Local optical flow considering object boundaries by adaptive window positioning

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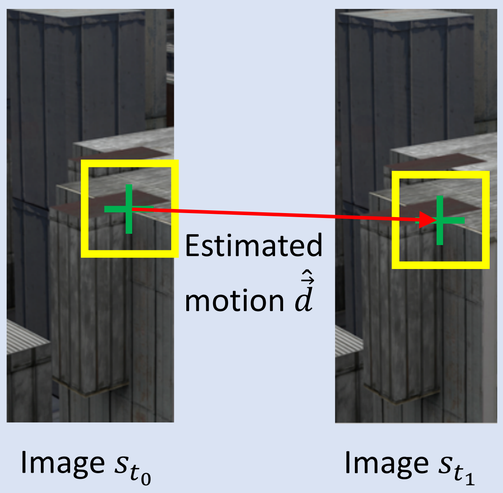
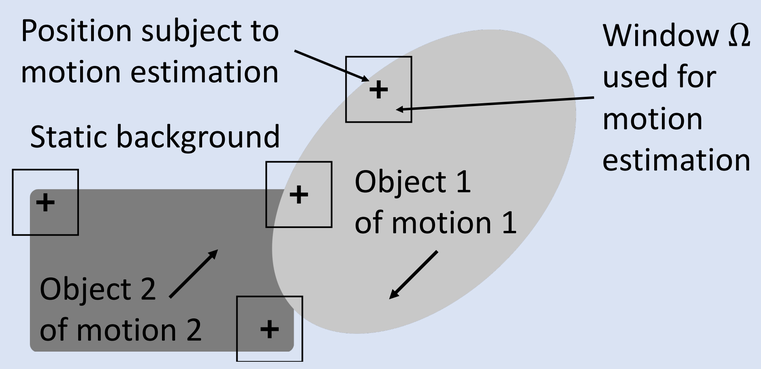
Introduction

Basic principle of local optical flow based reference motion estimation of Lucas & Kanade:



Motion estimation at object boundaries:



Goal:

Highly accurate motion estimation

Problem:

Large estimation errors at object boundaries

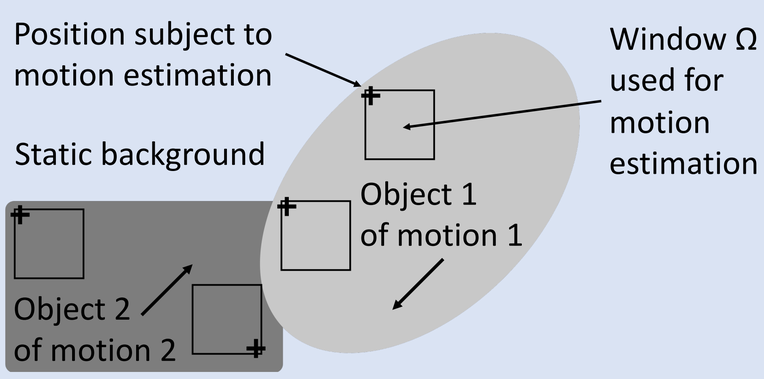
Main reason: Disclosures and occlusions within the window Ω

Approach:

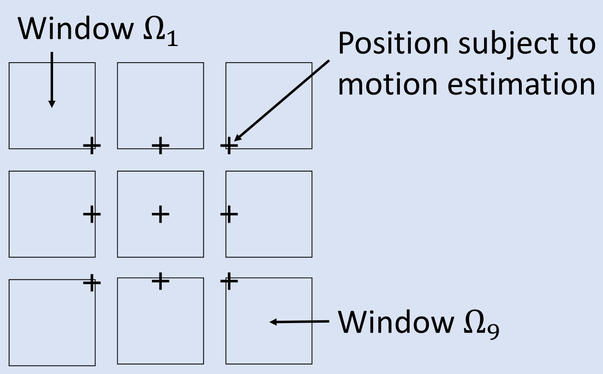
Adapt window position to object boundary

Adaptive window positioning

Motion estimation at object boundaries:

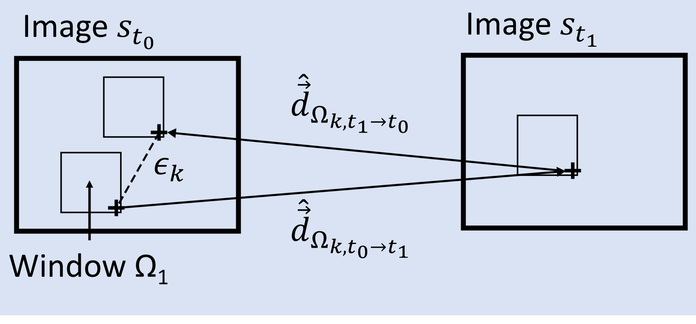


Set of 9 windows provided:



Selection process for one of the 9 windows:

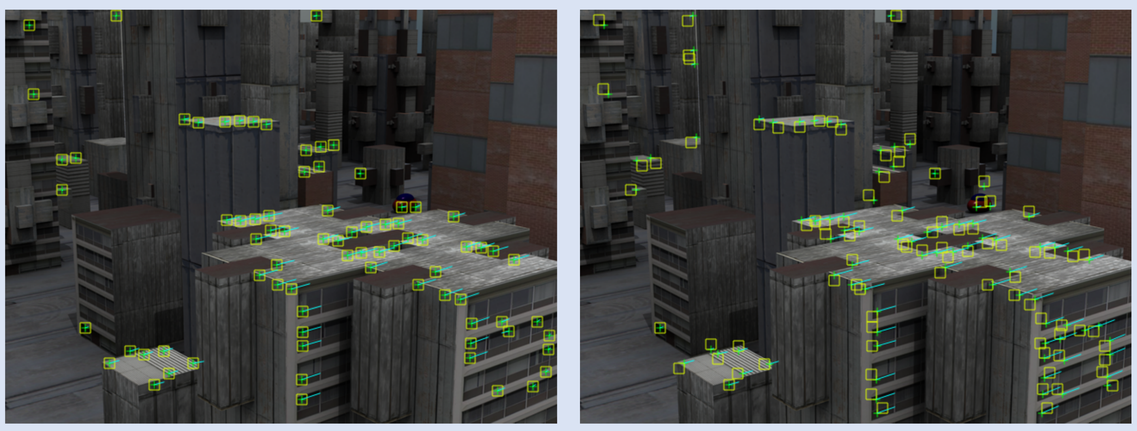
- Forward $\hat{\vec{d}}_{\Omega_{k,t_0\to t_1}}$ and backward $\hat{\vec{d}}_{\Omega_{k,t_1\to t_0}}$ estimation for each window Ω_k
- Select window minimizing distance ϵ_k



Experiments and results

Dataset	Optimized reference		Adaptive window positioning	
	AEE [pel]	*R0.5 [%]*	*AEE [pel]*	*R0.5 [%]*
Middlebury	0.628	81.503	0.354	88.325
MPI Sintel	7.980	63.050	2.970	71.700

AEE: Average absolute motion estimation error
R0.5: Relative frequency of absolute motion estimation errors below 0.5 picture elements (pel)



Reference | Adaptive window positioning

Visualization of motion: Color ≙ Direction, Intensity ≙ Length

Ground truth | Estimated by reference | Estimated by adaptive window positioning

Conclusions

- Motion estimation errors significantly reduced by around 50 %
- Total computational expense increased, but run time in the critical path stays approximately the same
- Interesting technology for all applications requiring high accurate motion estimation, e.g. 3D-Reconstruction

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