Illuminant Color Estimation for Real-World Mixed-Illuminant Scenes

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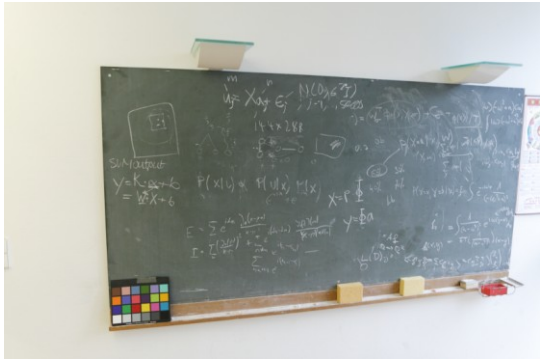
Pattern Recognition Lab
University of Erlangen-Nuremberg

Motivation

- Multi-illuminant scenarios are common!
- Most algorithms aim at single-illuminant setups
- Additional challenges:
  - Segmentation
  - Data poverty



Algorithm Outline (a draft to pick up the challenge)

- Segment image into homogeneous color [1]
- Perform illuminant estimation per segment
- Group illuminant estimates with quickshift [2]
- Keep the largest segments

[1] Felzenszwalb, P.F., Huttenlocher, D.P.: Efficient Graph-based Image Segmentation. International Journal of Computer Vision 59 (2004) 167-181.
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Algorithm Outline (a draft to pick up the challenge)

- Segment image into homogeneous color [1]
- Perform illuminant estimation per segment
- Group illuminant estimates with quickshift [2]
- Keep the largest segments
- The results are quite often plausible
  (we have no ground truth, unfortunately)

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Local Estimates: Inverse Intensity-Chromaticity (IIC)

- Physics-based color space by Tan et al. [3]:

Chromaticity Geometry Intensity Specular chromaticity

$$\sigma_c(\mathbf{x}) = p_c(\mathbf{x}) \frac{1}{\sum_i I_i(\mathbf{x})} + \Gamma_c$$

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Chromaticity channel

Color bands (camera)

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$$y = m \cdot x + t$$

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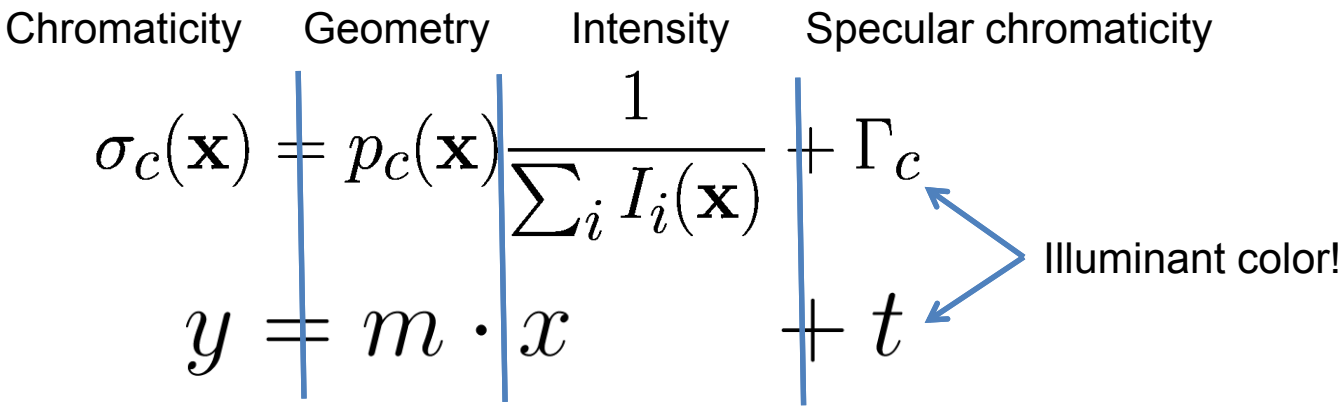

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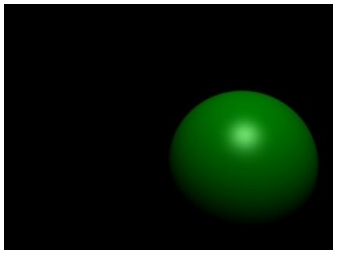

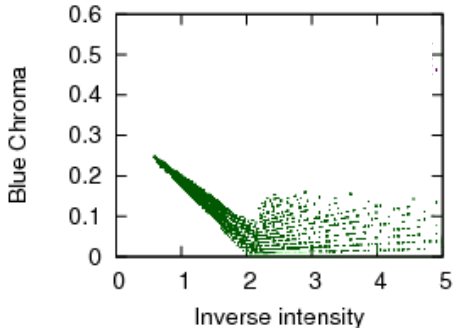

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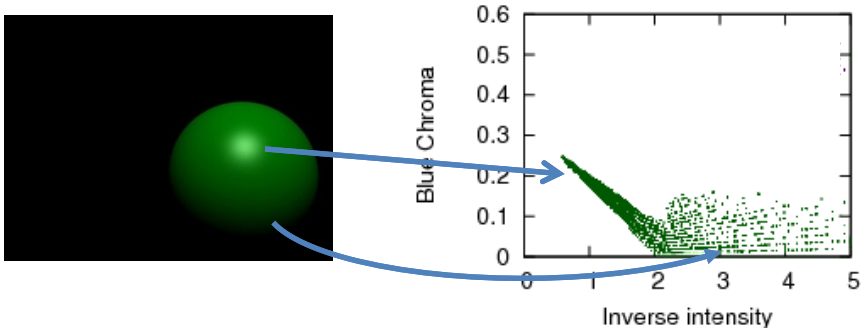

