



Stereoscopic Depth Refinement by Mid-Level Hypothesis

Olgierd STANKIEWICZ
Marek DOMAŃSKI
Krzysztof WEGNER

Chair of Multimedia Telecommunications and Microelectronics
Poznań University of Technology, Poland

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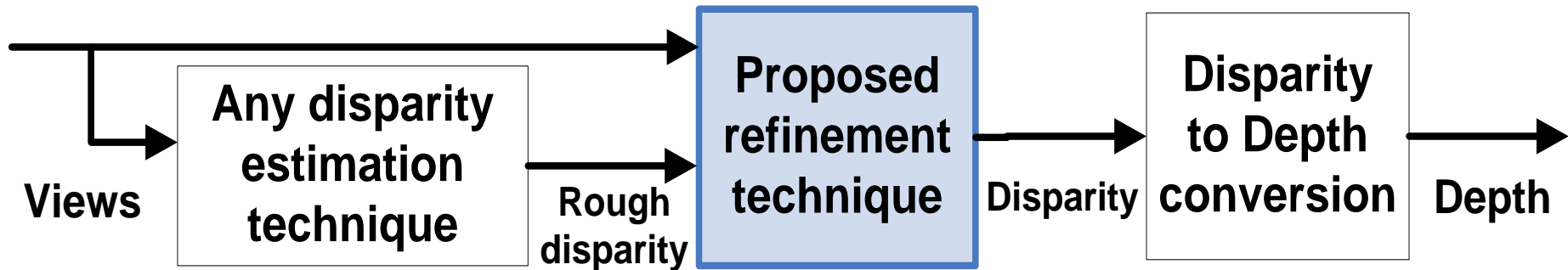


Introduction

- A technique for refinement of depth maps
- Input:
 - Stereoscopic pair of images
 - Pixel precise depth map
- Output:
 - Sub-pixel depth map
- Spatial resolution is unchanged

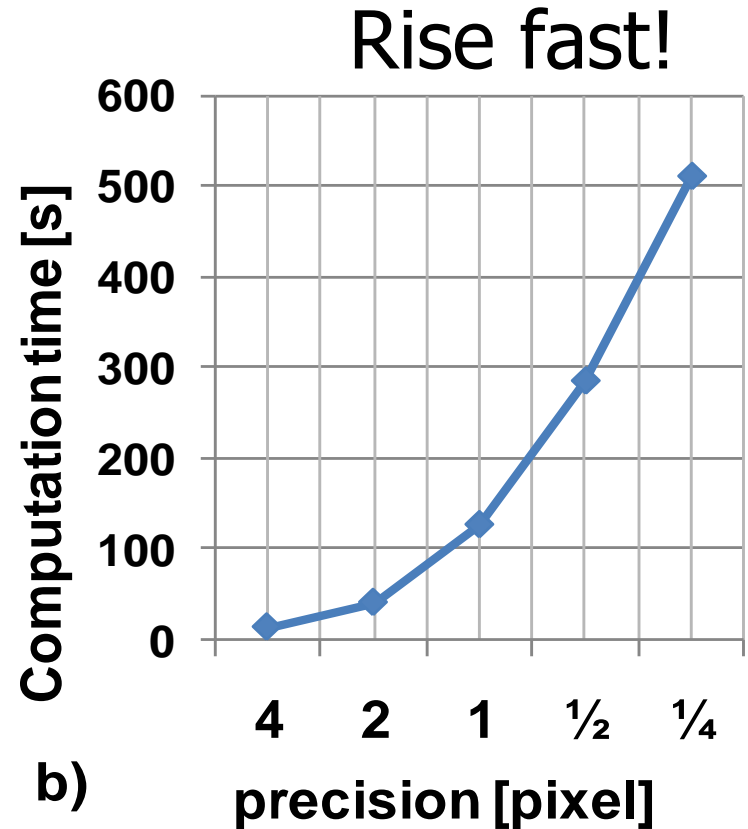
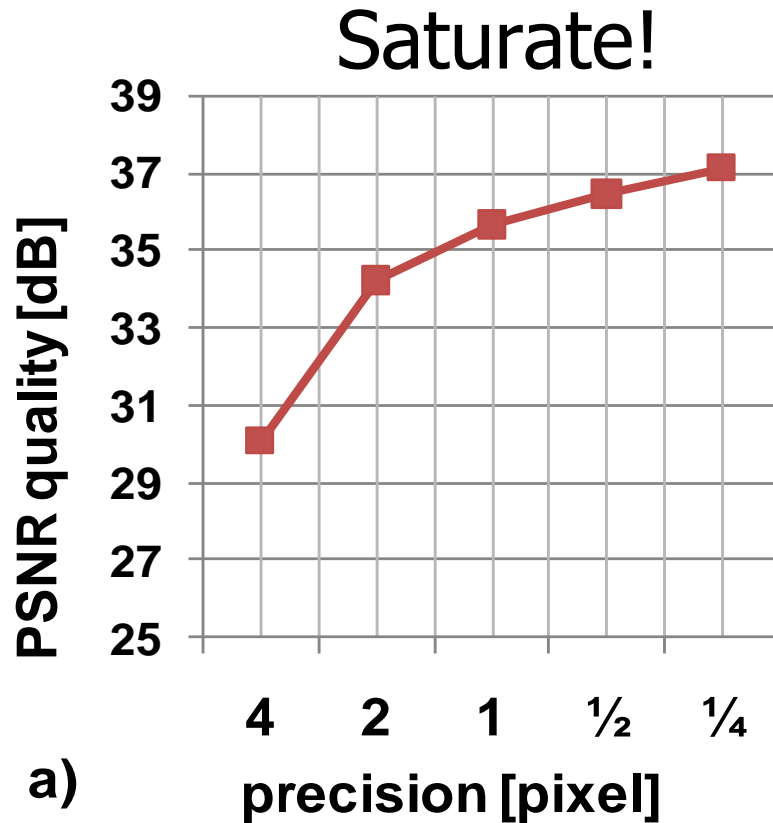


Application





Why not „single-stage“ estimation?





