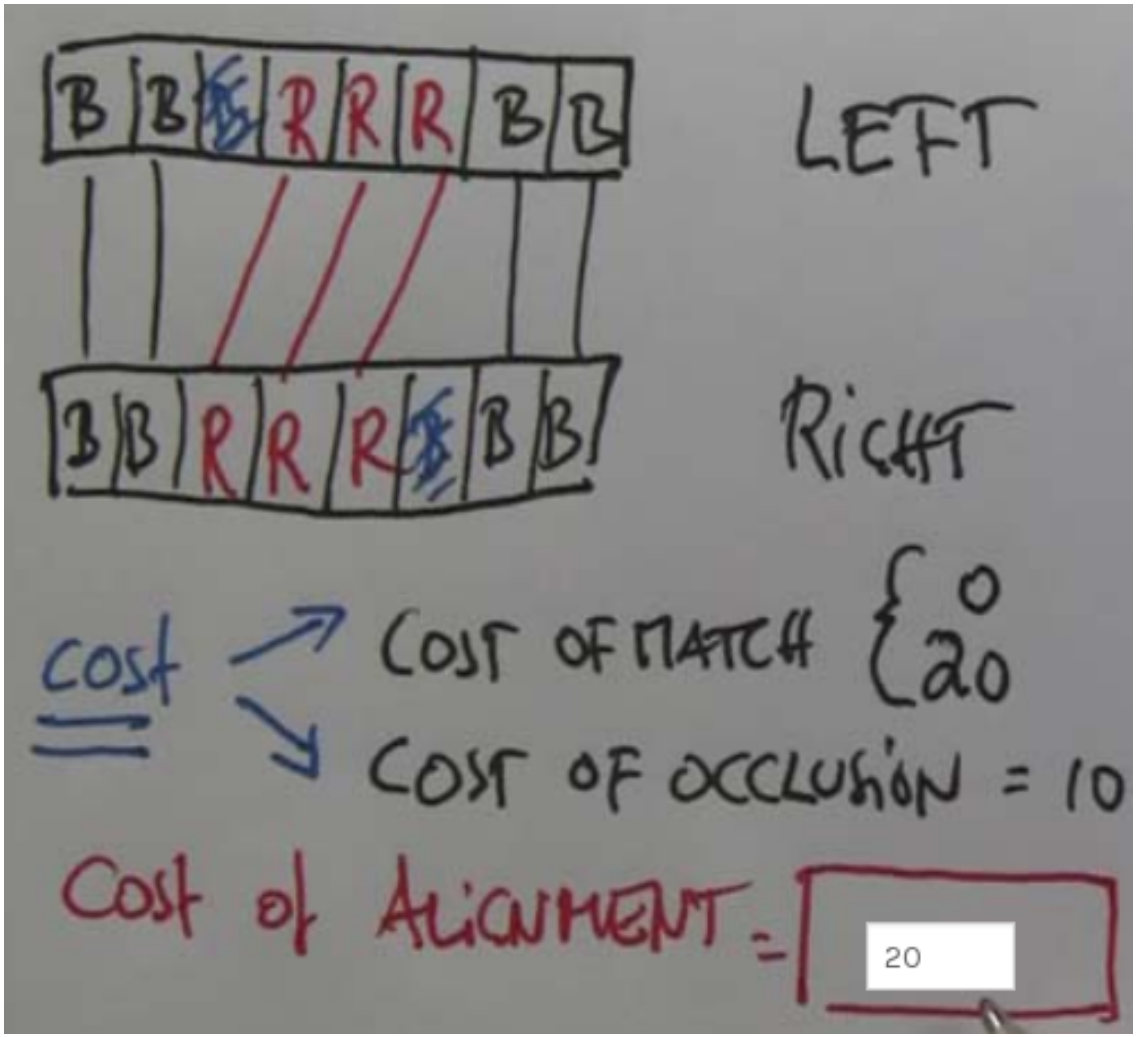

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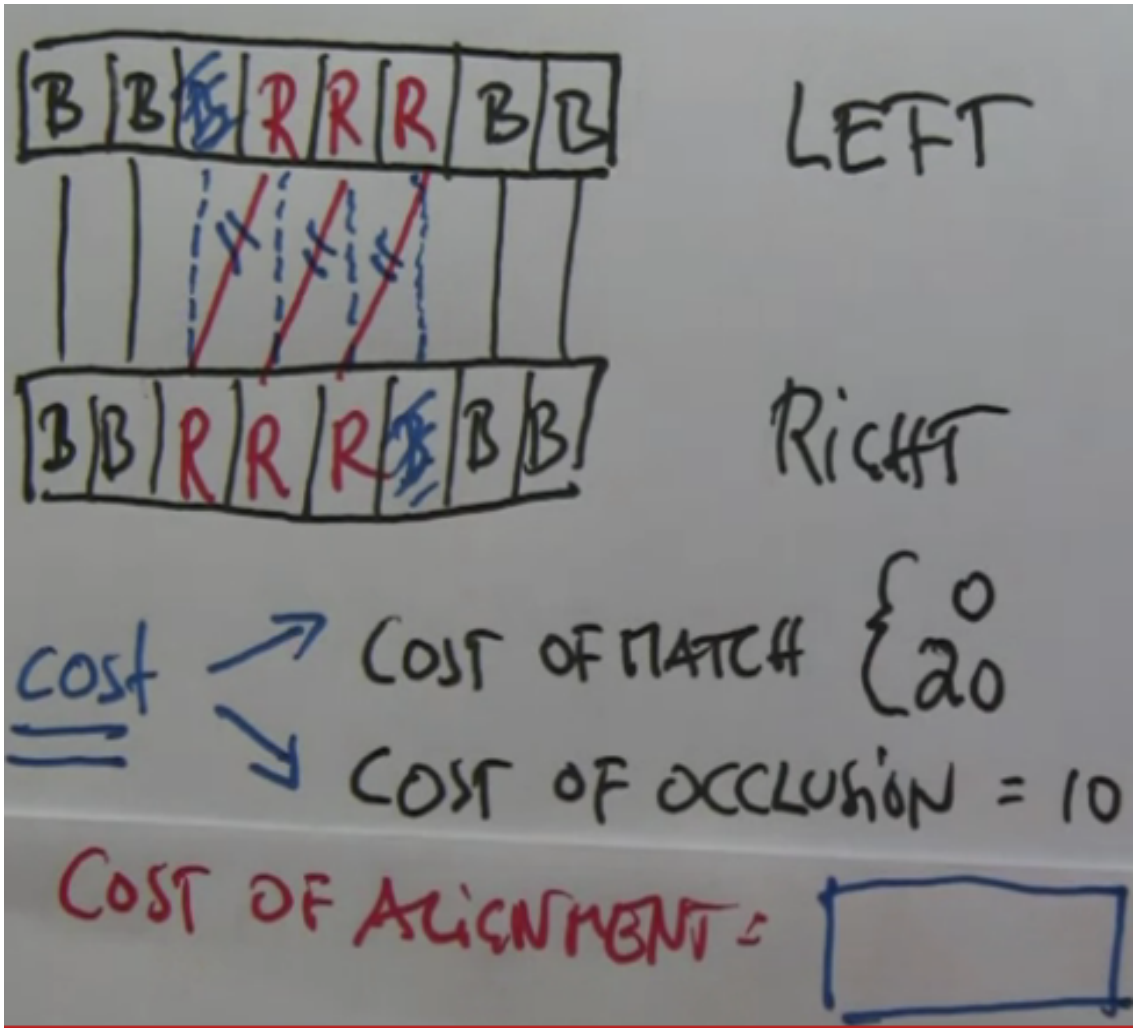

