

Coarse-to-Fine Flow Estimation

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Columbia University

Topic: Motion and Optical Flow, Module: Reconstruction II

First Principles of Computer Vision

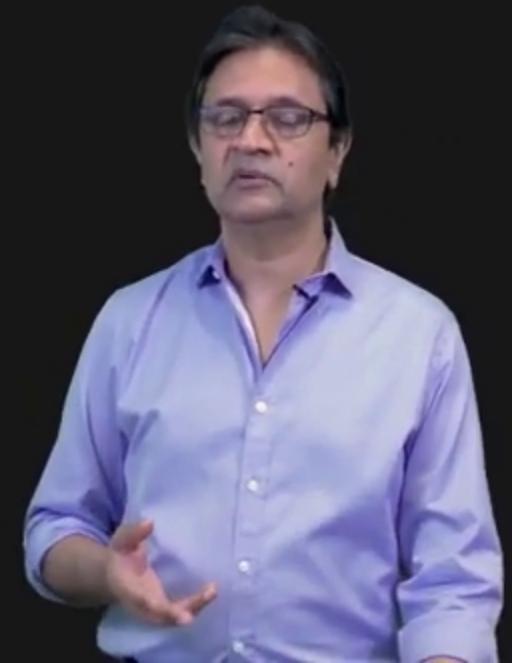
What if we have Large Motion?



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Taylor Series approximation of
 $I(x + \delta x, y + \delta y, t + \delta t)$ is not valid