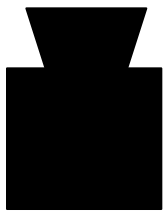
The main idea

- Improve depth accuracy by inserting additional disparity levels
- Verify in evaluation-by-hypothesis process

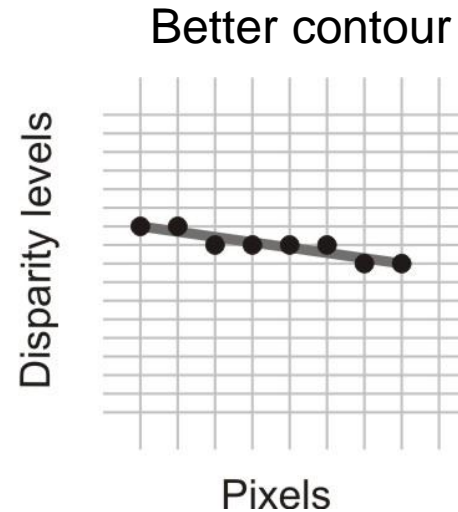
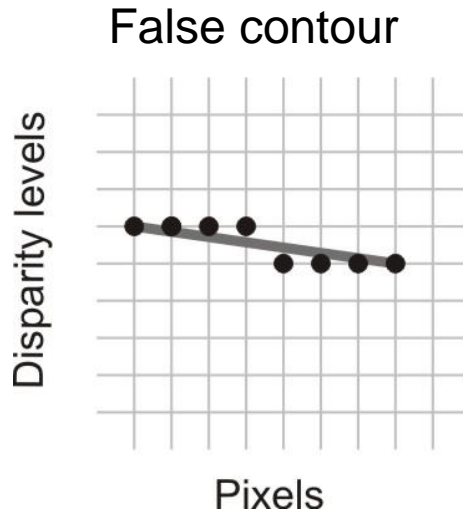


Where to insert additional disparity levels?

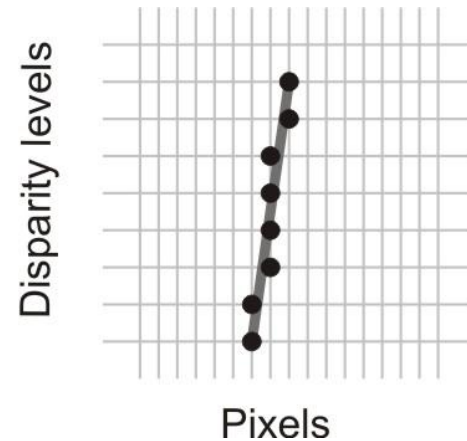
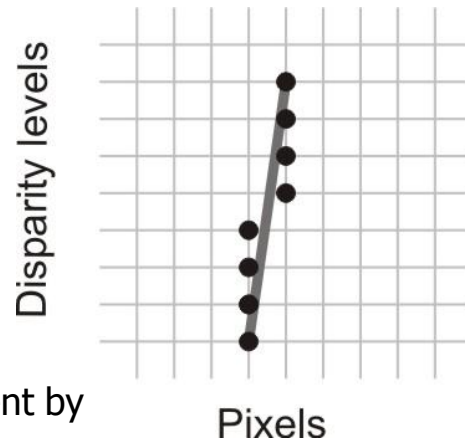
↑
Depth



