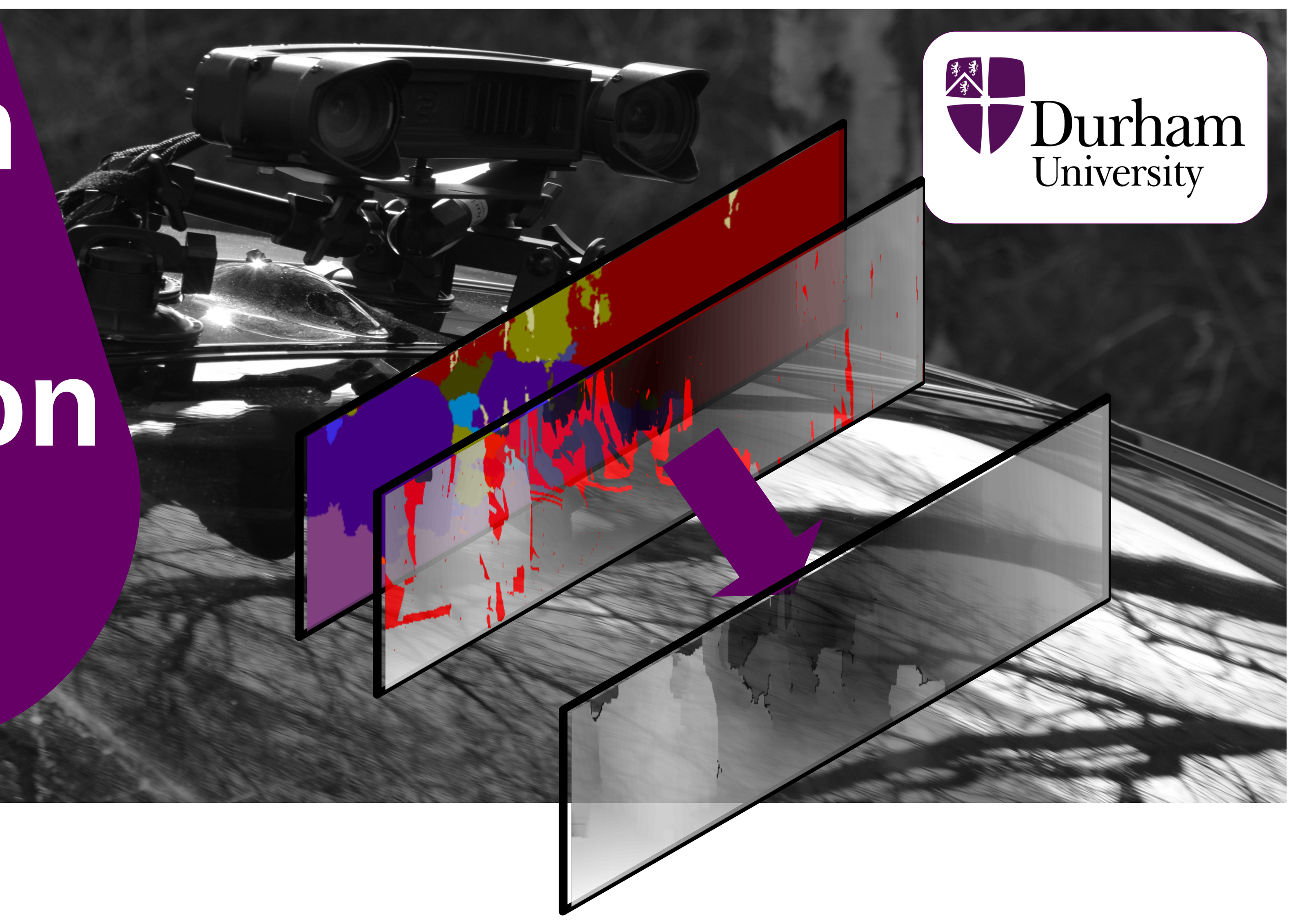
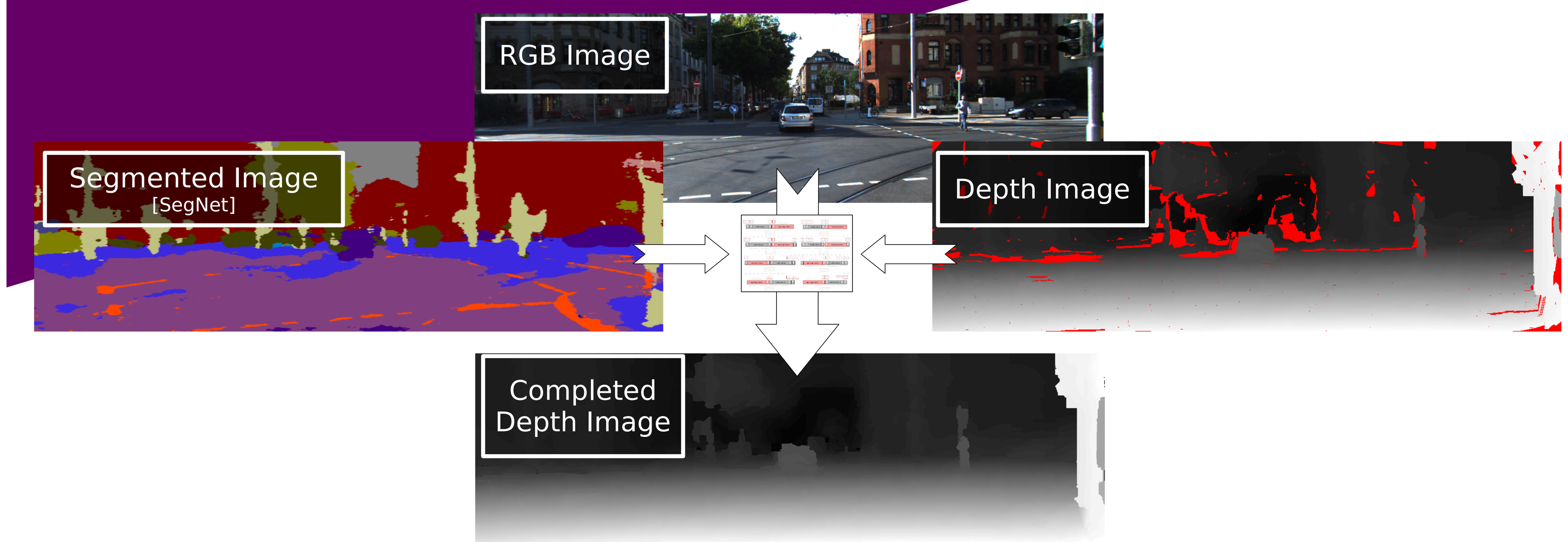
DepthComp: Real-time Depth Completion Based on Prior Semantic Scene Segmentation