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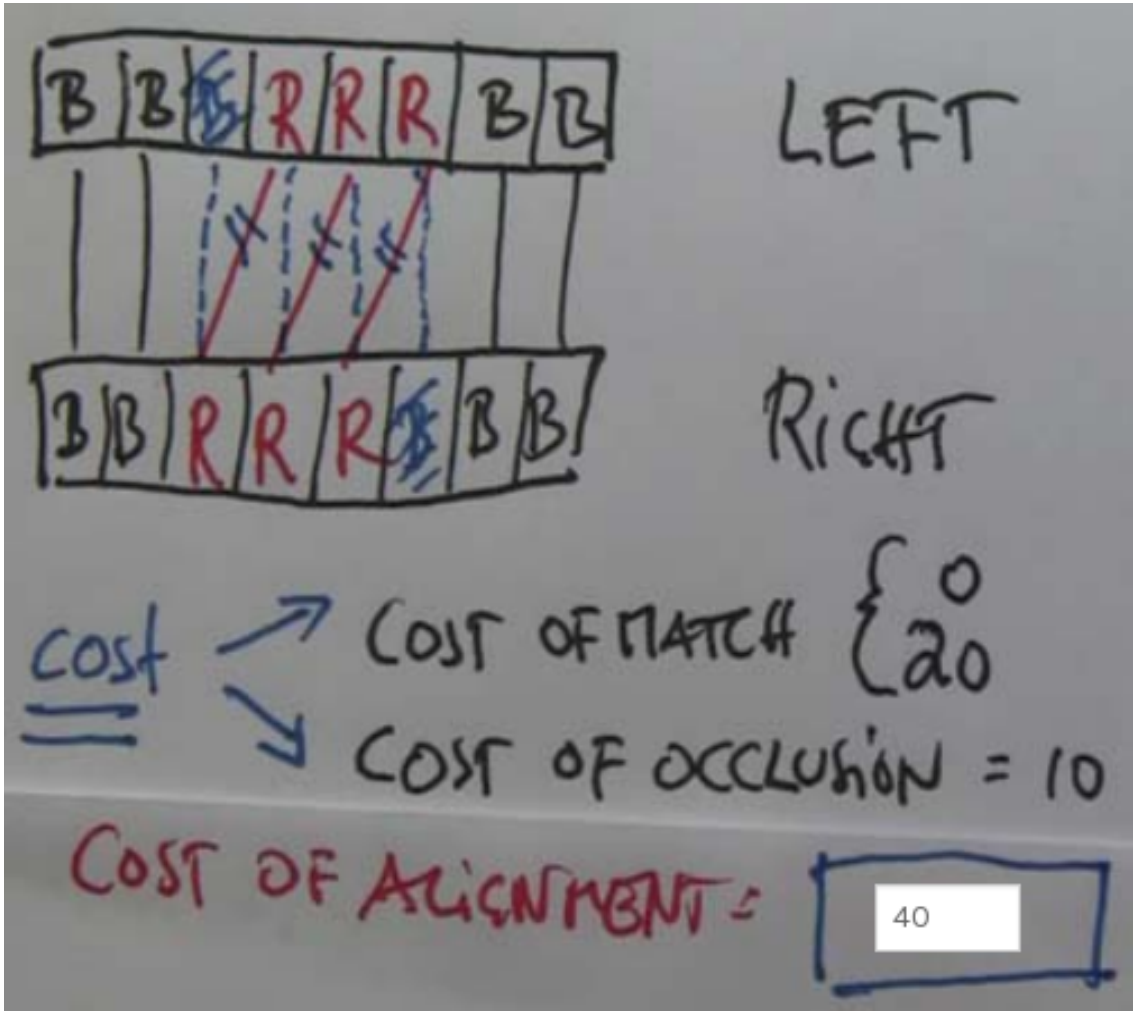
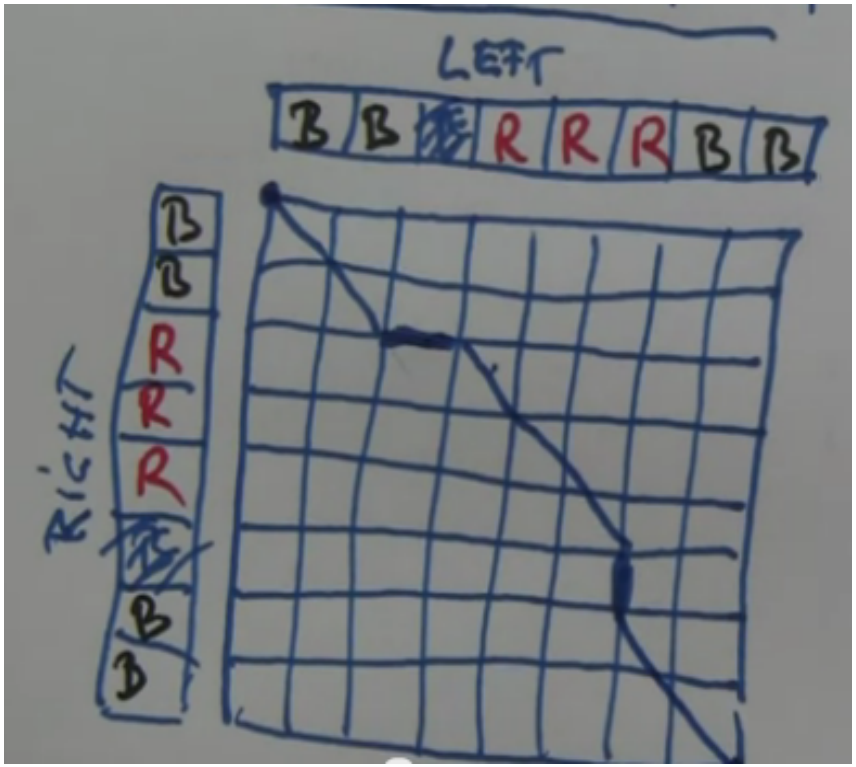


So How to Compute Best Alignment?

Use **dynamic programming**:

- calculate **correspondence matrix** with $O(n^2)$:



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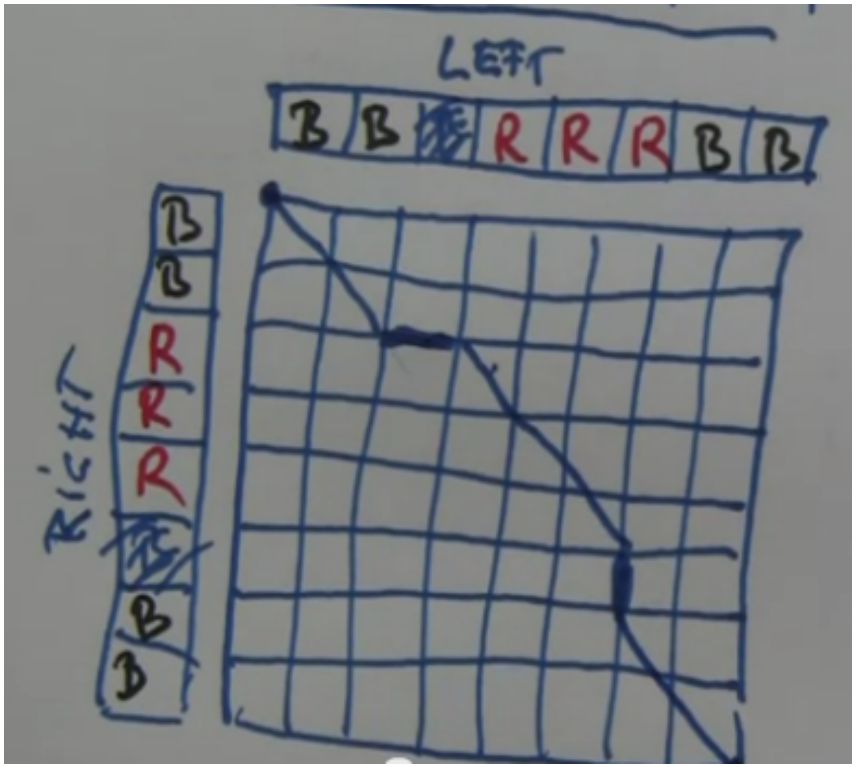