A camera



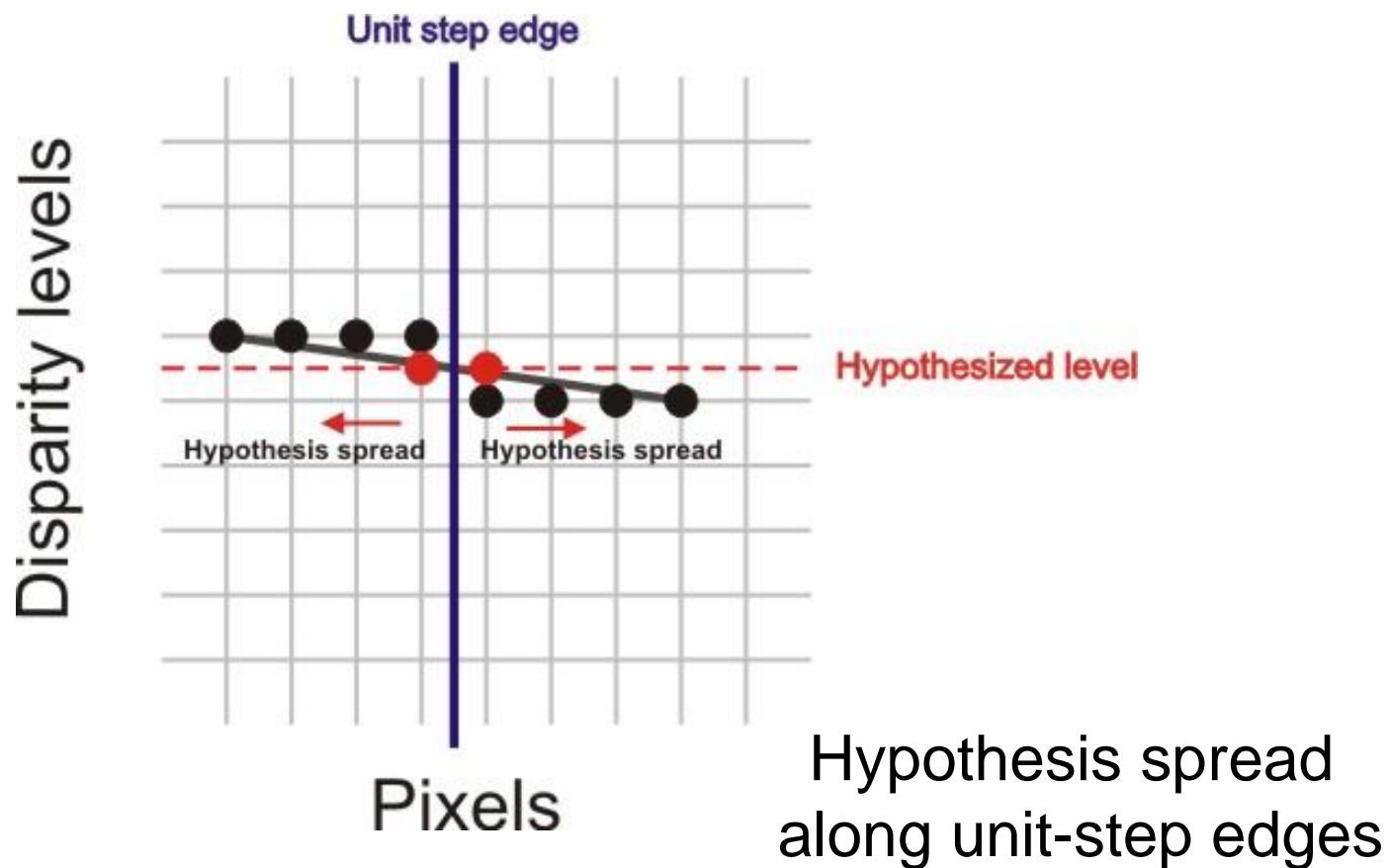
„horizontal”
edge



„vertical”
edge

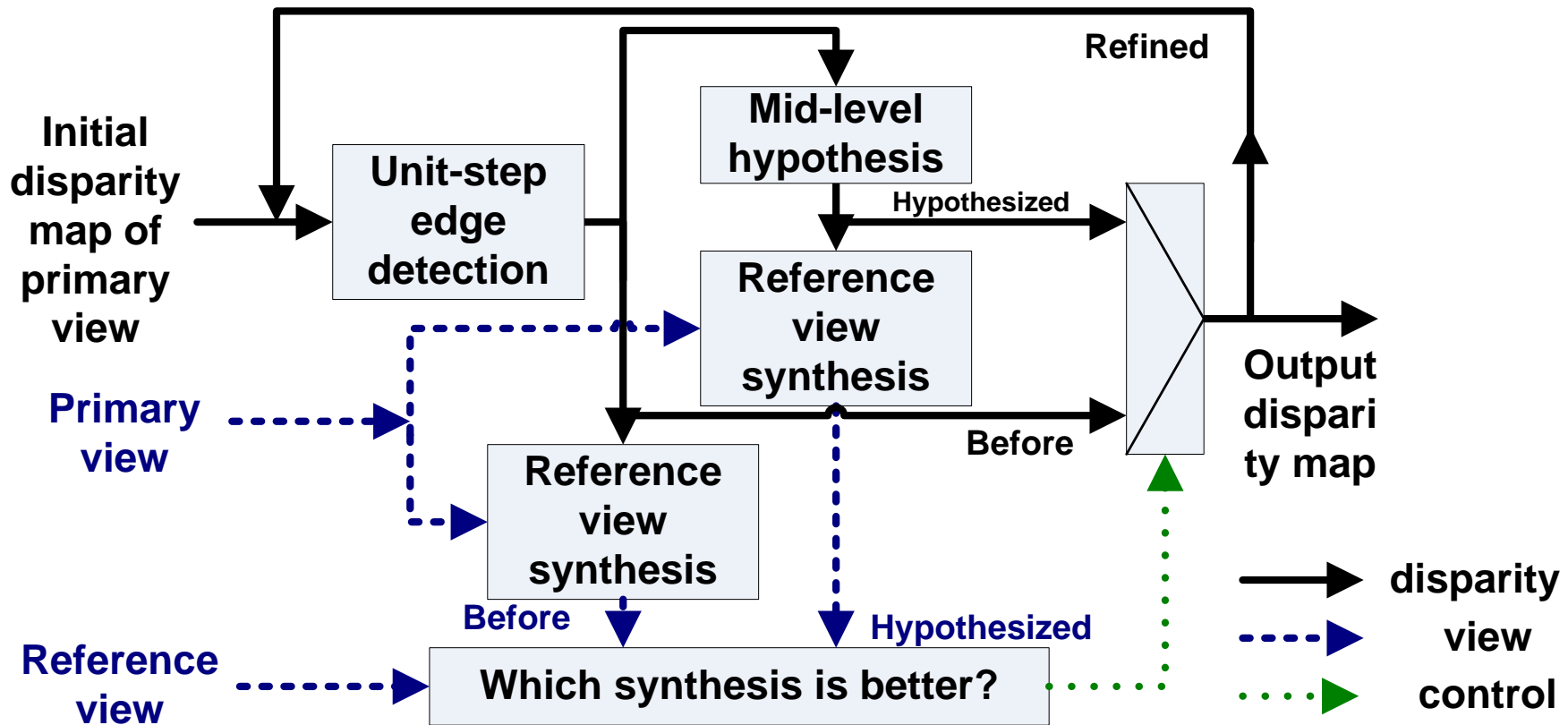


Focus on unit-step edges!





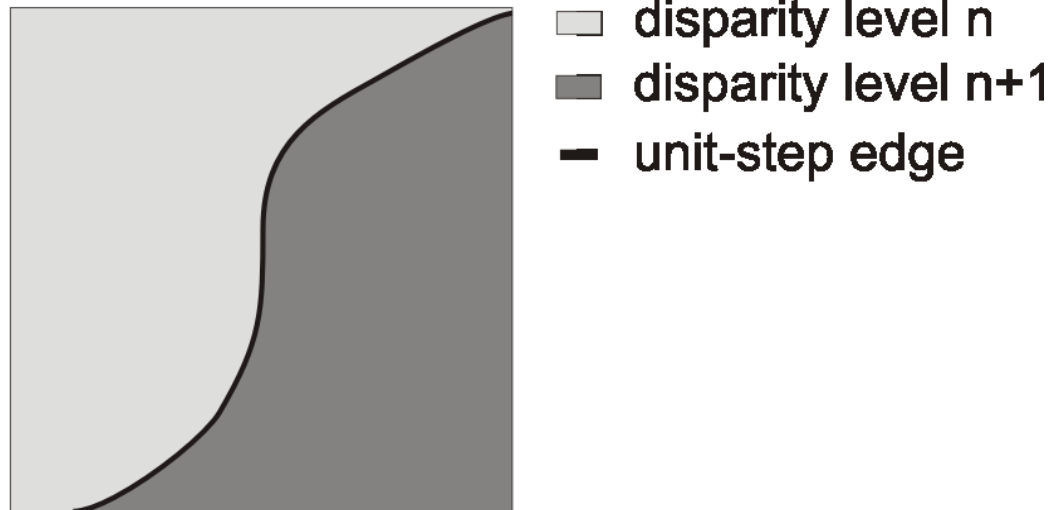
Scheme of proposed disparity refinement algorithm