Amir Atapour Abarghouei, Toby P. Breckon
Durham University, UK



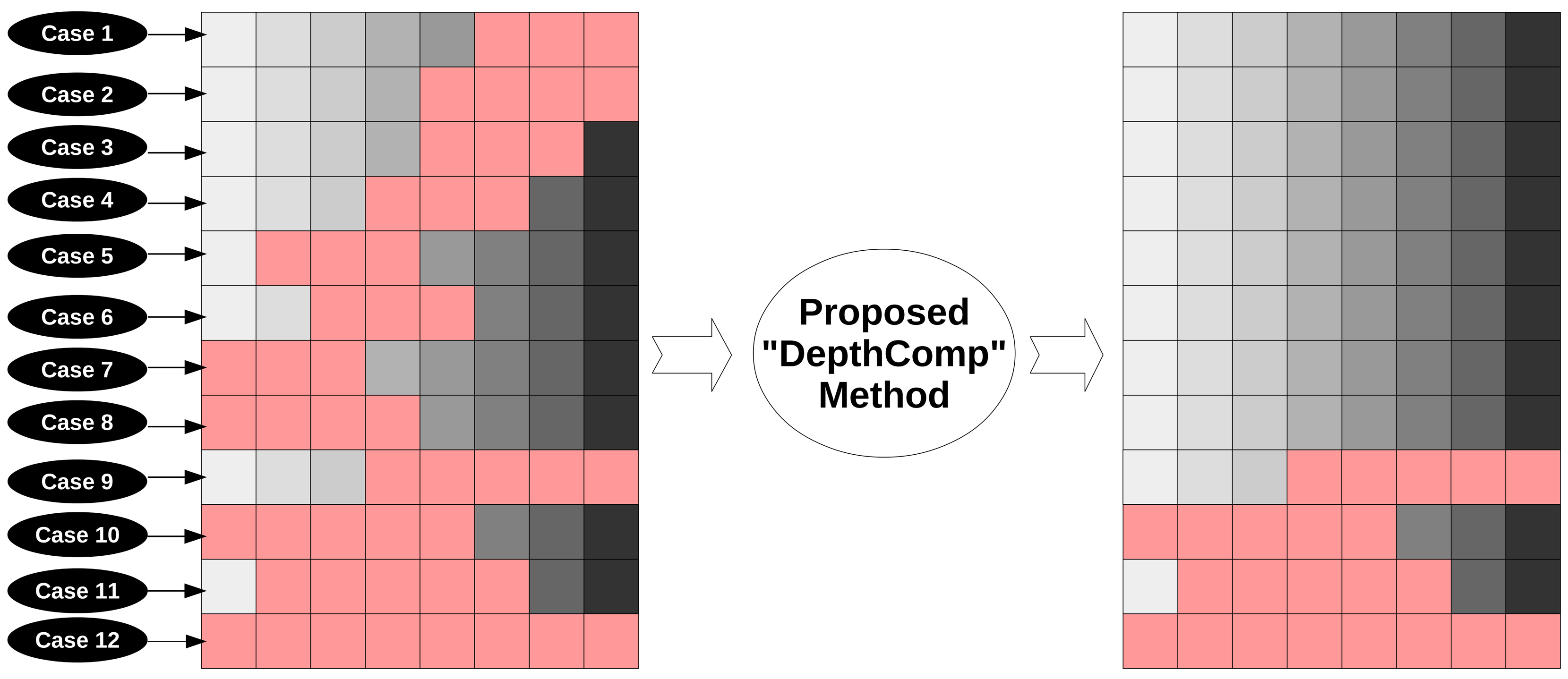
Issue: efficient depth filling with surface relief continuity via prior semantic segmentation



Approach: completing depth images:

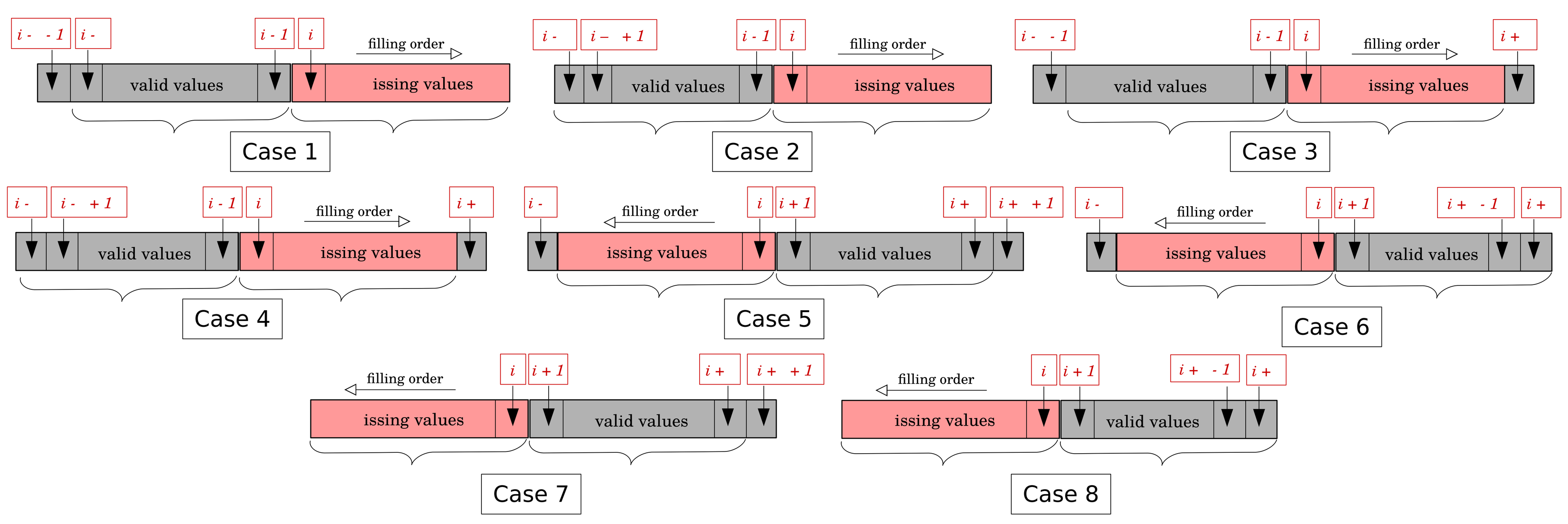
(1) ***Segmentation*** *of colour image. Any segmentation technique can be used. Here, the* ***semantic segmentation*** *approach in [1] is used.*