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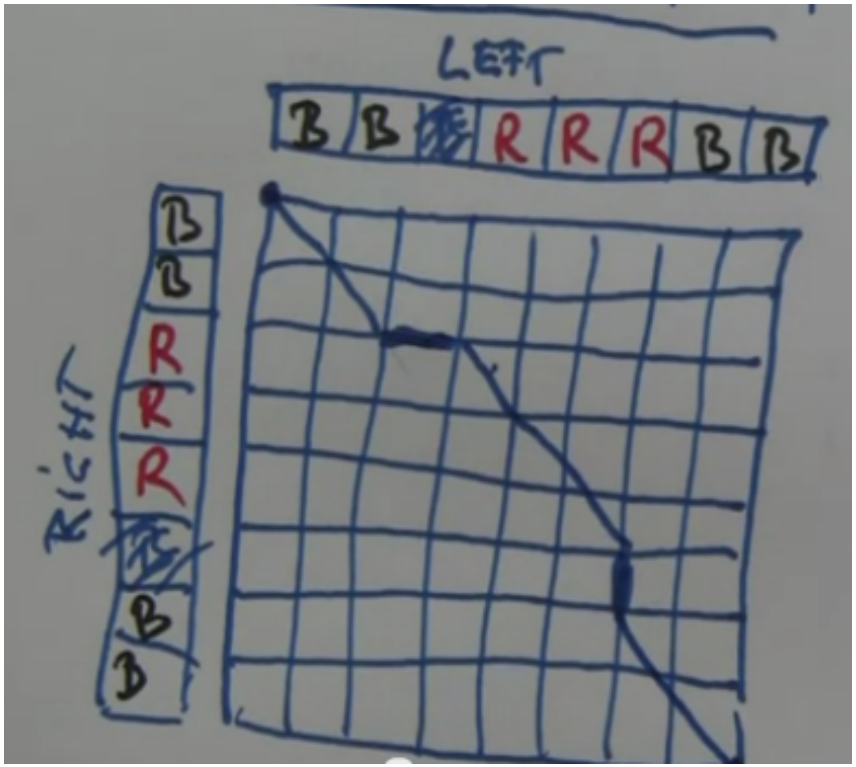

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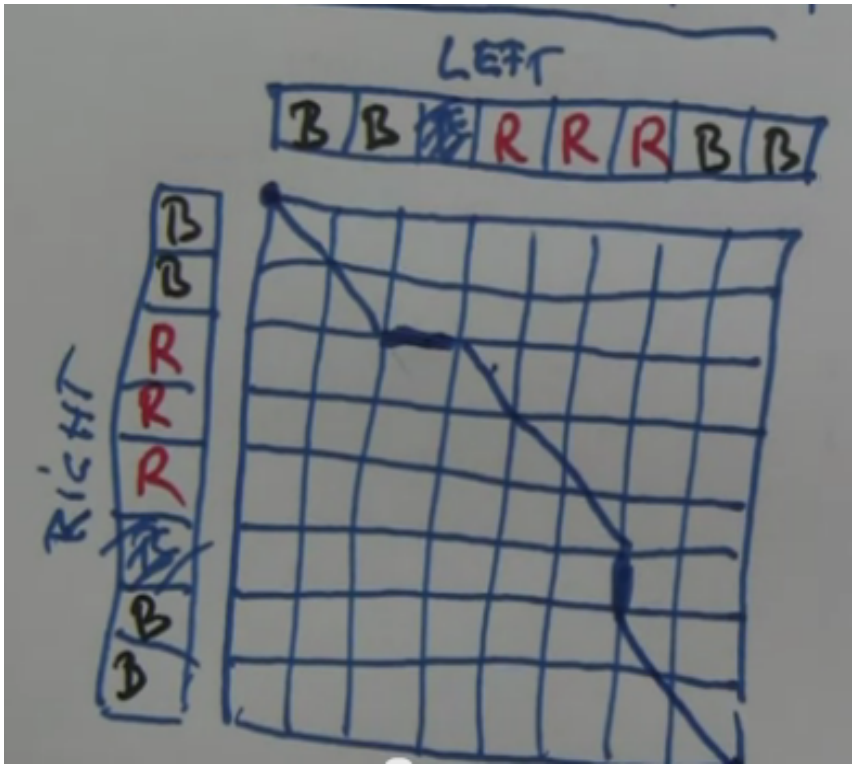

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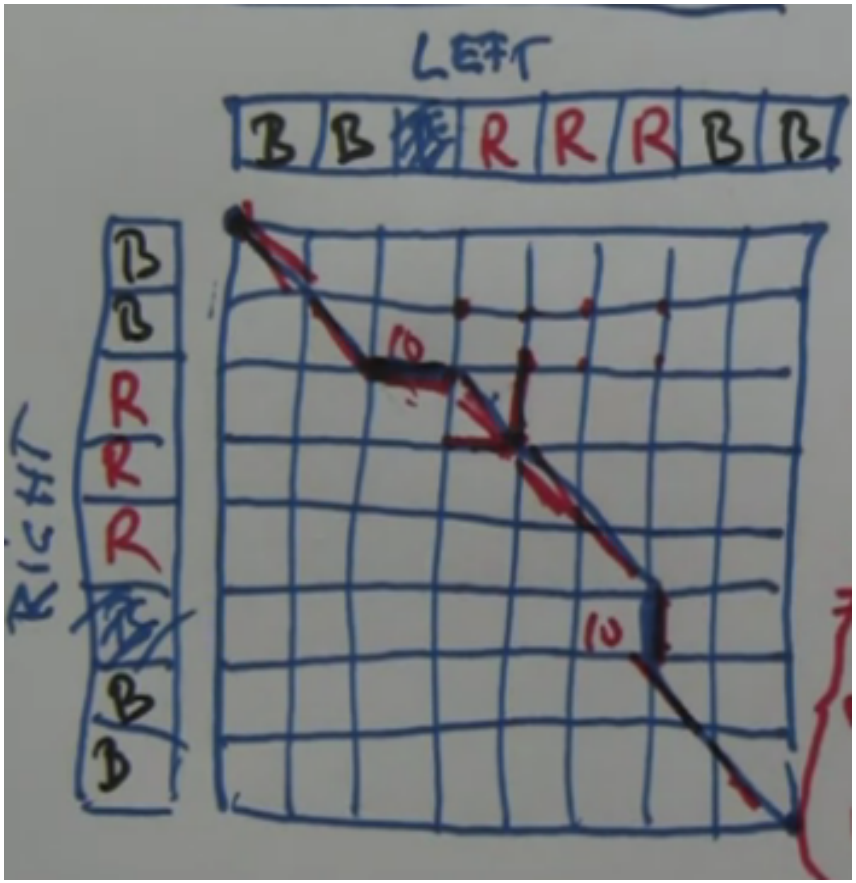