Our simple linear
constraint equation not valid

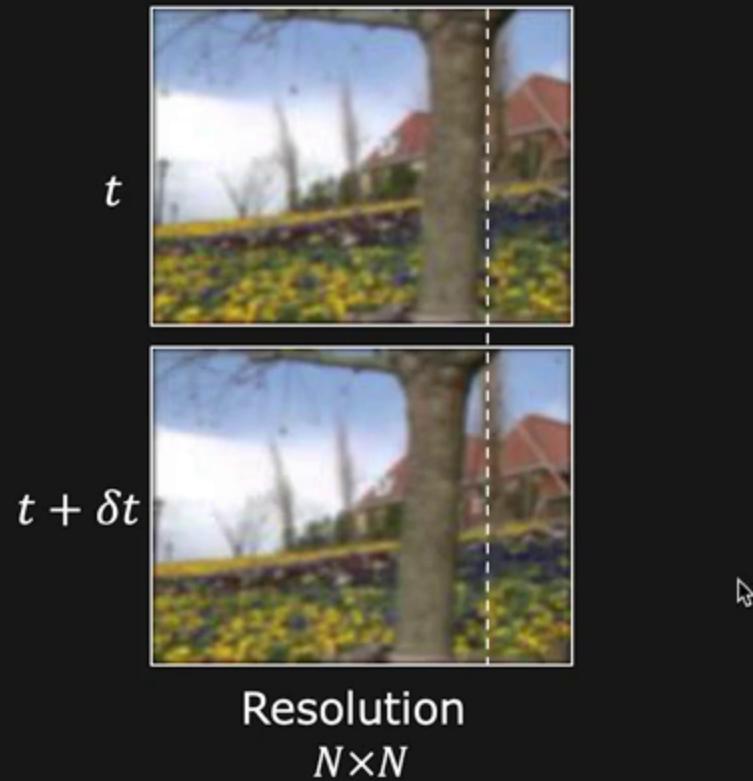
$$I_x u + I_y v + I_t \neq 0$$



Large Motion: Coarse-to-Fine Estimation



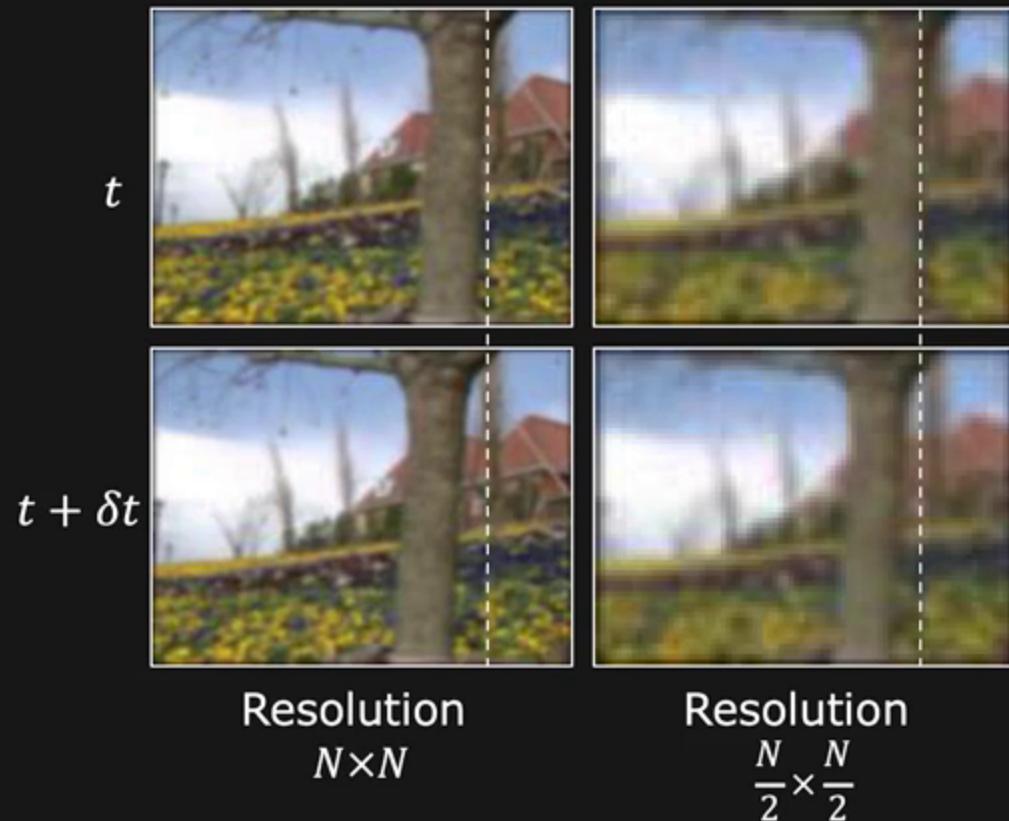
Large Motion: Coarse-to-Fine Estimation



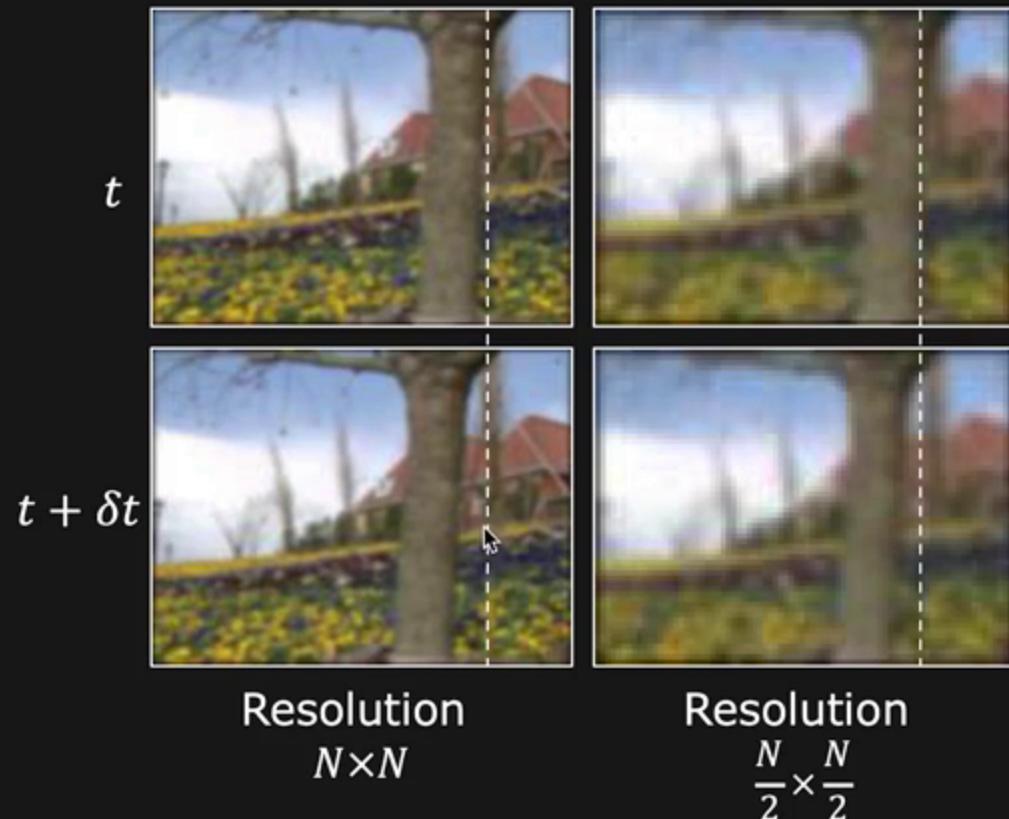