(2) Depth ***holes*** *are categorized into a bounded set of* ***12 explicit completion cases*** *for depth holes (defined as missing depth values in one object within a single row).*



(3) Holes are processed in three passes: ***primary row-wise, column-wise and secondary row-wise****.*

(4) ***Relief, texture*** *and* ***slight depth discontinuities*** *are* ***propagated*** *into the hole based on completion cases with unresolvable cases left for subsequent passes.*



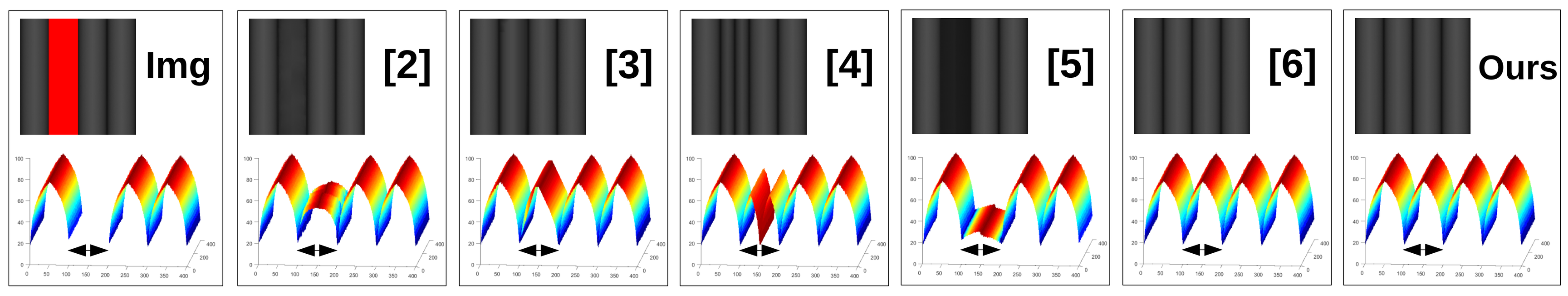
Non-Parametrically Solvable Completion Cases.

Case	%	Case	%	Case	%	Case	%
1	11.19	4	1.99	7	7.75	10	2.47
2	0.32	5	3.44	8	0.33	11	10.31
3	57.02	6	0.22	9	1.93	12	3.03