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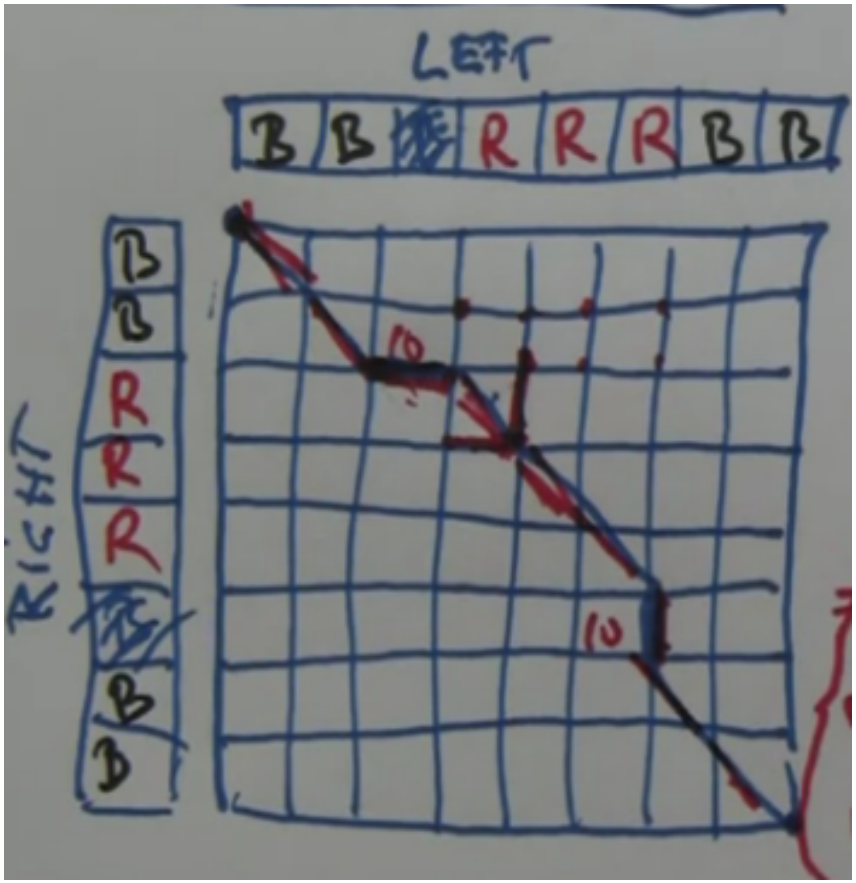

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State-of-the-art in computer vision!

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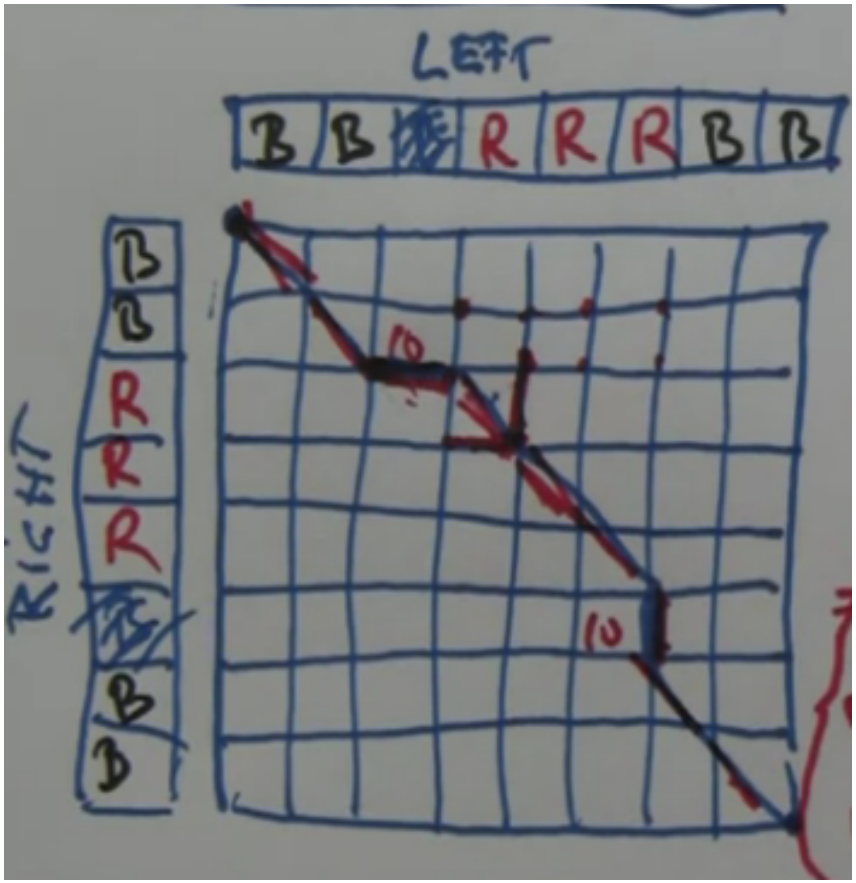

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State-of-the-art in computer vision!

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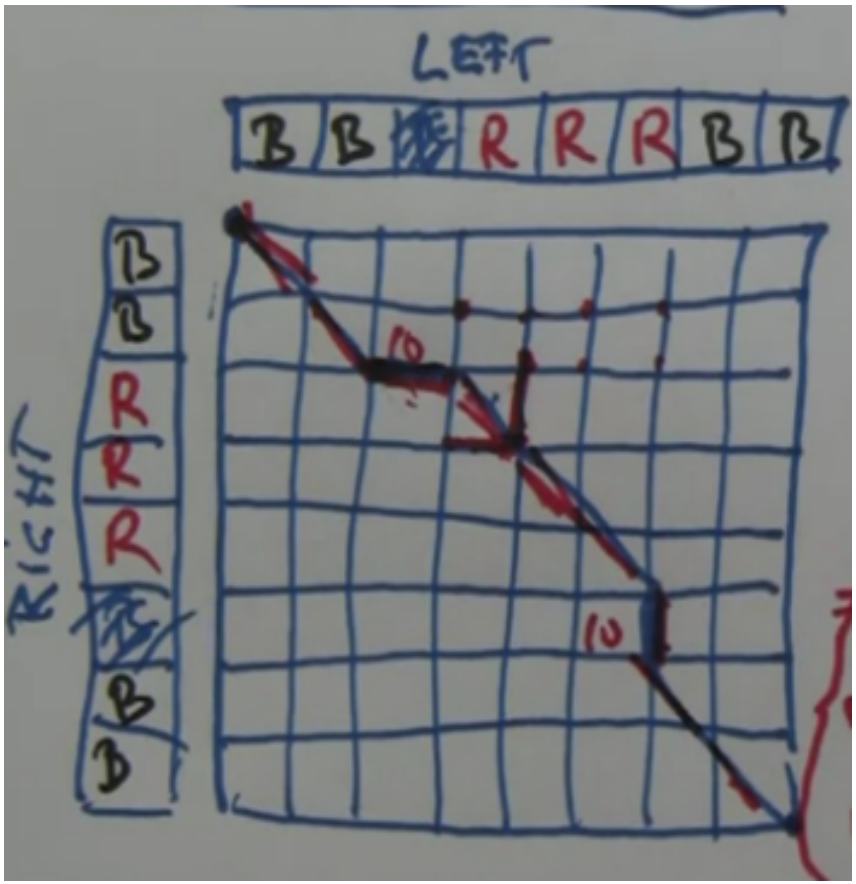

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State-of-the-art in computer vision!
How would the brain do it?

- In parallel, each node in matrix a separate neuron
- How fast?