Resolution
 $N \times N$



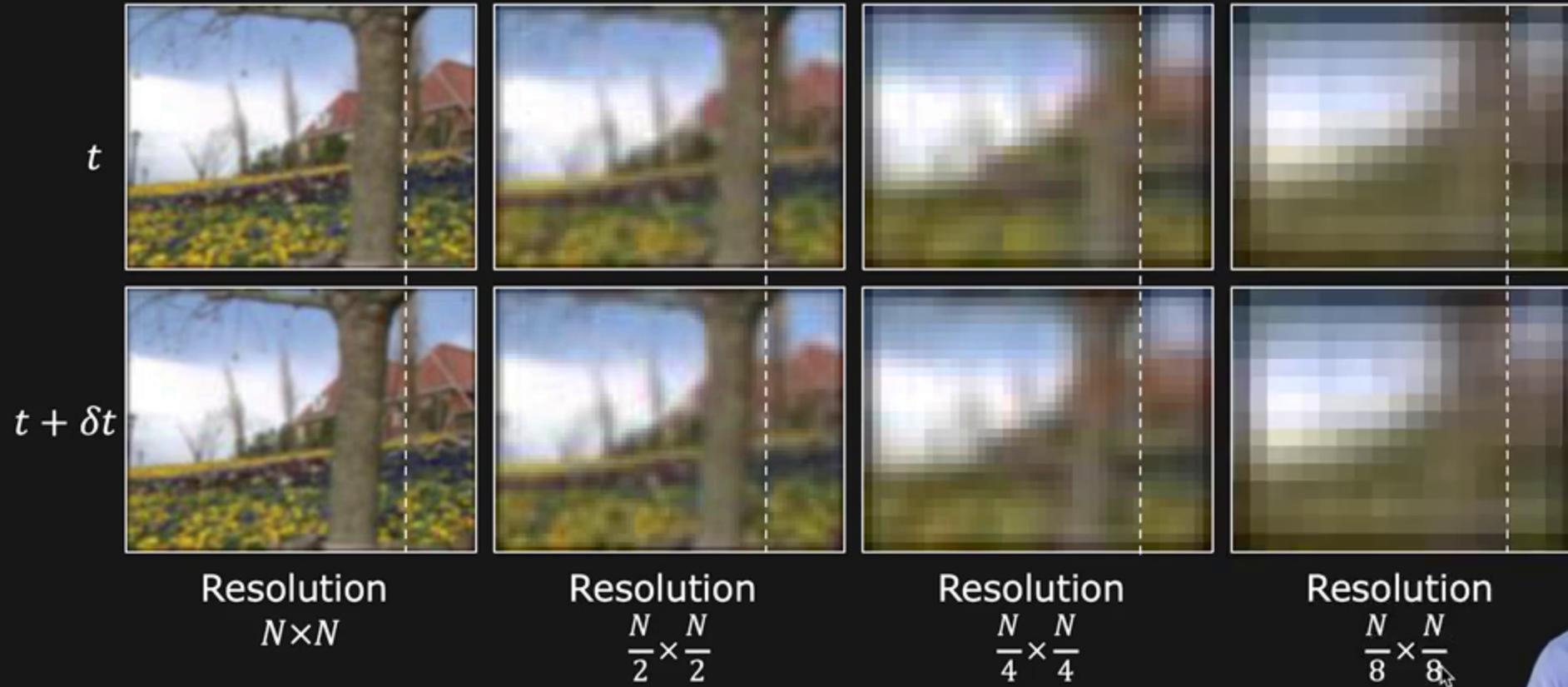
Large Motion: Coarse-to-Fine Estimation



Large Motion: Coarse-to-Fine Estimation



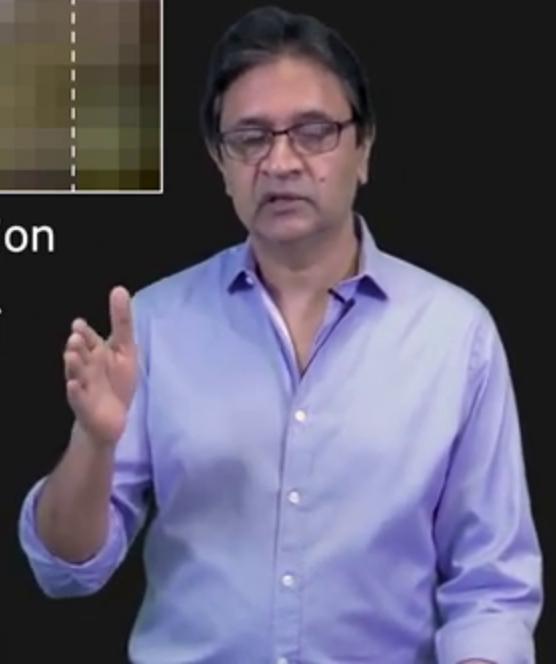
Large Motion: Coarse-to-Fine Estimation