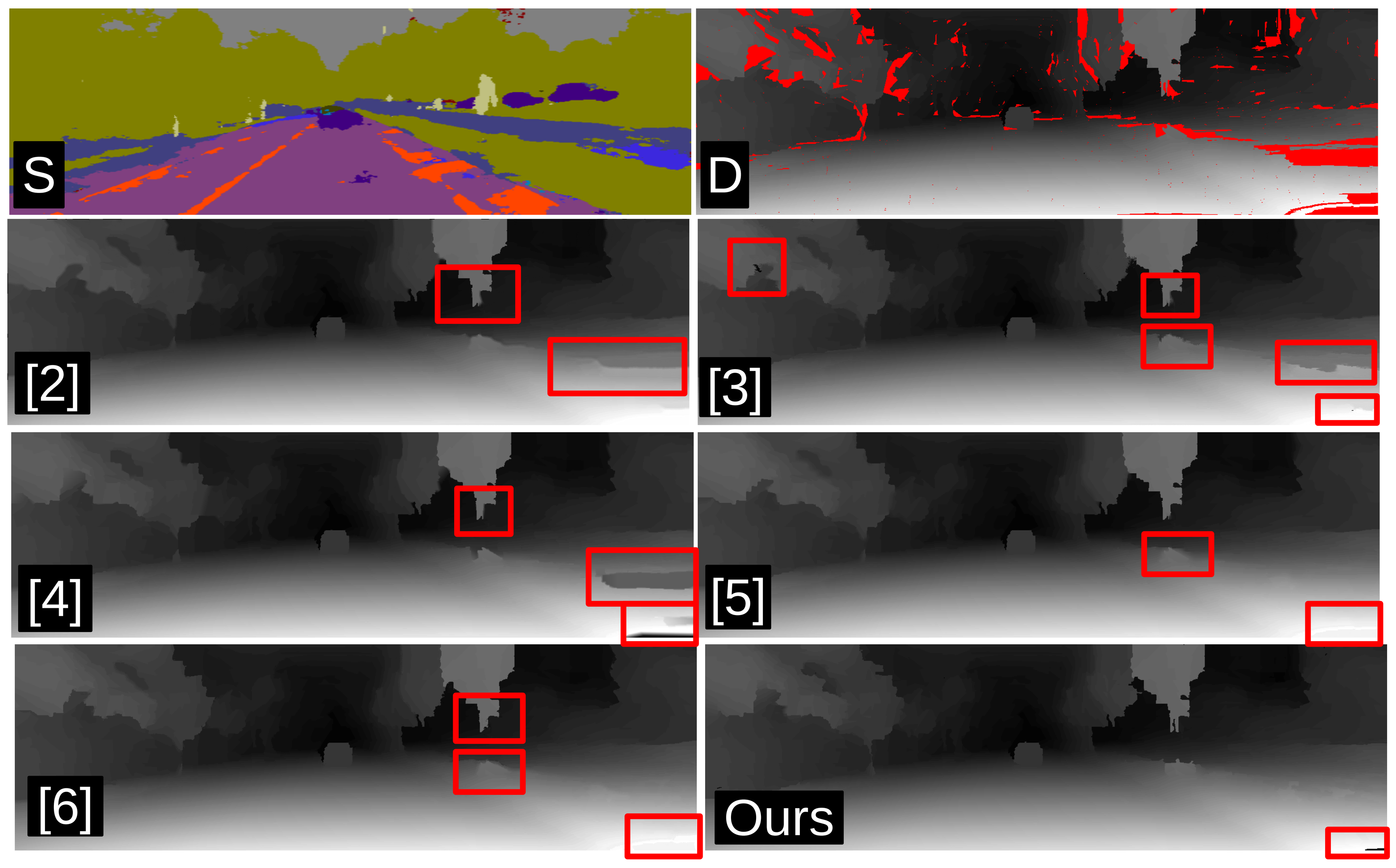
Frequency of Completion Cases in KITTI Test Images.

Source Code: *https://github.com/atapour/depthComp*

Evaluation: synthetic and real-world imagery:



Evolutions over Synthetic Test Image Simulating Exaggerated Relief.