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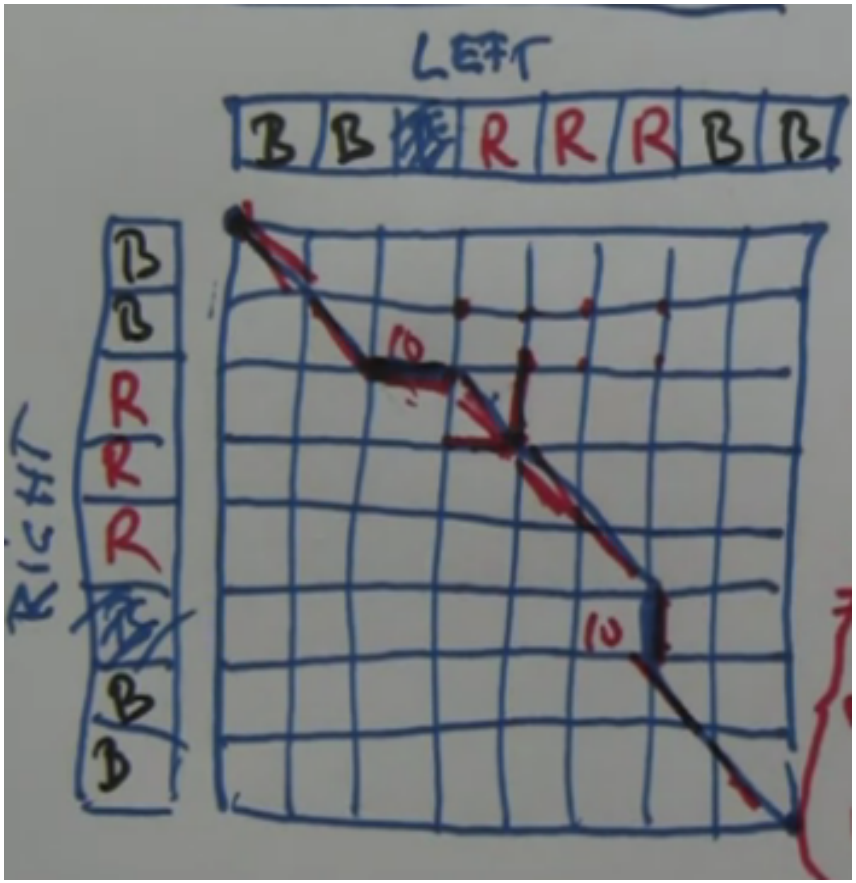
Use **dynamic programming**:

- calculate **correspondence matrix** with $O(n^2)$:



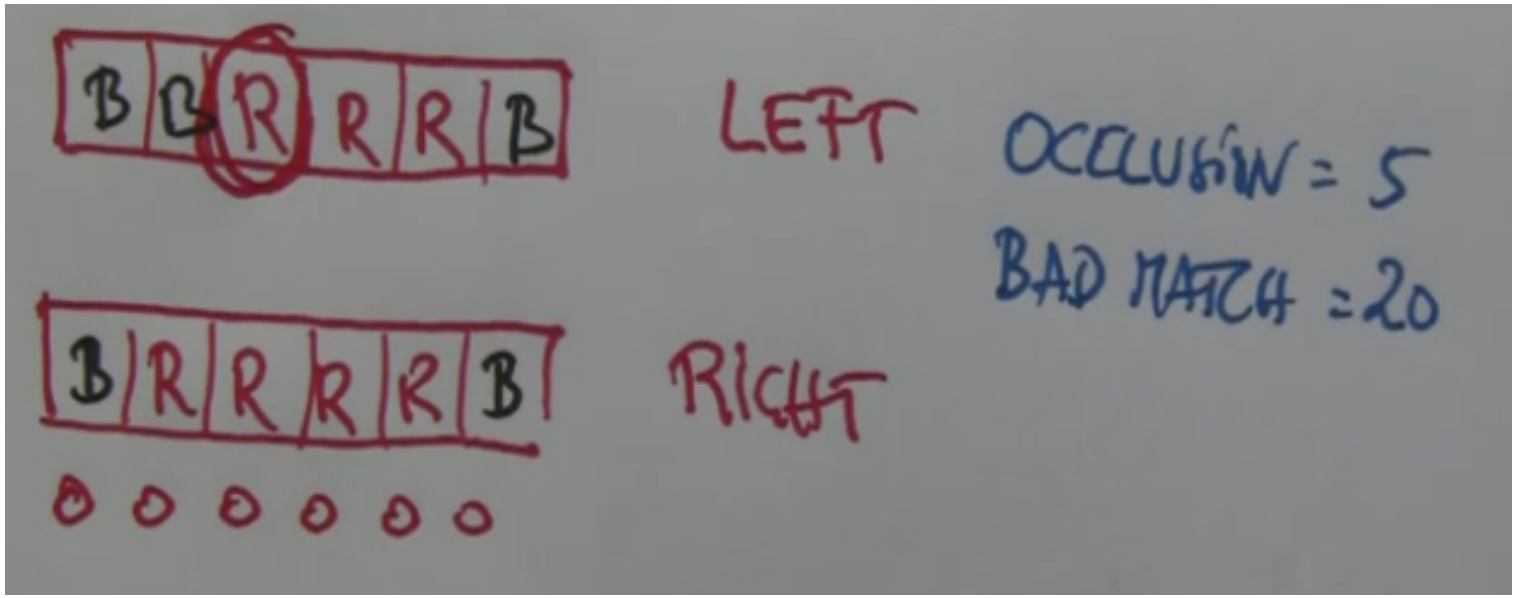
Does this look familiar?
Can we use MDP?

$$V(i,j) = \max \begin{cases} \text{match}(i,j) + V(i-1,j-1) \\ \text{occl}(i,j) + V(i-1,j) \\ \text{occl}(i,j) + V(i,j-1) \end{cases}$$

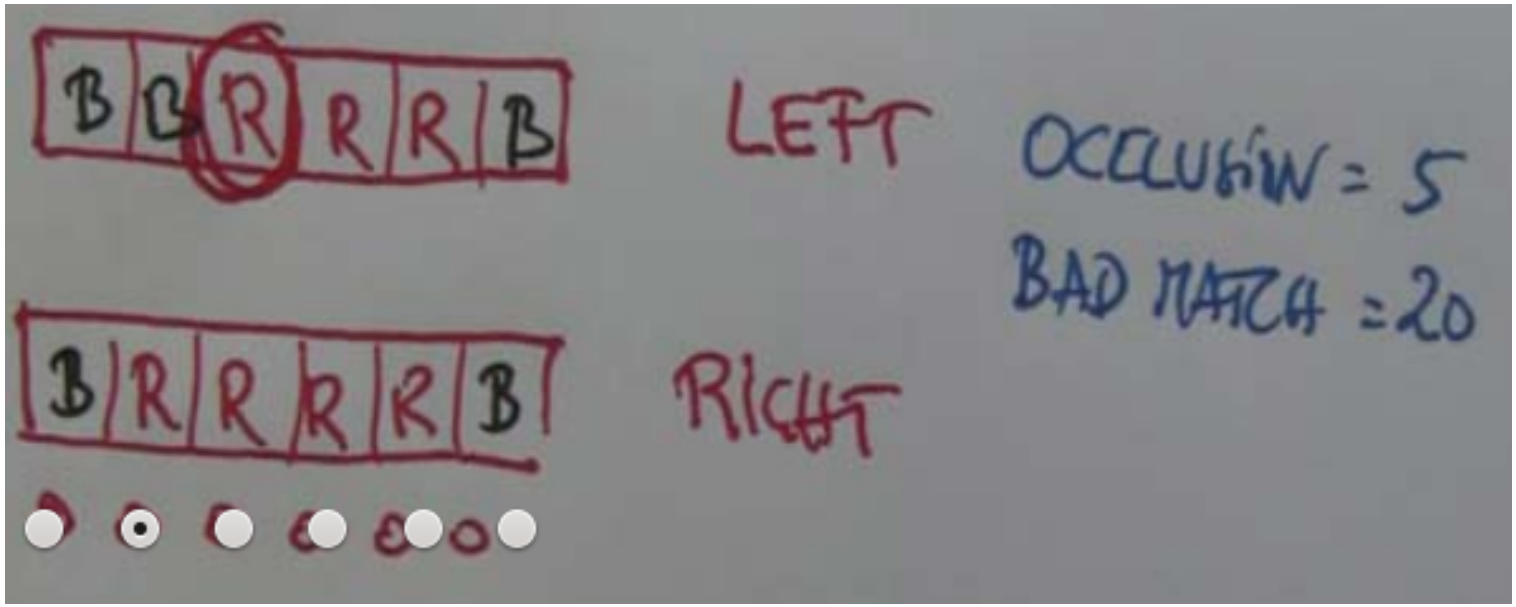
State-of-the-art in computer vision!
How would the brain do it?