Large Motion: Coarse-to-Fine Estimation



At lowest resolution, motion ≤ 1 pixel



Large Motion: Coarse-to-Fine Estimation



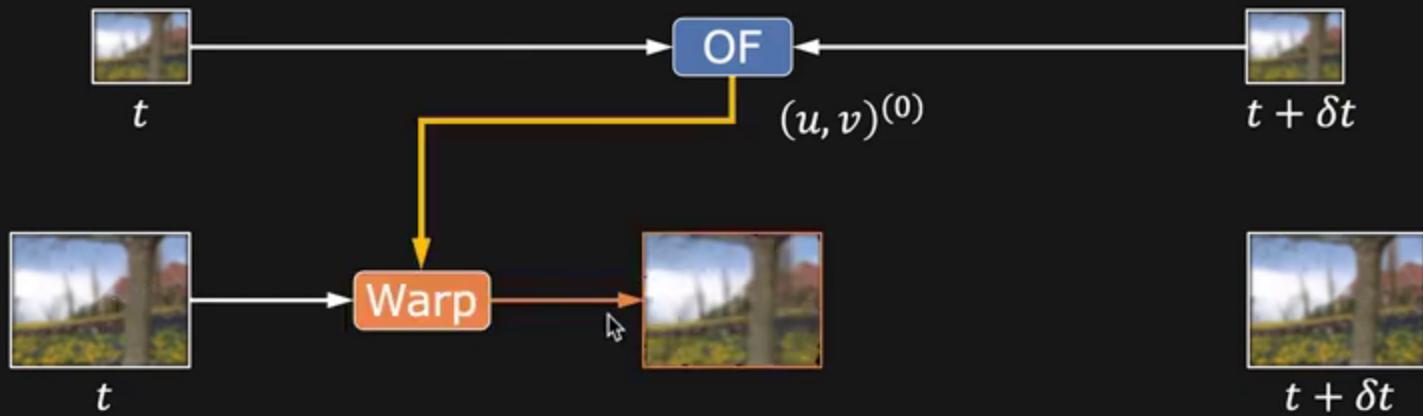
At lowest resolution, motion ≤ 1 pixel



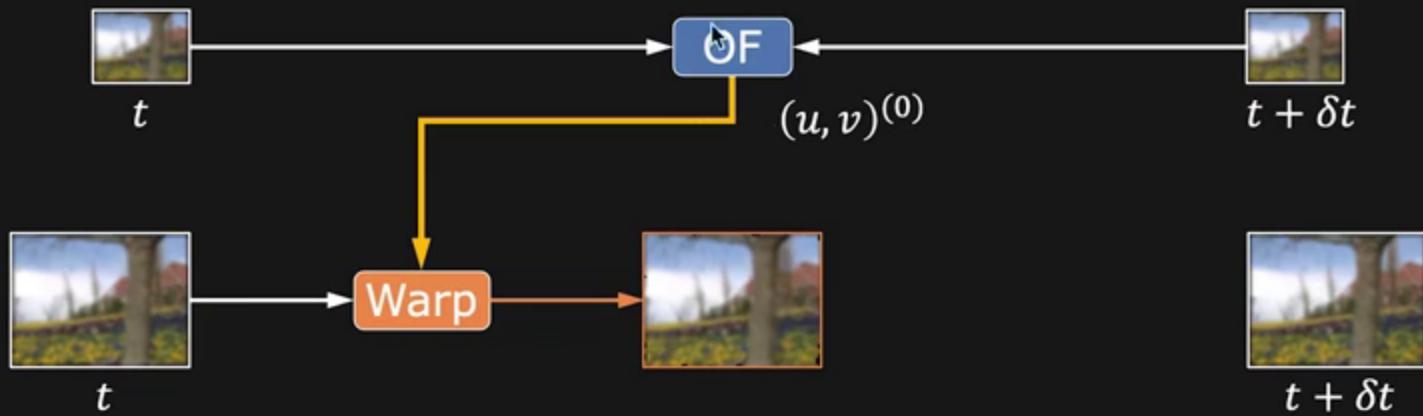
Coarse-to-Fine Estimation Algorithm