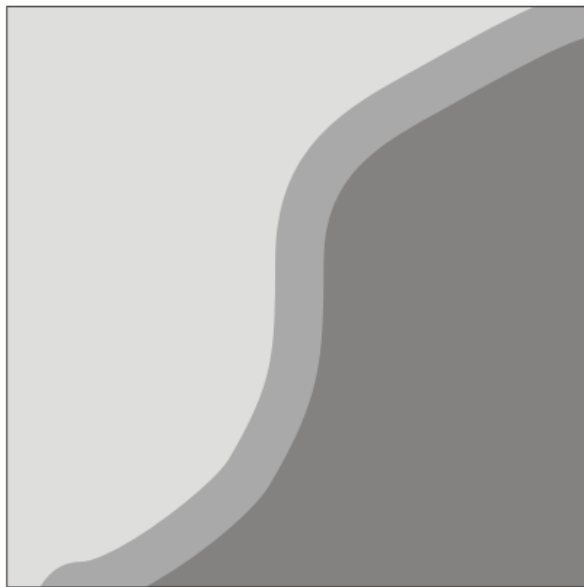
1. Detection of unit-step edges

- Pixels, whose disparity differs by 1 from neighboring pixels are marked





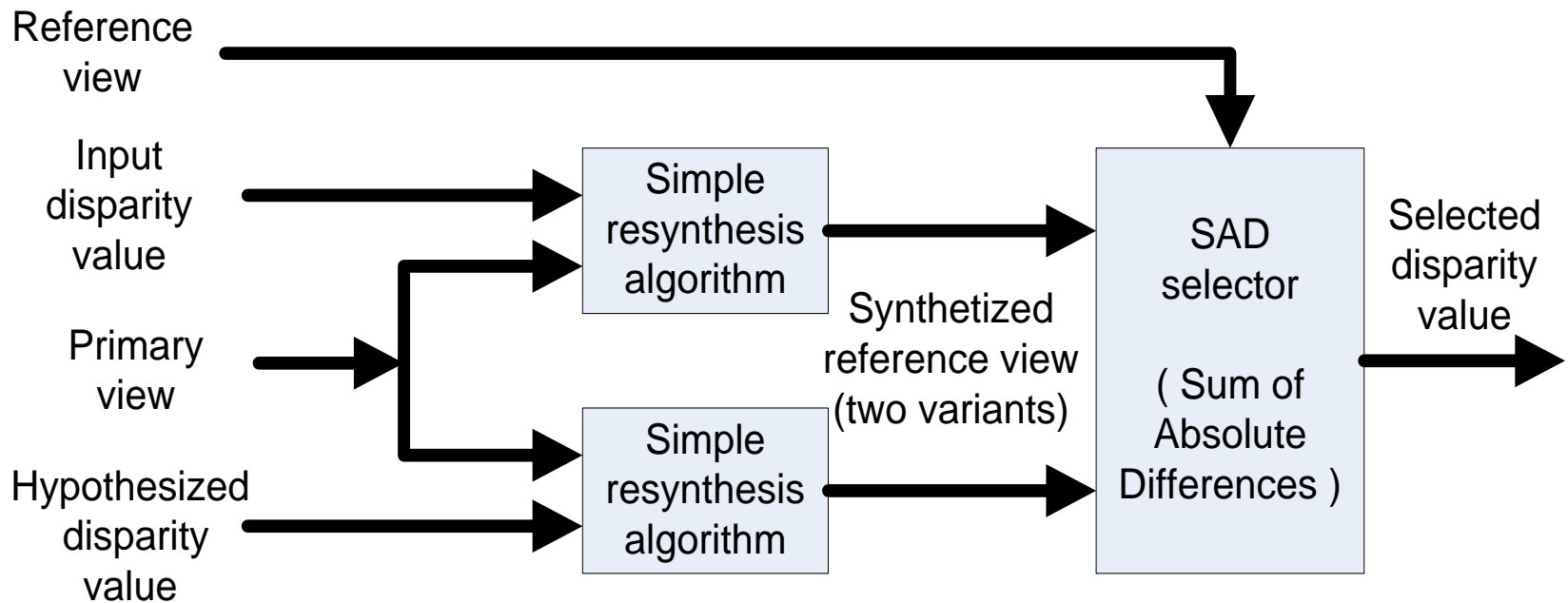
2. Insertion of intermediate disparity levels