- In parallel, each node in matrix a separate neuron
- How fast? $O(1)$

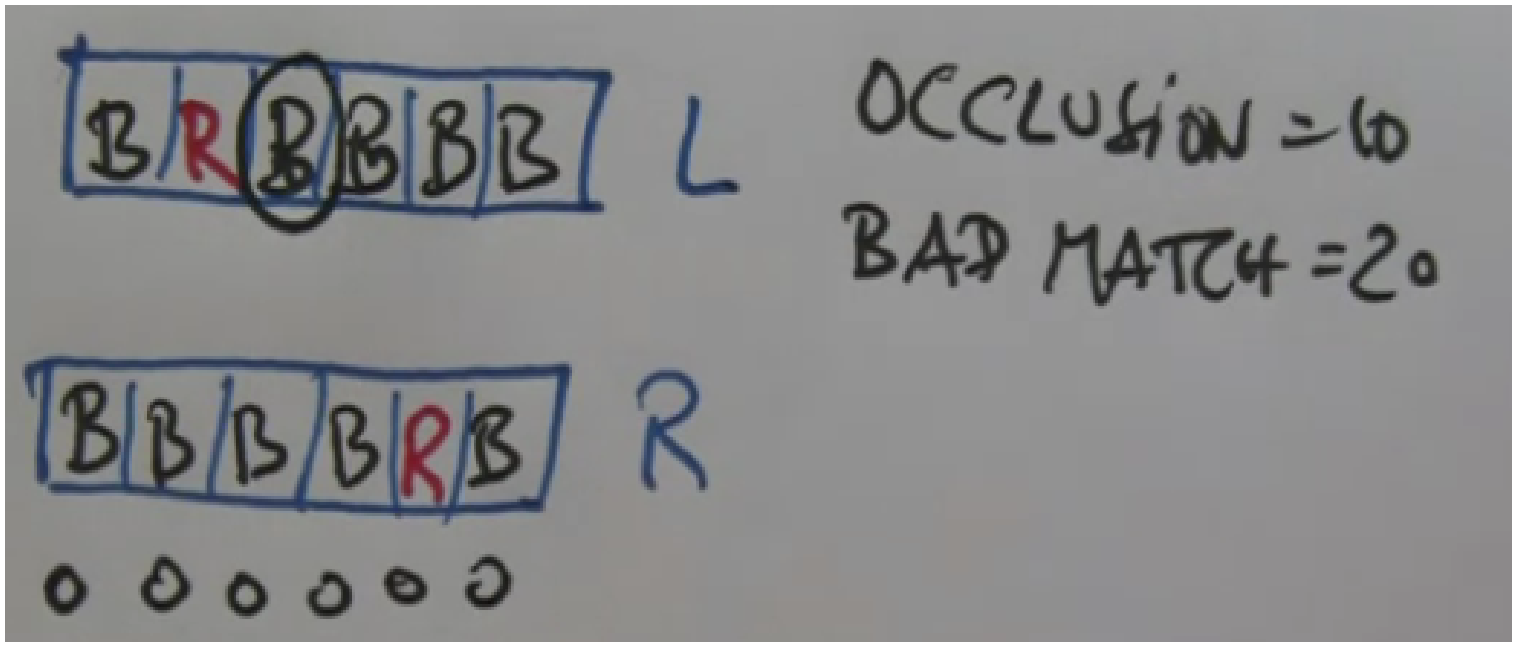
Alignment Questions



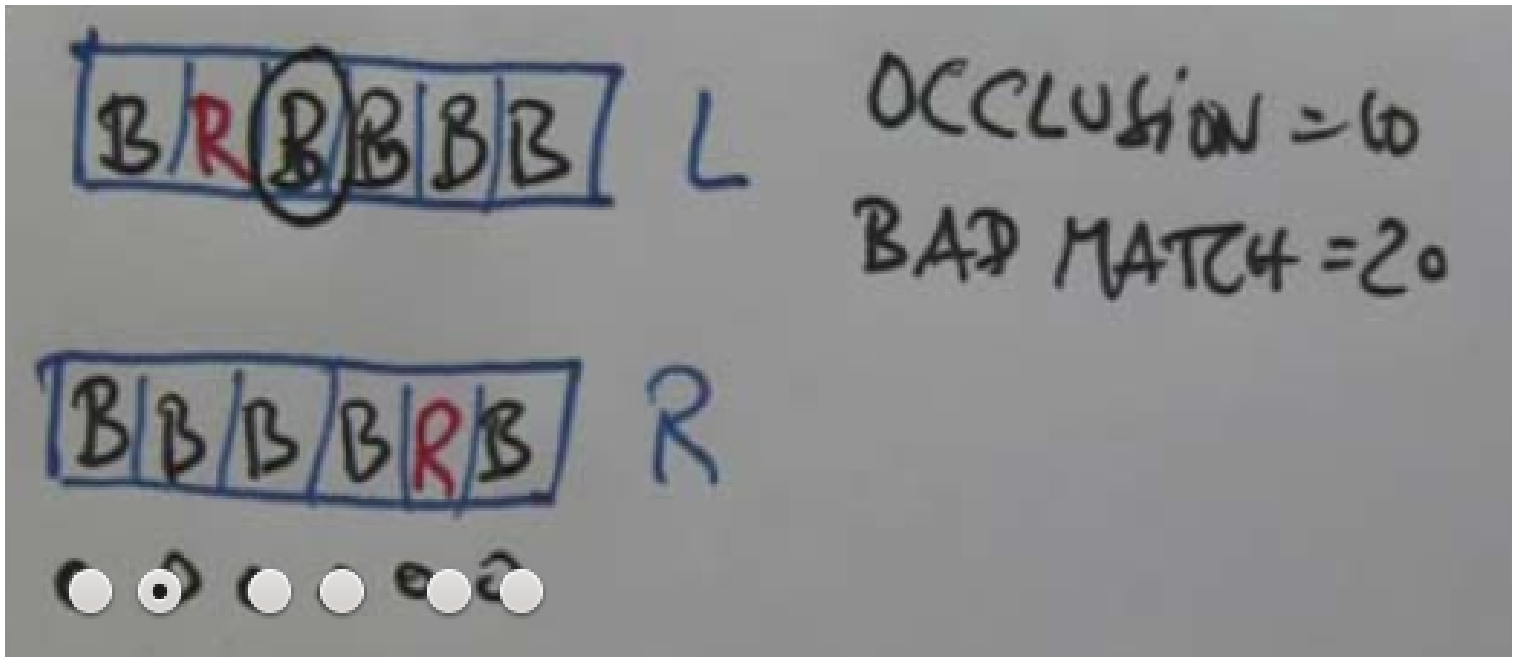
Alignment Questions



Alignment Questions