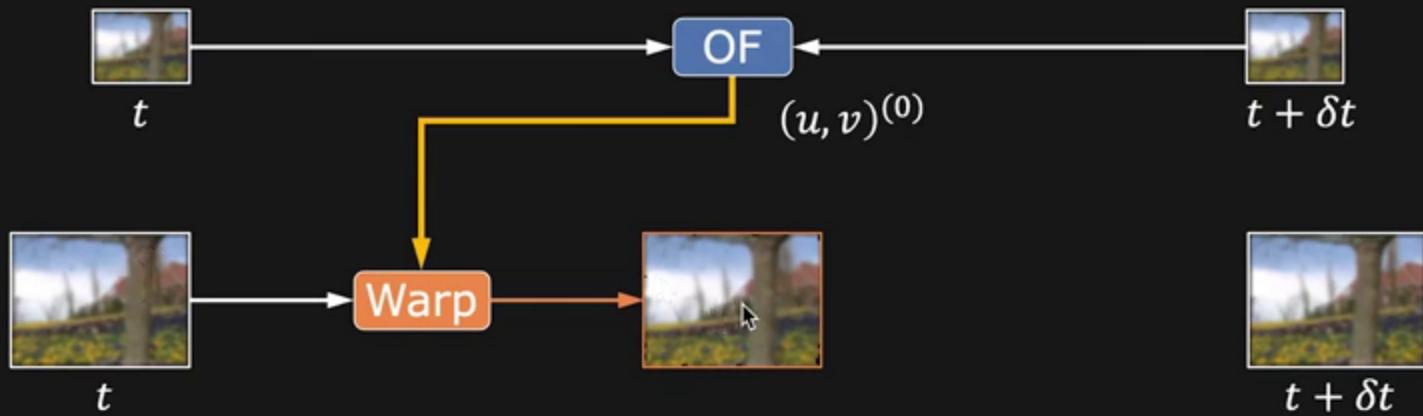
Coarse-to-Fine Estimation Algorithm



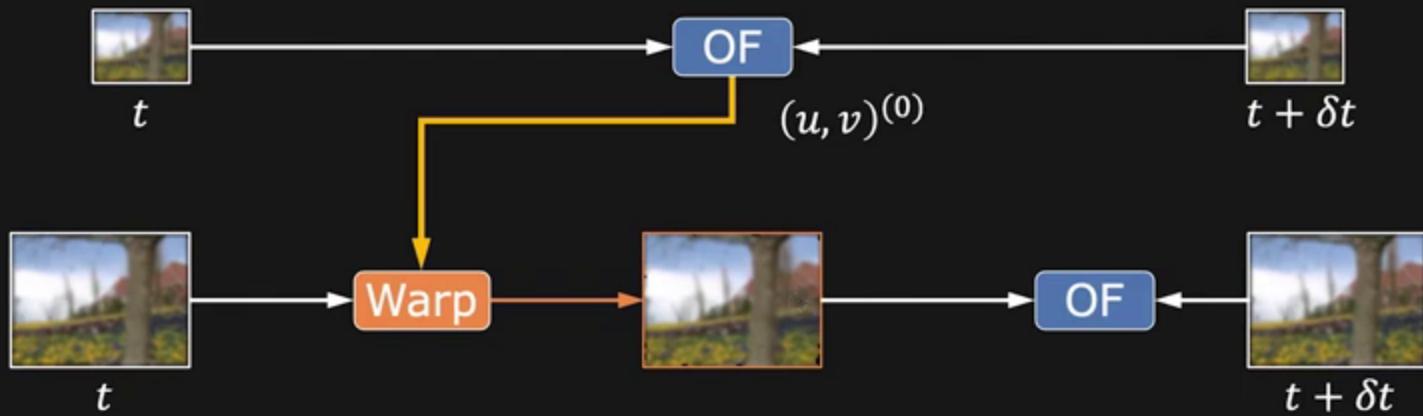
Coarse-to-Fine Estimation Algorithm



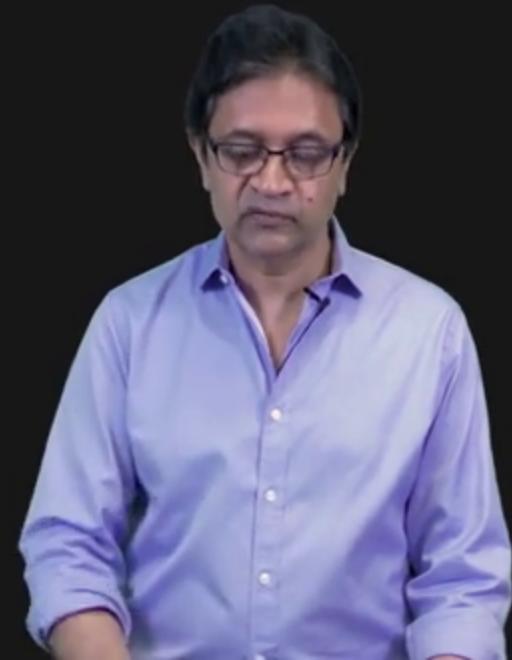
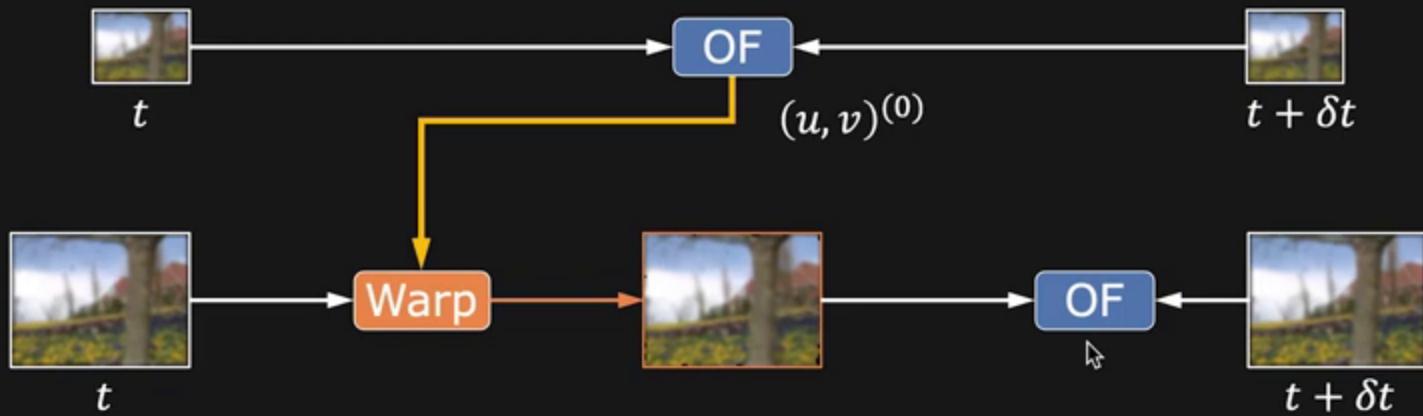
Coarse-to-Fine Estimation Algorithm



