RELATIVE DEPTH FROM MONOCULAR OPTICAL FLOW

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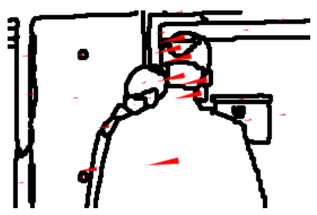
Summary

Our method computes a relative depth ordering from a segmented video and its optical flow.

input sequence



flow models

relative depth map

Context

There are many cues for depth perception:

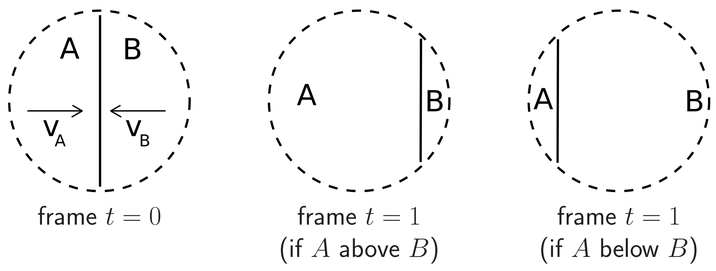
Single-image: Perspective, Texture gradients, Distance fog, Focus, T-junctions, Shading, Size

Multiple image: Parallax, Depth from motion, Depth from occlusion

What kind of depth information can be recovered from occlusions alone?

Our proposal: depth from occlusion

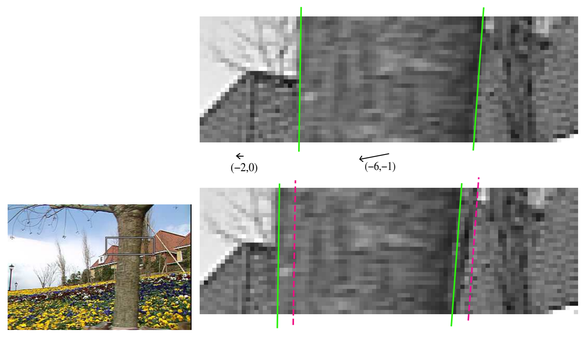
The boundary between two moving objects follows the object which is closest to the camera.



frame $t = 0$

frame $t = 1$ (if A above B)

frame $t = 1$ (if A below B)

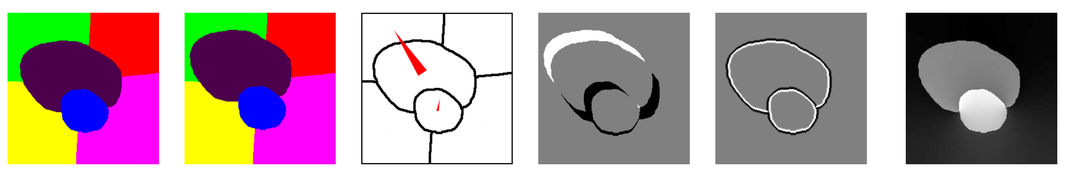


example

counterexample

Implementation

Each occluded or disoccluded pixel votes for a candidate ordering.

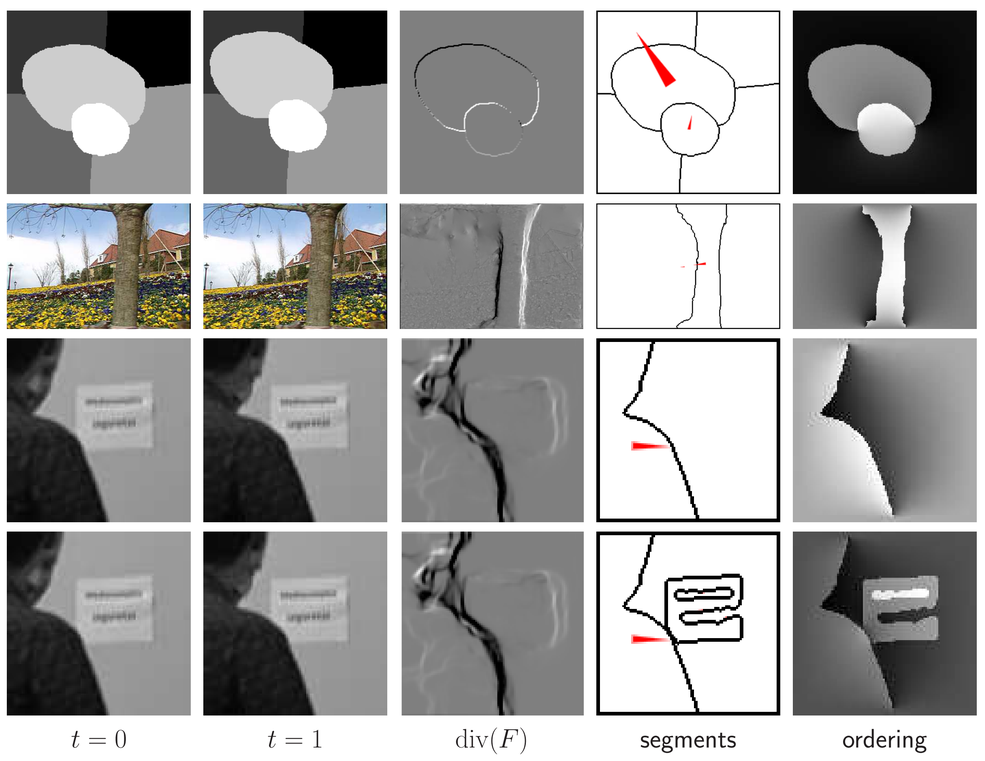


$t = 0$ $t = 1$ flow models occluded pixels output output (propagated)

Input: a spatio-temporal segmentation of a video and a dense optical flow F.
Output: a relative ordering of pairs of neighboring regions of the segmentation.
Algorithm:

1. **for** each region A_t on frame t **do**
2. $M_{A_t,A_{t+1}} :=$`movement_model`(A_t, F)
3. **for** each pixel p on frame t **do**
4. $A_t :=$ `region_of_pixel`(p)
5. $q := M_{A_t,A_{t+1}}(p)$
6. $B_{t+1} :=$ `region_of_pixel`(q)
7. **if** $B \neq A$ **then**
8. vote $+1$ that B_t is above A_t

Experiments



$t = 0$ $t = 1$ $\mathrm{div}(F)$ segments ordering

Practical application

Video inpainting aided by depth information

inpainting mask without depth information using depth information

Prerequisite: Spatio-temporal segmentations

We compute an over-segmentation of the whole video, based on Mumford-Shah functional.

input video
$2s \approx 6.7 \cdot 10^6$ voxels

spatio-temporal segmentation
617 tubes

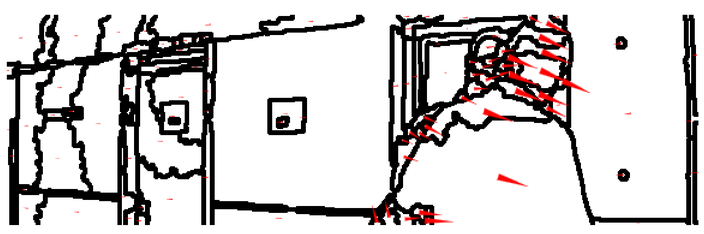
each tube is a tracked object

Prerequisite: Discontinuous optical flow

We force the flow to be discontinuous near the occlusions.

Smooth flow given by Horn & Schunck

Discontinuous flow by averaging on each region



Flow models