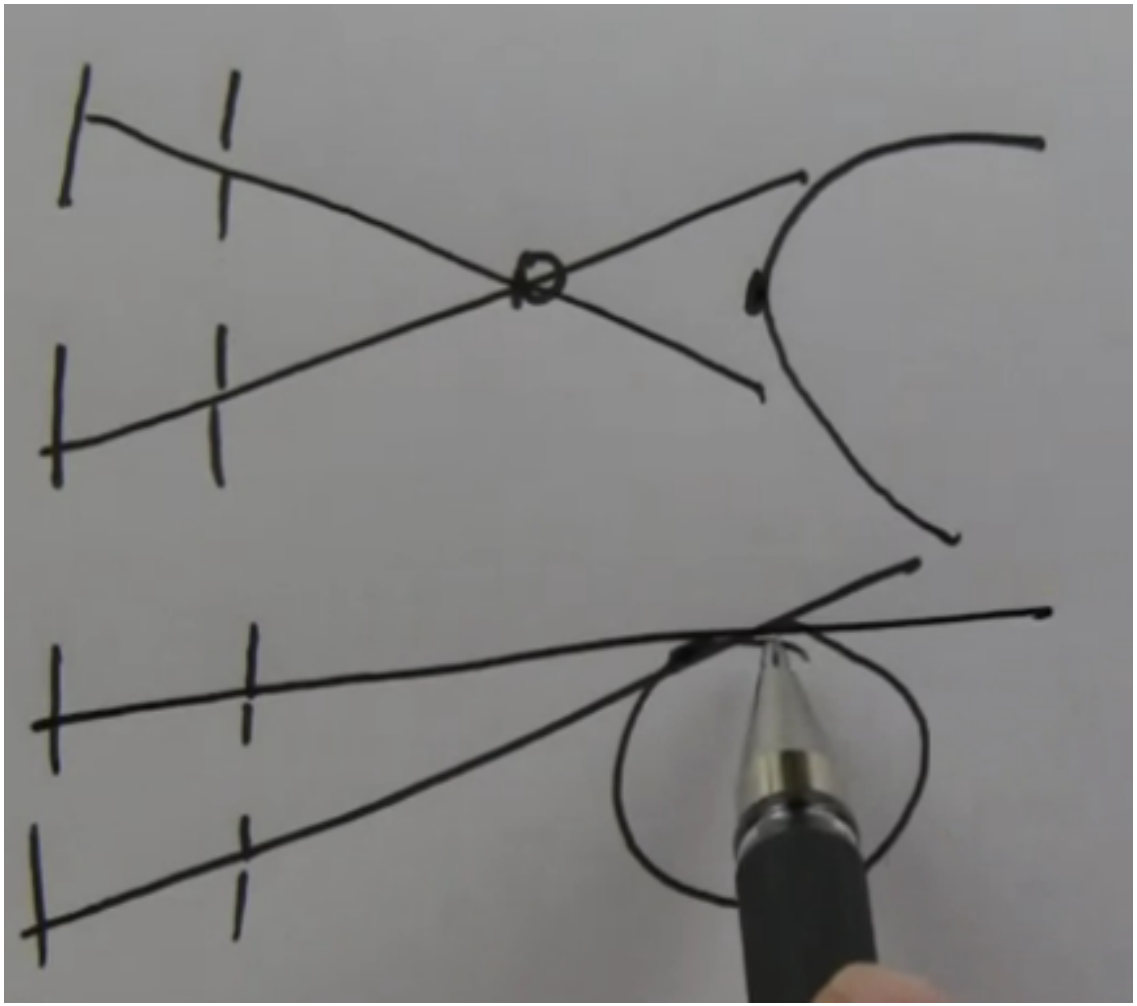


Alignment Questions



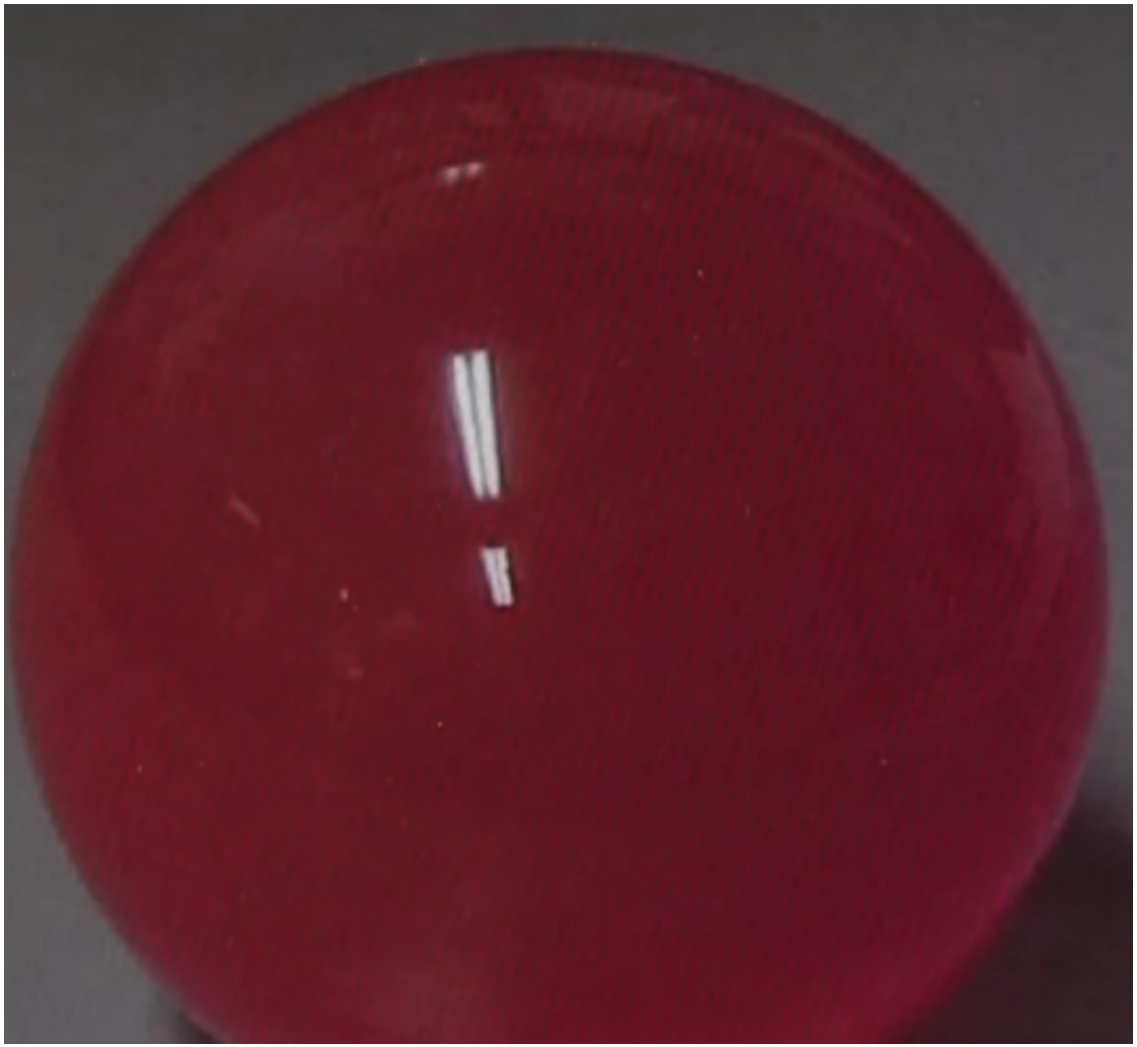
Problem Cases for Alignment

Problems with: Foreground-background separation and circular edges.