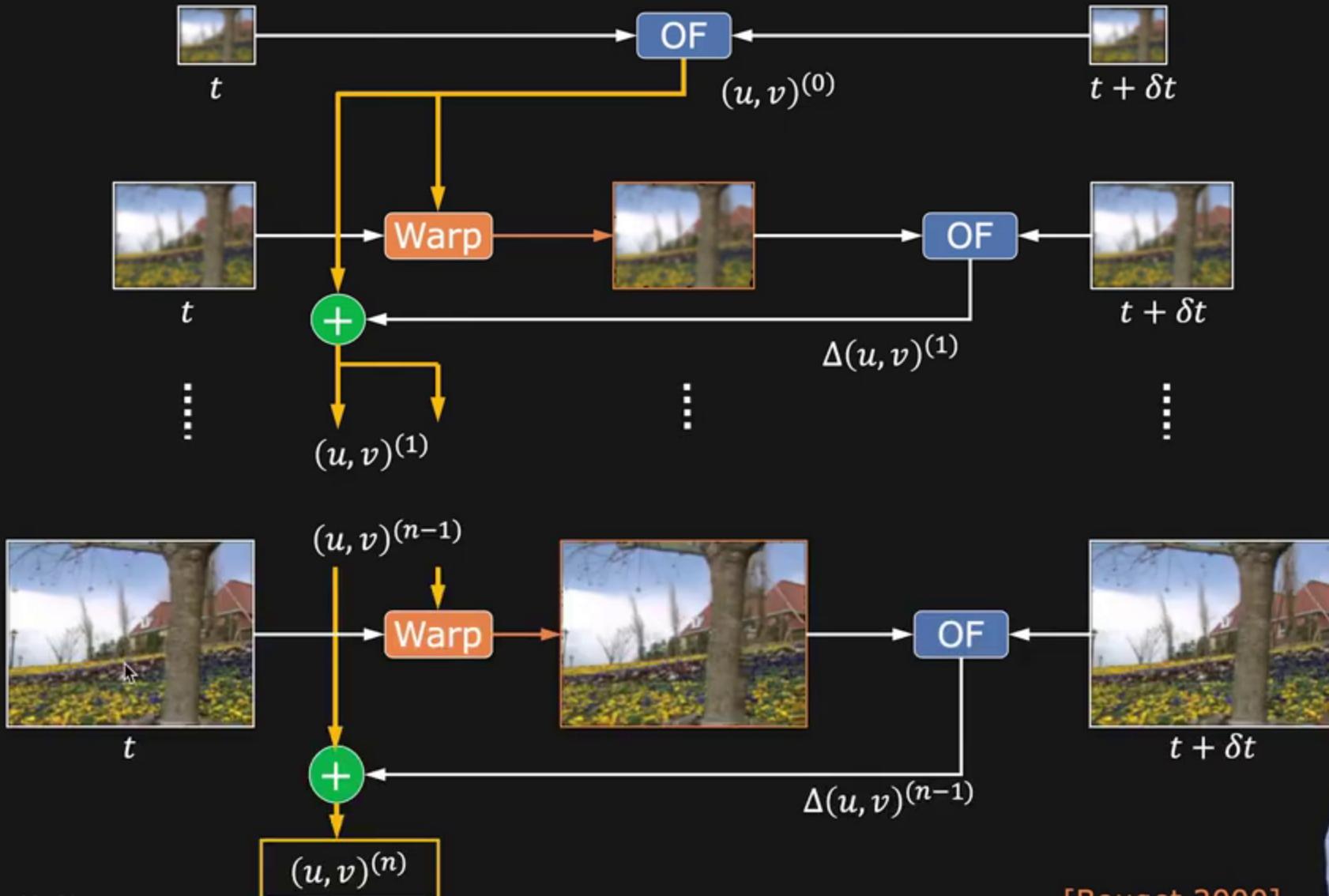
Coarse-to-Fine Estimation Algorithm



Coarse-to-Fine Estimation Algorithm

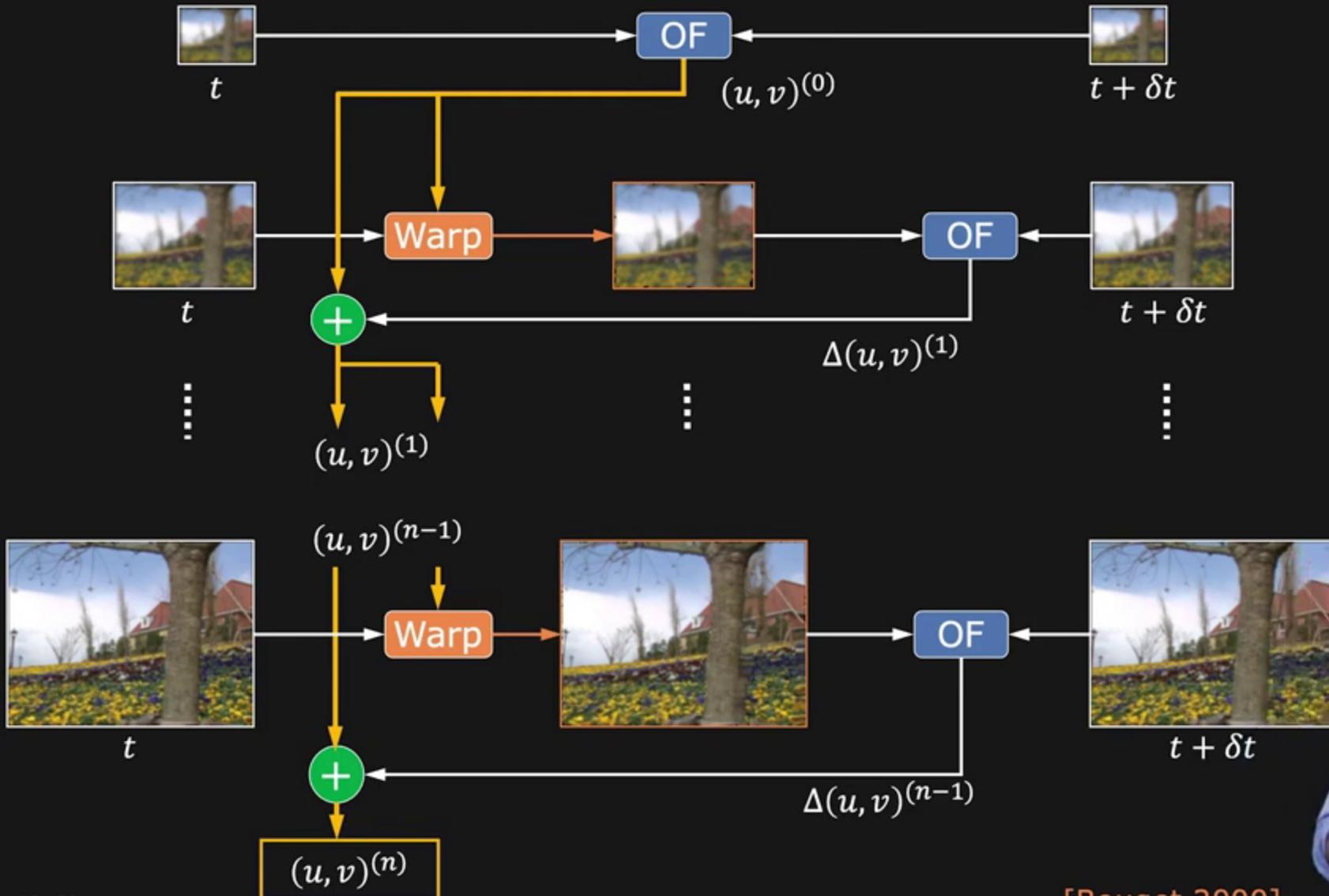


Coarse-to-Fine Estimation Algorithm



[Bouget 2000]

Coarse-to-Fine Estimation Algorithm

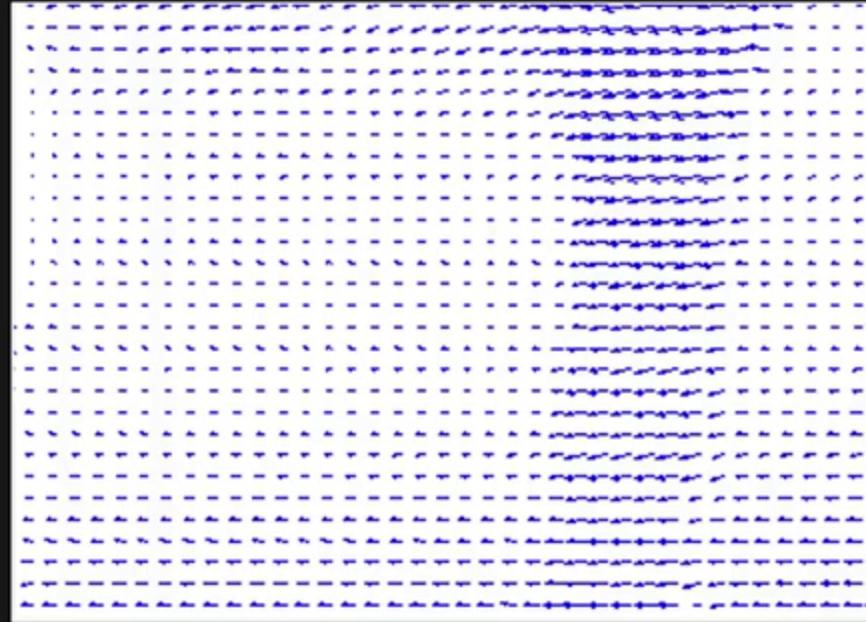


[Bouget 2000]