- disparity level n
- intermediate disparity level
- disparity level n+1

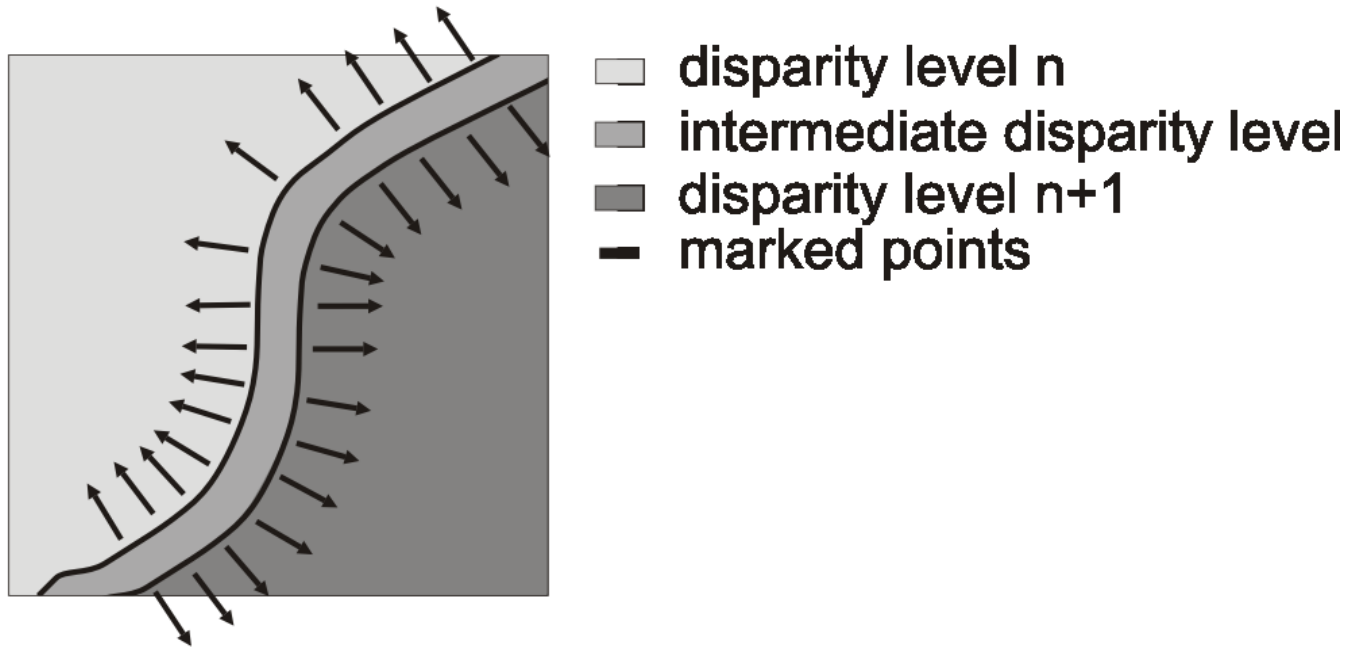


3. Verification of intermediate level hypothesis.





4. Spreading of the hypothesis.





Experimental verification

- Still images
 - “Middlebury Stereo Vision Page”
<http://vision.middlebury.edu/stereo/>
- Moving images
 - Test sequences of ISO/IEC MPEG 3DV/FTV
 - Yo-Sung Ho, E.-K. Lee, C. Lee “Video Test Sequence and Camera Parameters” ISO/IEC MPEG M15419, Archamps, France, April 2008.
 - I. Feldmann, M. Müller, F. Zilly, et al. „HHI Test Material for 3D Video”, ISO/IEC JTC1/SC29/WG11, MPEG M15413, Archamps, France, April 2008.
 - M. Tanimoto, T. Fujii, N. Fukushima, “1D Parallel Test Sequences for MPEG-FTV”, MPEG M15378, Archamps, France, April 2008.

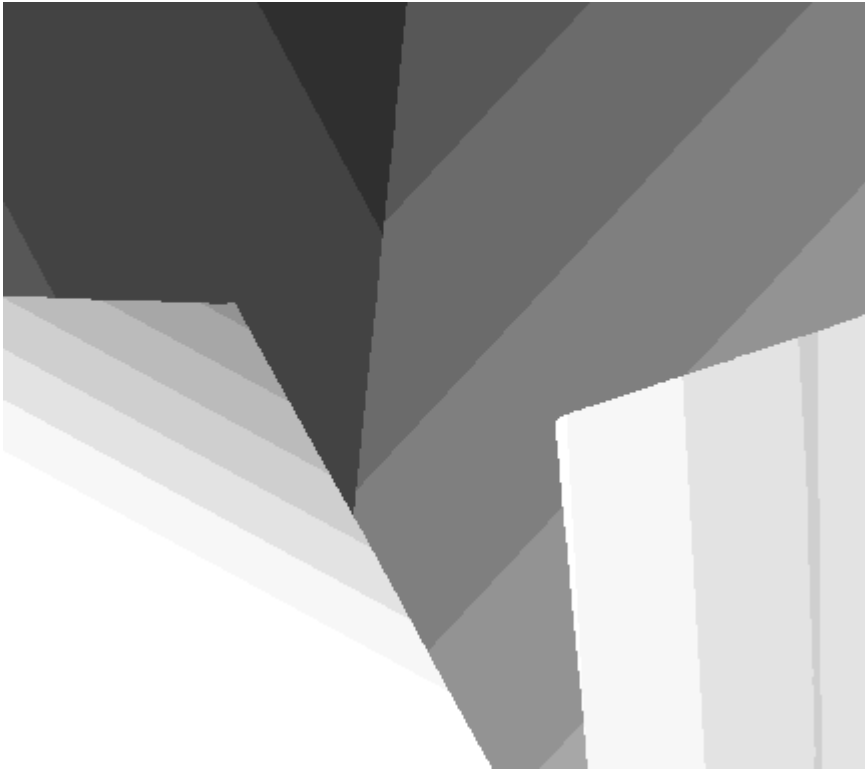


Still images – Middlebury ranking

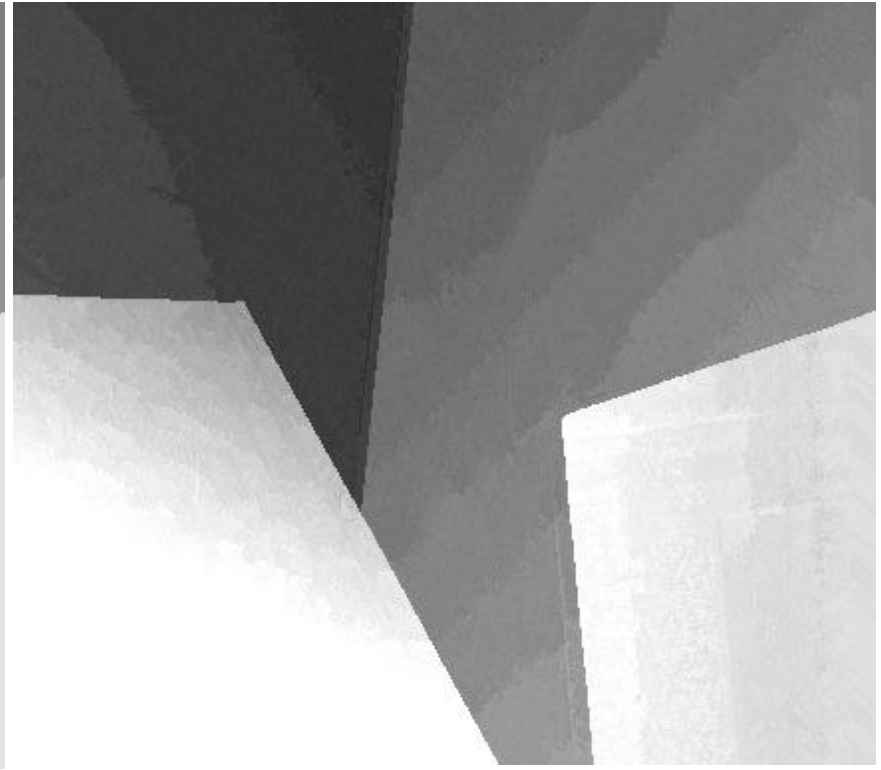
Algorithm	Average percent of bad-pixels [%]	
	Threshold = 1.0	Threshold = 0.5
Middlebury - <i>Adapting BP</i>	4.23	13.6
Middlebury - <i>Double BP</i>	4.19	15.7
Middlebury - <i>OutlierConf</i>	4.60	17.3
<i>DERS (QPel)</i>	6.82	15.1
<i>DERS (Pel) + MLH (QPel)</i> proposed technique	7.03	16.5
<i>DERS (Pel)</i>	8.36	17.5
Middlebury - <i>SAD-IGMCT</i>	12.5	16.0
Middlebury - <i>Infection</i>	20.7	29.4