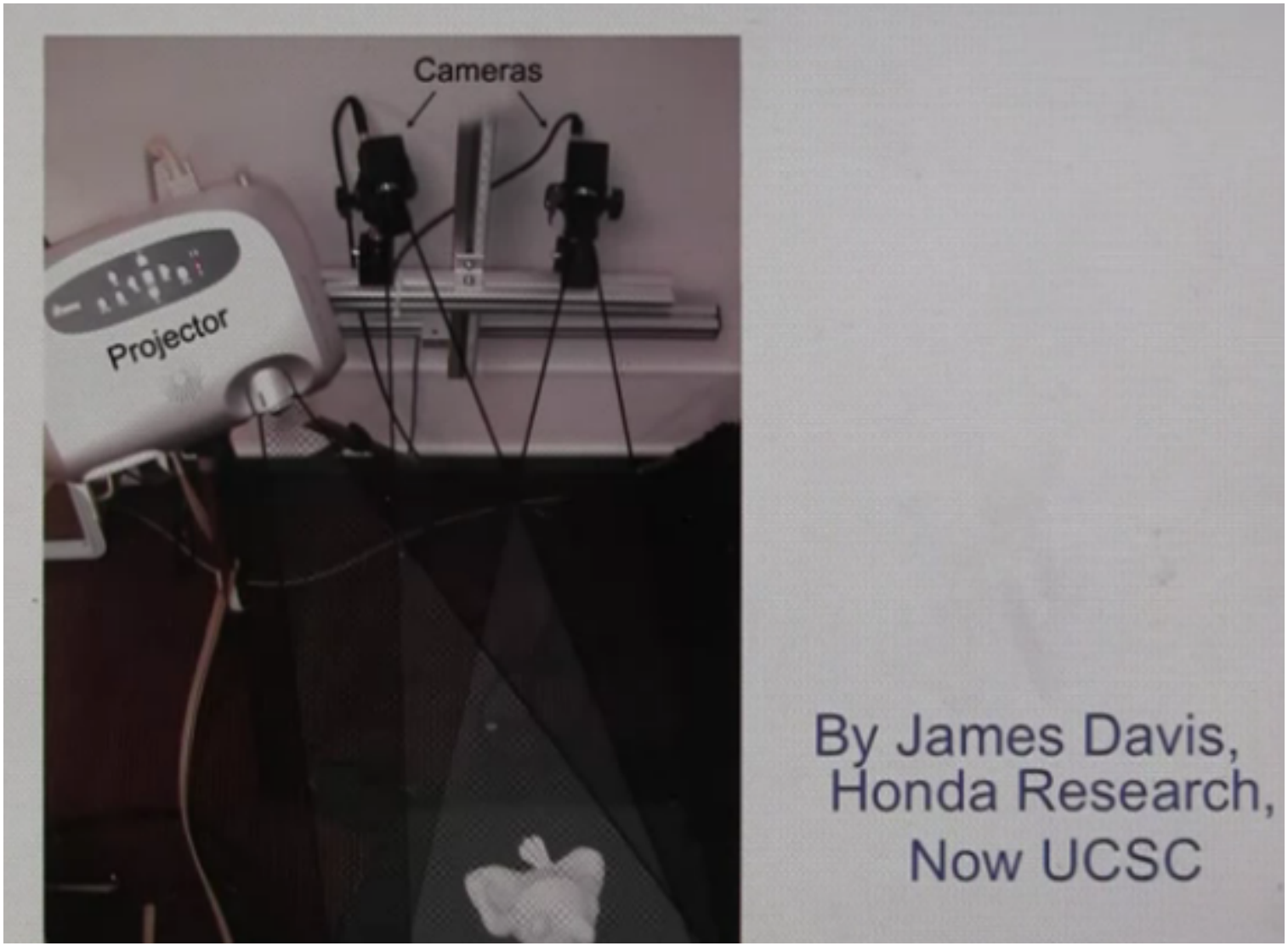


Problem Cases for Alignment

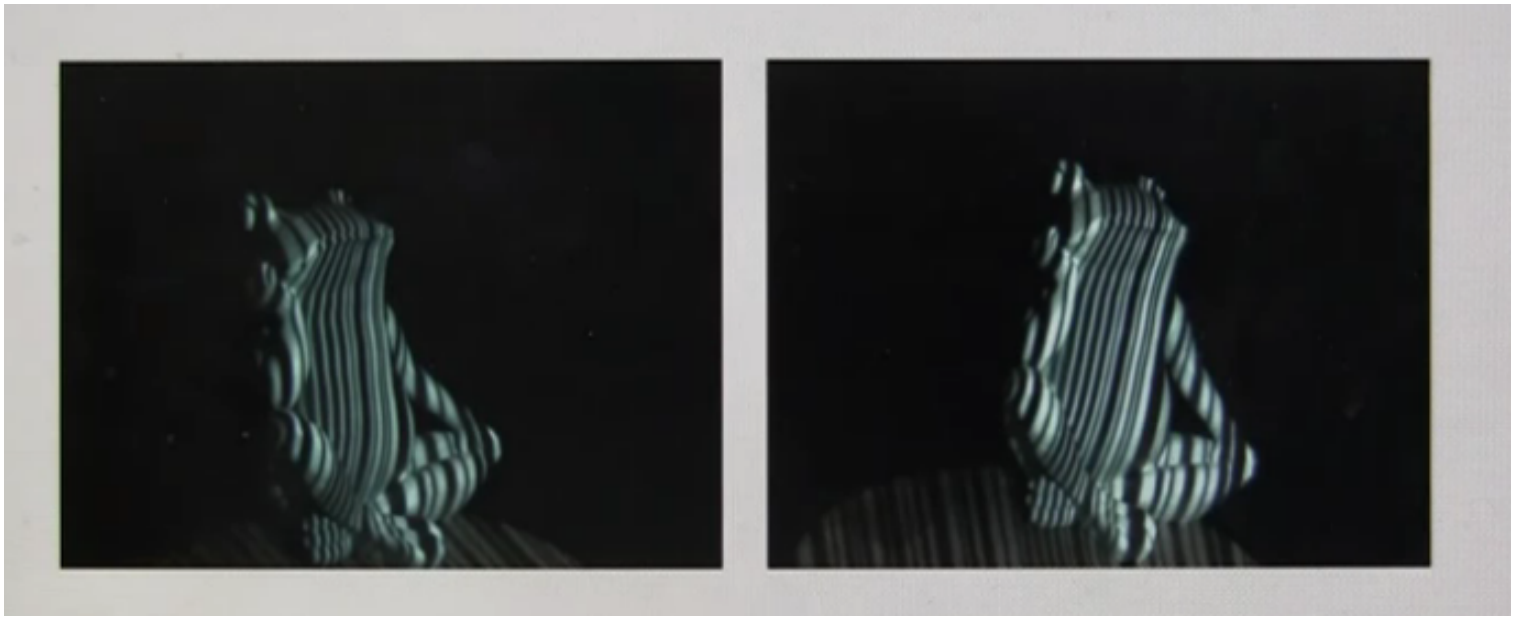
Problems with: Reflection.



New Technologies



New Technologies



New Technologies