Results: Tree Sequence



Image Sequence



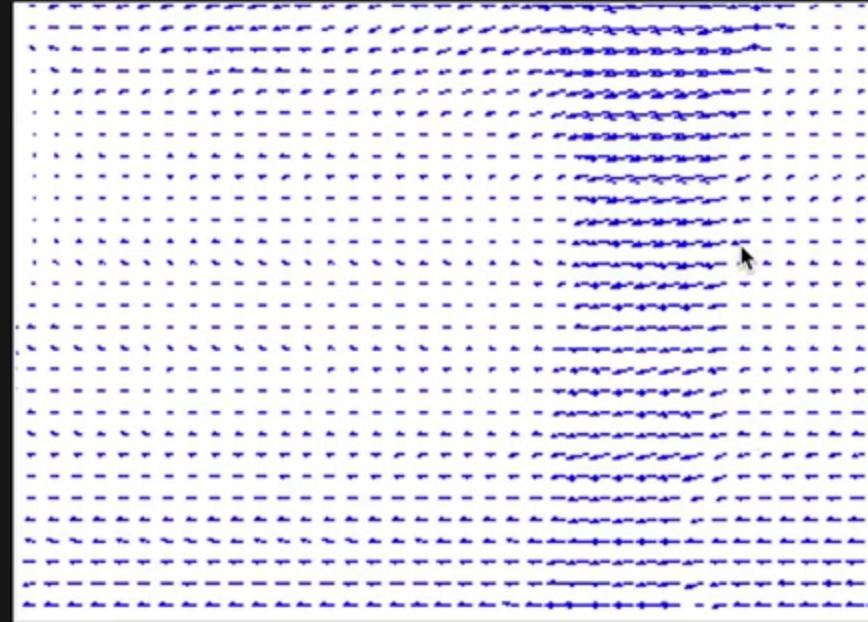
Optical Flow



Results: Tree Sequence



Image Sequence



Optical Flow



Results: Rotating Ball

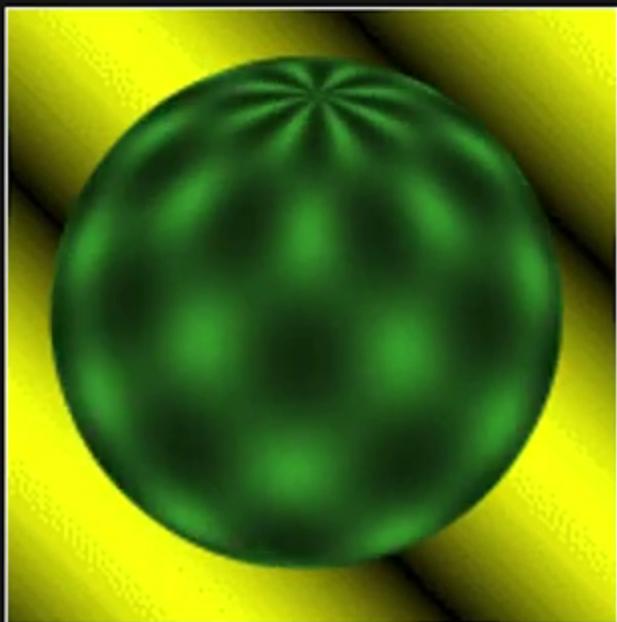
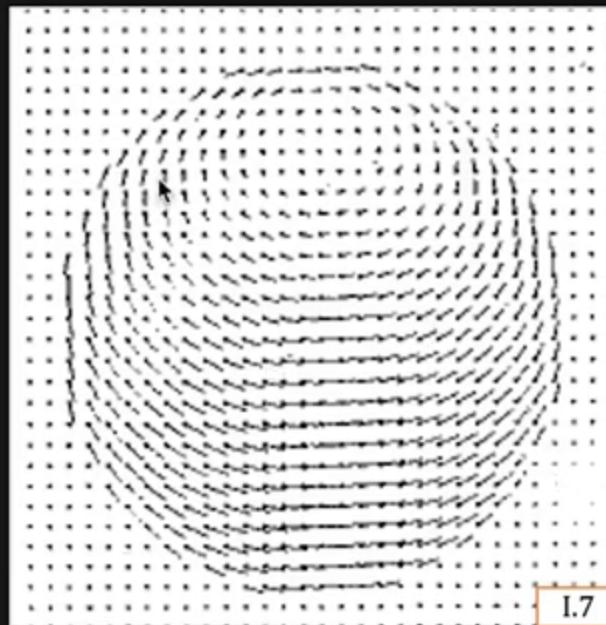