Exemplary image – „Venus” dataset



Pixel accurate disparity (1x)



After refinement (8x)

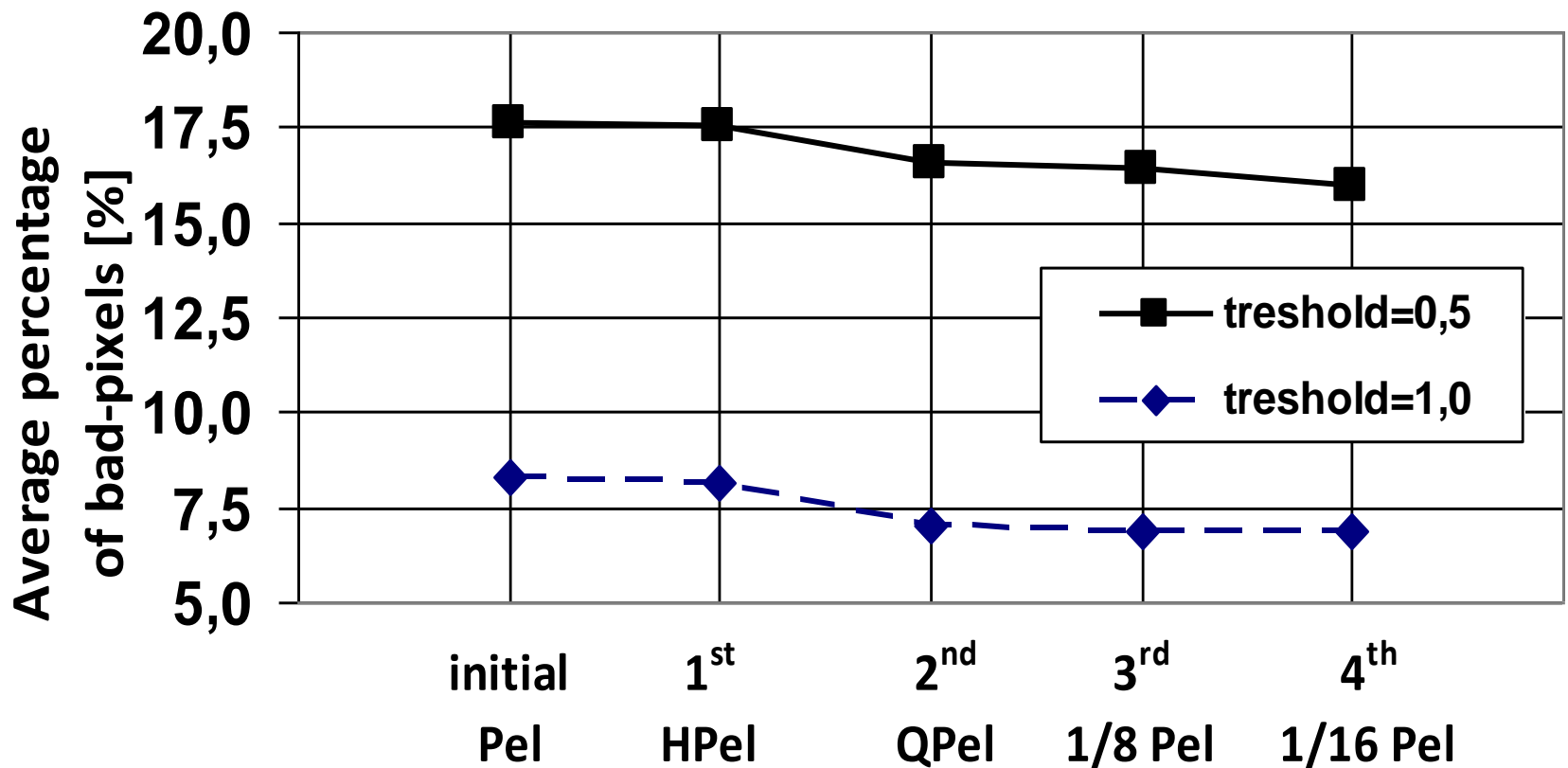


Works over untextured regions





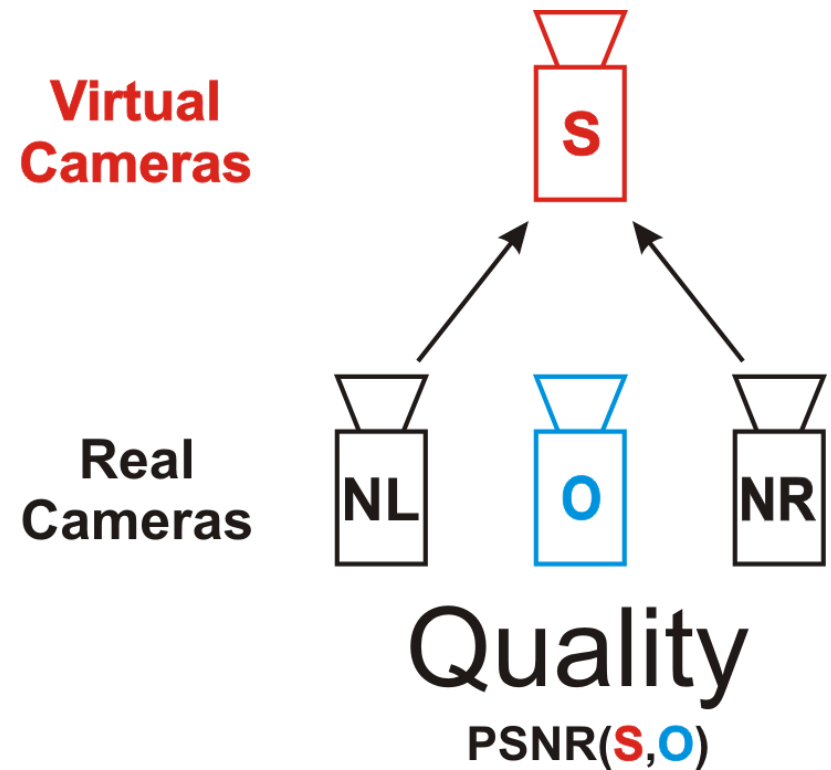
Results





Video sequences

- Depth map quality is assessed indirectly by evaluation of quality of resynthesized view