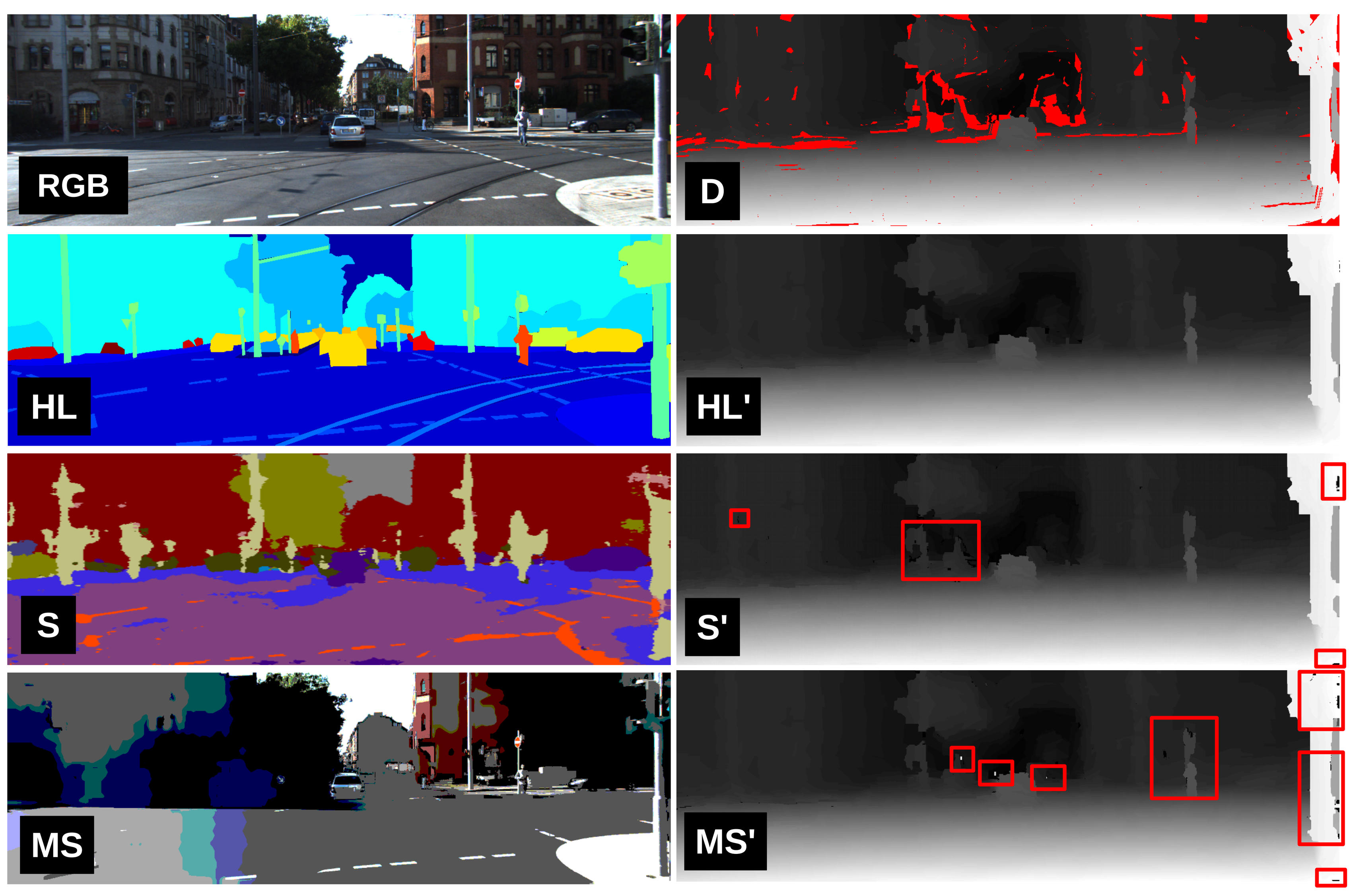


Qualitative Evolutions over KITTI Test Images.

Method	RMSE	PBMP	Run-time	Method	RMSE	PBMP	Run-time
Linear Inter.	1.3082	0.0246	25.12 ms	Result of [4]	0.6188	0.0030	8.25 min
Cubic Inter.	1.3501	0.0236	27.85 ms	Result of [5]	1.0117	0.0365	4.307 s
Result of [2]	0.7797	0.0383	3.521 s	Result of [6]	0.6944	0.0058	3.43 h
Result of [3]	3.7382	0.0245	51.56 s	Our Result	0.4869	0.0016	99.09 ms

Qualitative Evolutions over Middlebury Test Images (mean results).

Any and all segmentation methods can be used with the approach with the qualities of the segmentation and the final result corresponding directly.



Effects of the Quality of the Segmentation Step on the Results.

[1] Badrinarayanan, V. and Kendall, A. and Cipolla, R., "SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation," in IEEE Trans. Pattern Analysis and Machine Intelligence, 2017.
[2] Liu, J. and Gong, X. and Liu, J., "Guided inpainting and filtering for kinect depth maps". In Int. Conf. Pattern Recognition, 2011.
[3] Herrera, D. and Kannala, J. and Heikkilä J., "Depth map inpainting under a second-order smoothness prior," In Scandinavian Conference on Image Analysis, 2013.
[4] Arias, P. and Facciolo, G. and Caselles, V. and Sapiro, G., "Variational framework for exemplar based image inpainting," in Int. J. Computer Vision, 2011.
[5] Telea, A., "An image inpainting technique based on the fast marching method," in Graphics Tools, 2004.
[6] Atapour-Abarghouei, A. and Payen de La Garanderie, G. and Breckon, T. P., "Back to butterworth - a Fourier basis for 3d surface relief hole filling within rgb-d imagery" in Int. Conf. Pattern Recognition, 2016.