Image Sequence



Optical Flow



Results: Rotating Camera



Image Sequence



Optical Flow



Alternative Approach: Template Matching

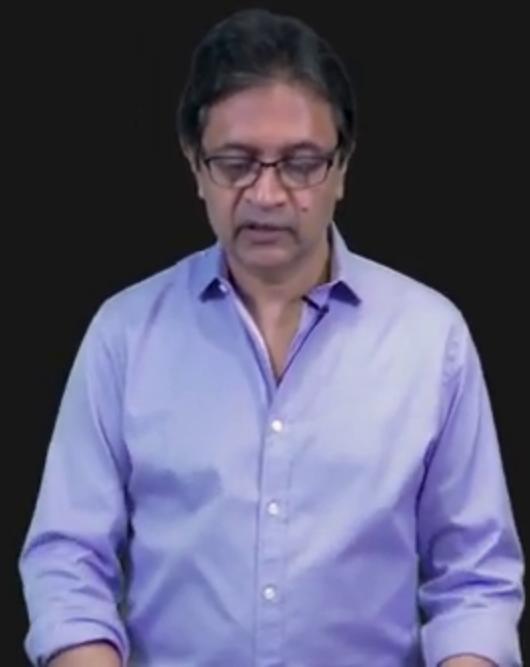
Determine Flow using Template Matching



Image I_1 at time t



Image I_2 at time $t + \delta t$



Alternative Approach: Template Matching

Determine Flow using Template Matching

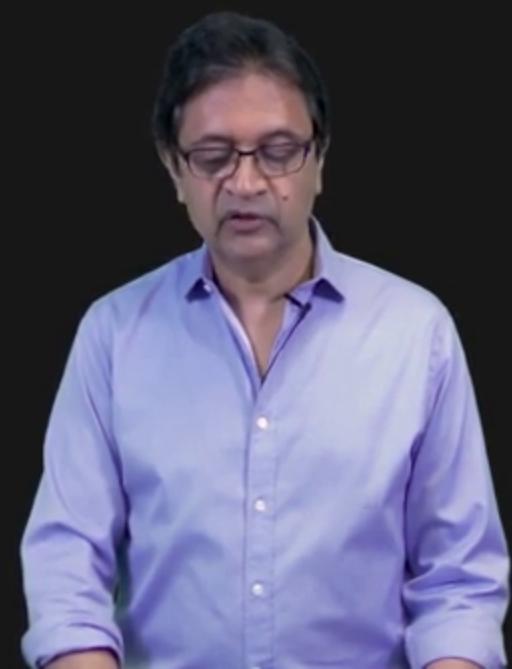


Template Window T
Image I_1 at time t



Image I_2 at time $t + \delta t$

For each template window T in image I_1 ,



Alternative Approach: Template Matching

Determine Flow using Template Matching



Image I_1 at time t

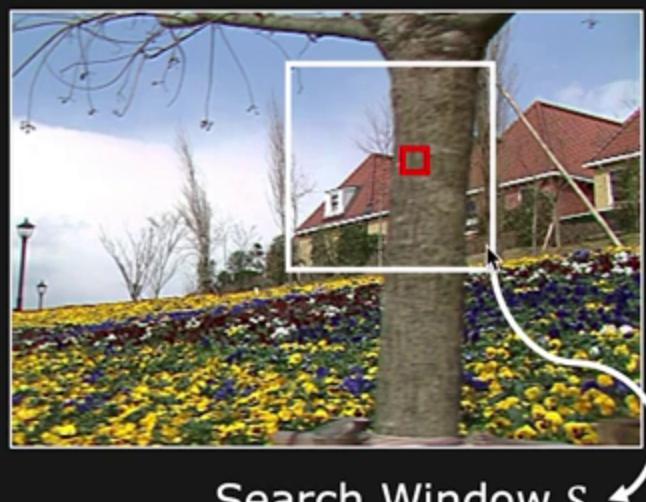


Image I_2 at time $t + \delta t$

For each template window T in image I_1 ,
find the corresponding match in image I_2 .



Alternative Approach: Template Matching

Determine Flow using Template Matching



Image I_1 at time t



Image I_2 at time $t + \delta t$

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Large Motion: Template matching

Determine Flow using Template Matching



Image I_1 at time t

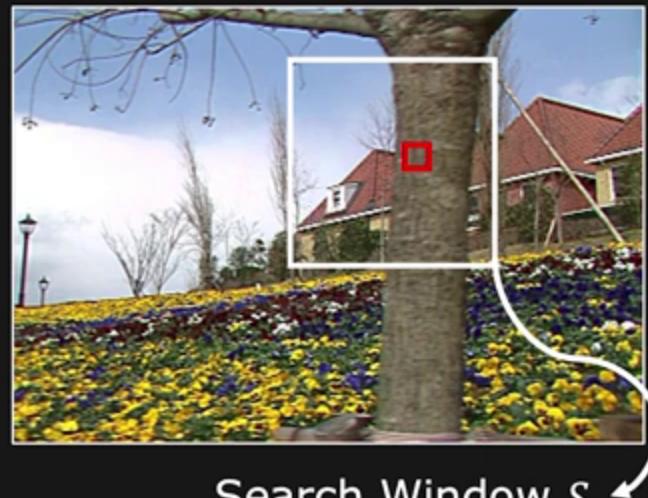


Image I_2 at time $t + \delta t$

Template matching is slow
when search window S is large.
Also, mismatches are possible.



Large Motion: Template matching

Determine Flow using Template Matching



Image I_1 at time t



Image I_2 at time $t + \delta t$

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Large Motion: Template matching

Determine Flow using Template Matching



Image I_1 at time t

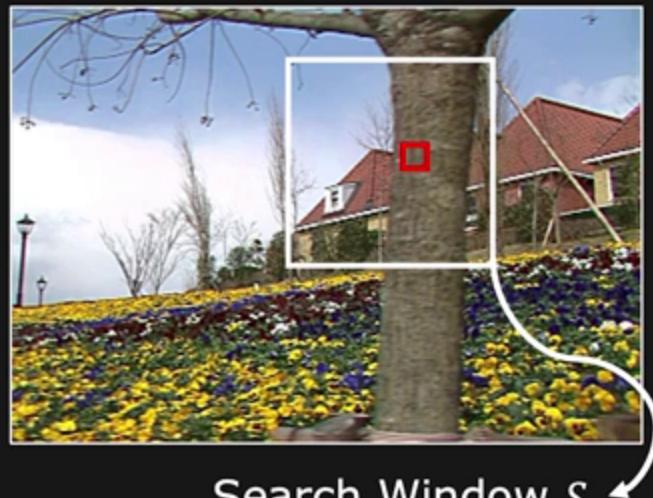


Image I_2 at time $t + \delta t$

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