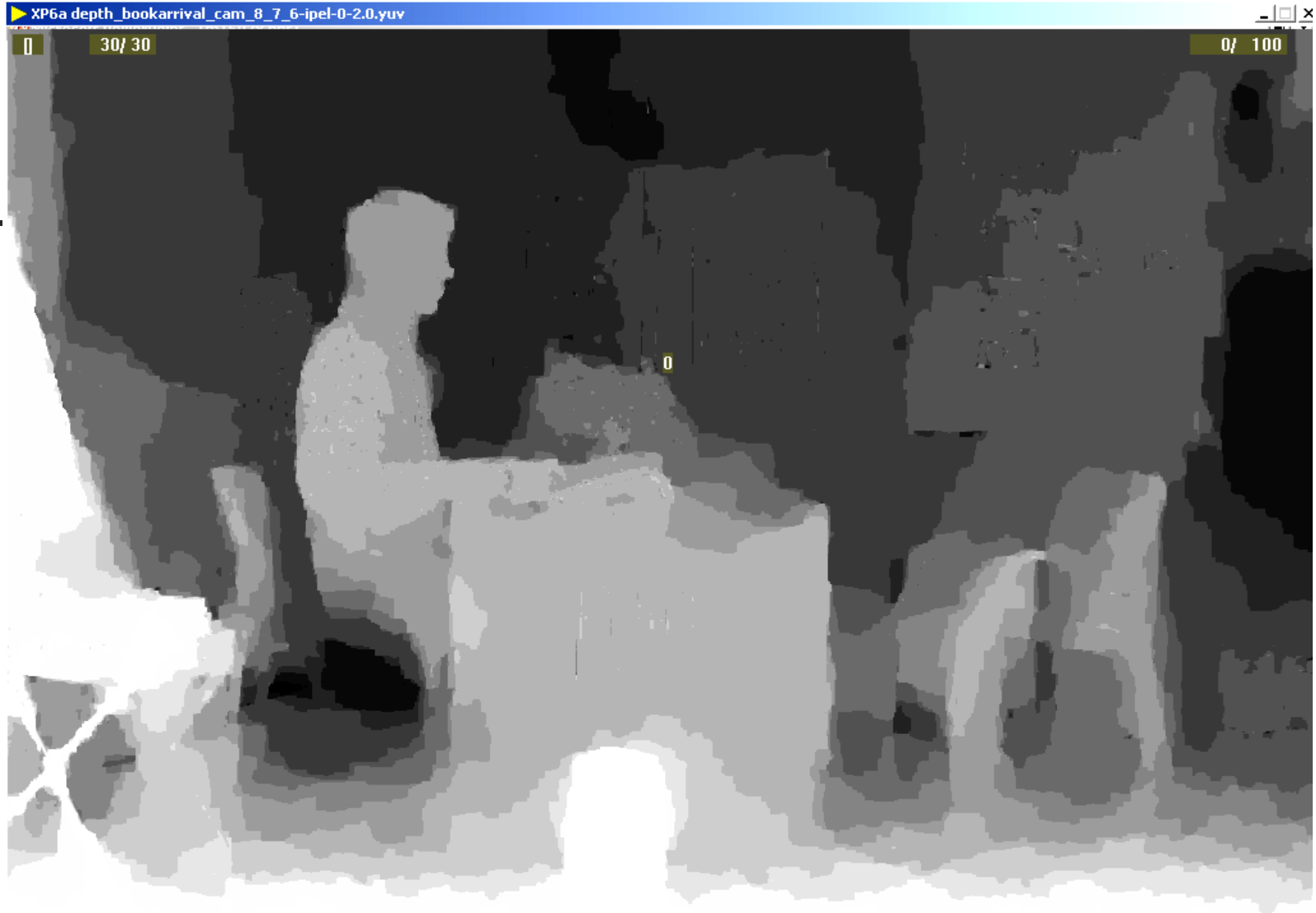


DERS – QPel precision



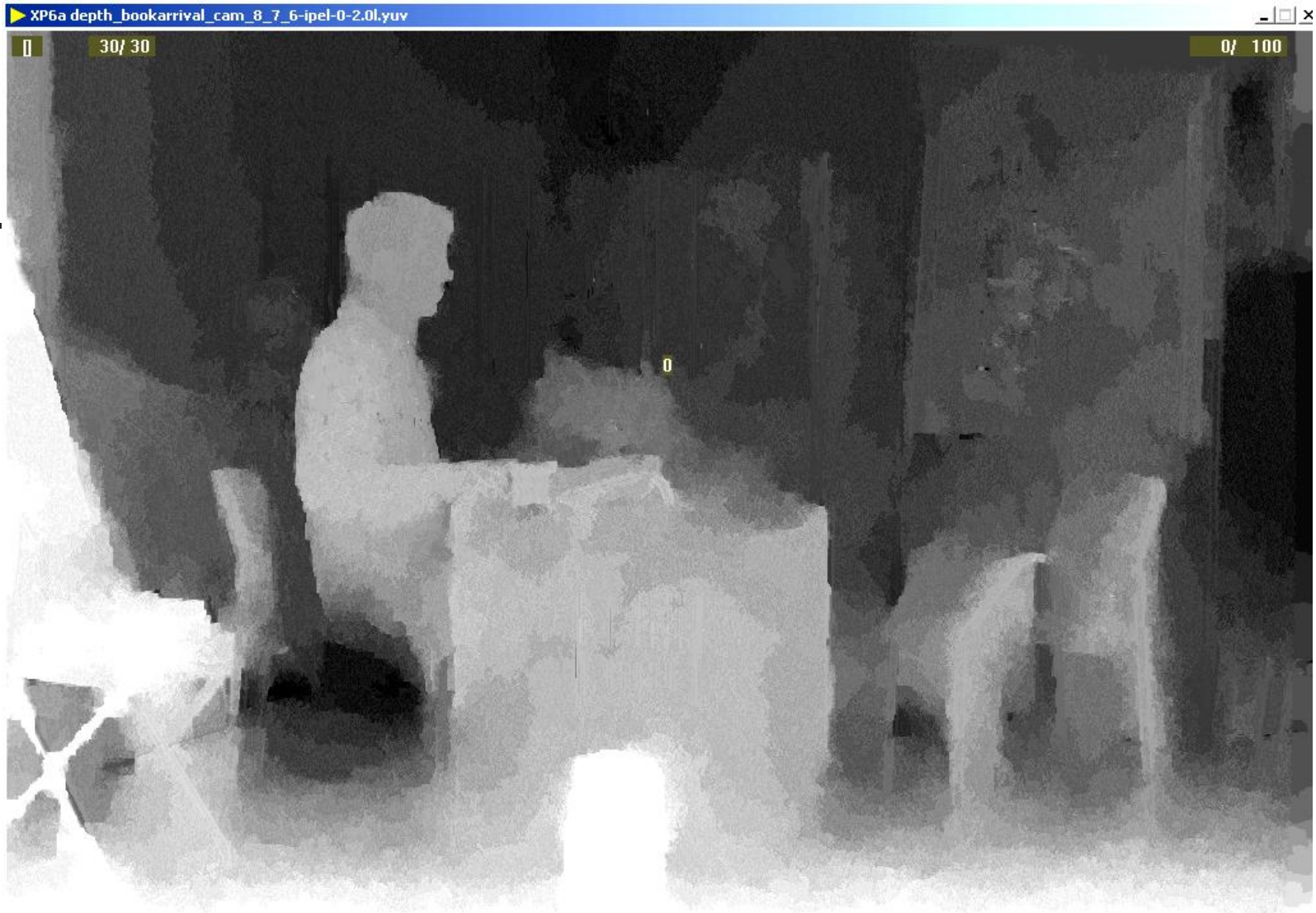
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DERS – Pixel precision

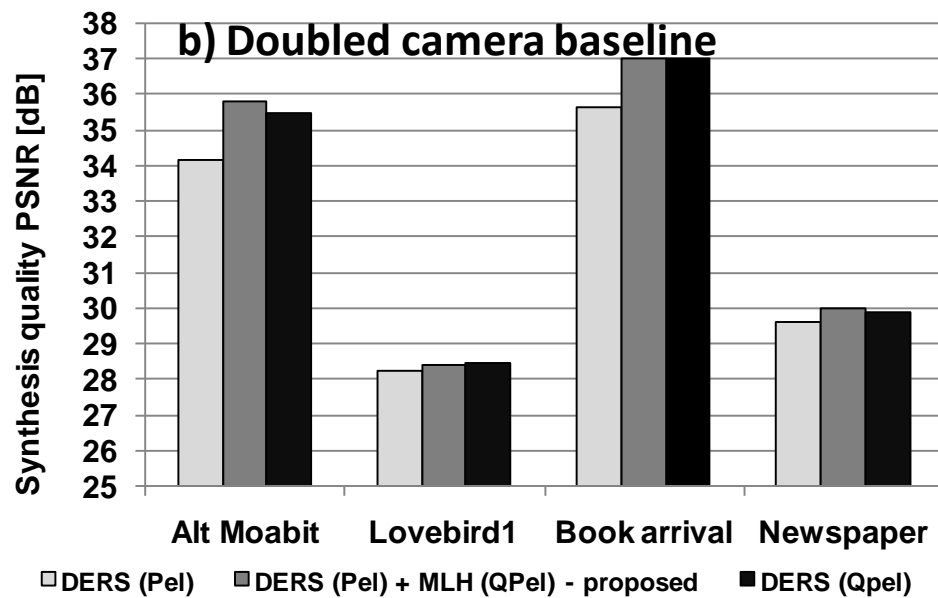
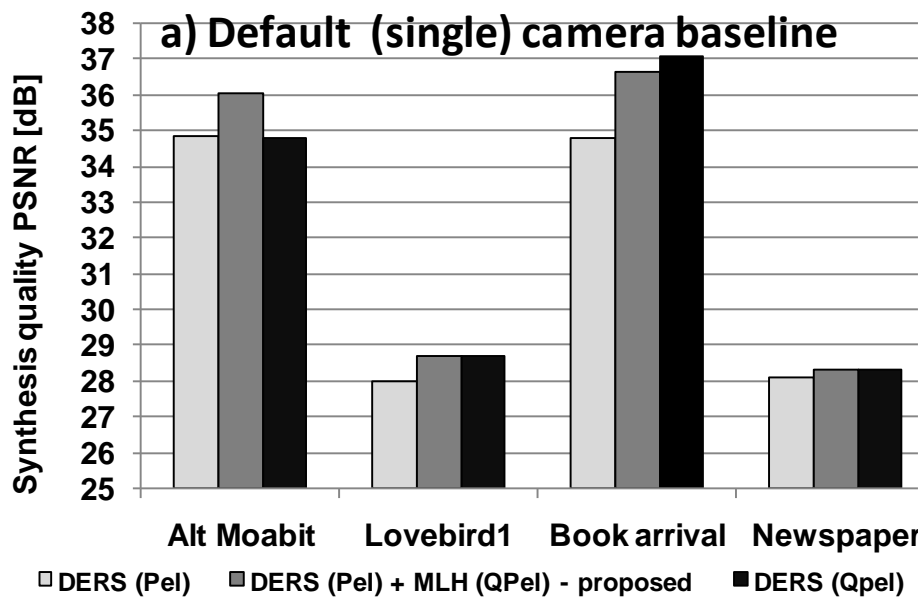


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DERS + MLH \rightarrow QPel precision



Stereoscopic Depth Refinement by
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Computational complexity

Algorithm	Depth map computation time [s]
<i>DERS (QPel)</i>	511.6
<i>DERS (Pel) + MLH (QPel)</i> Proposed technique	127.4 + 36.3 = 163.7
<i>DERS (Pel)</i>	127.4



Conclusions - improvement

- Compared to DERS Pel precision
 - 0.5 dB to 2 dB of PSNR gain
- Compared to DERS HPel precision
 - up to 1 dB of PSNR gain
- Subjectively more 'smooth'



Conclusions

- Can be used with little effort
- Low computational cost
- Further test over variety of sequences are encouraged



Thanks for your attention!

- Questions?