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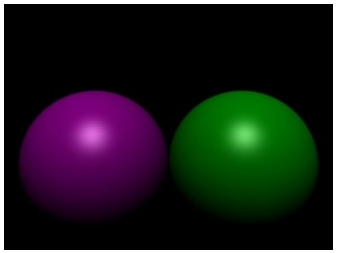

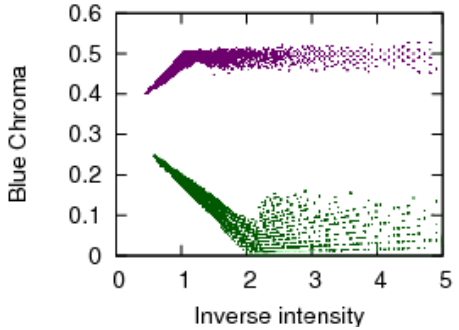

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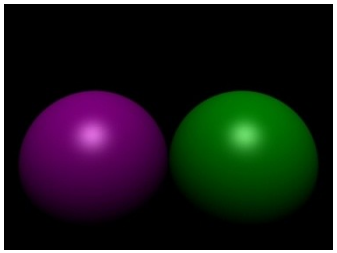

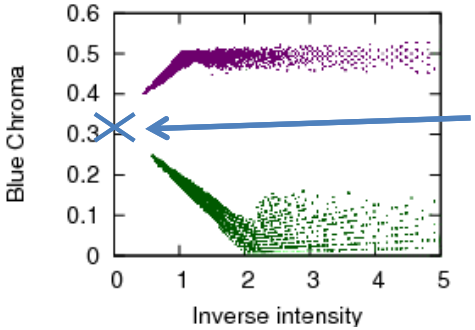

Blue component of the illuminant chroma!

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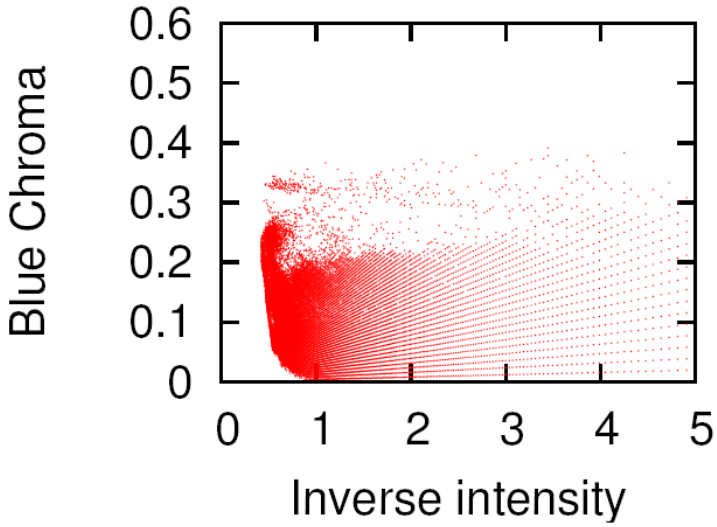
Local Exploitation of IIC Distribution

- Specular pixels point towards illuminant color
- Specularity segmentation too hard?
- -> „some specularity“ often suffices!



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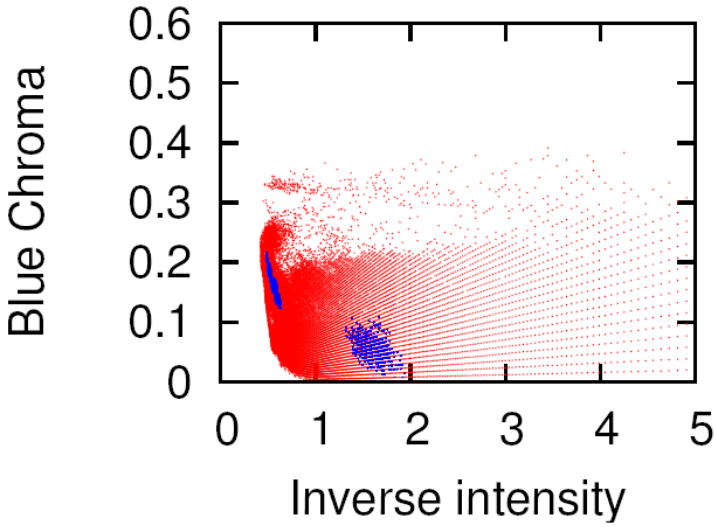

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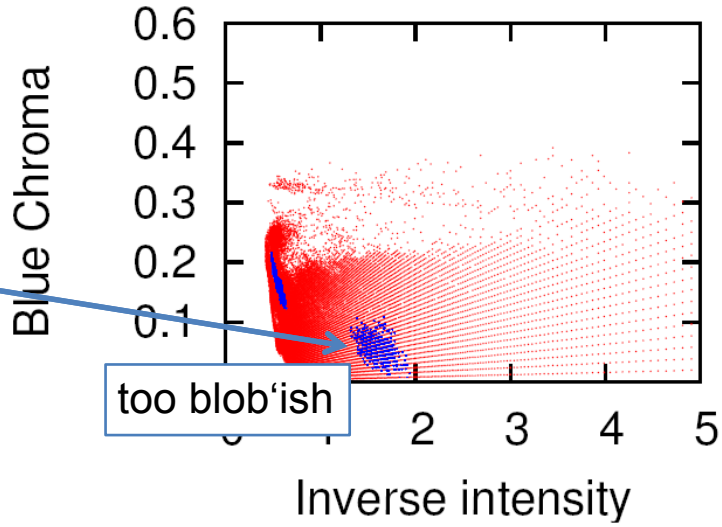

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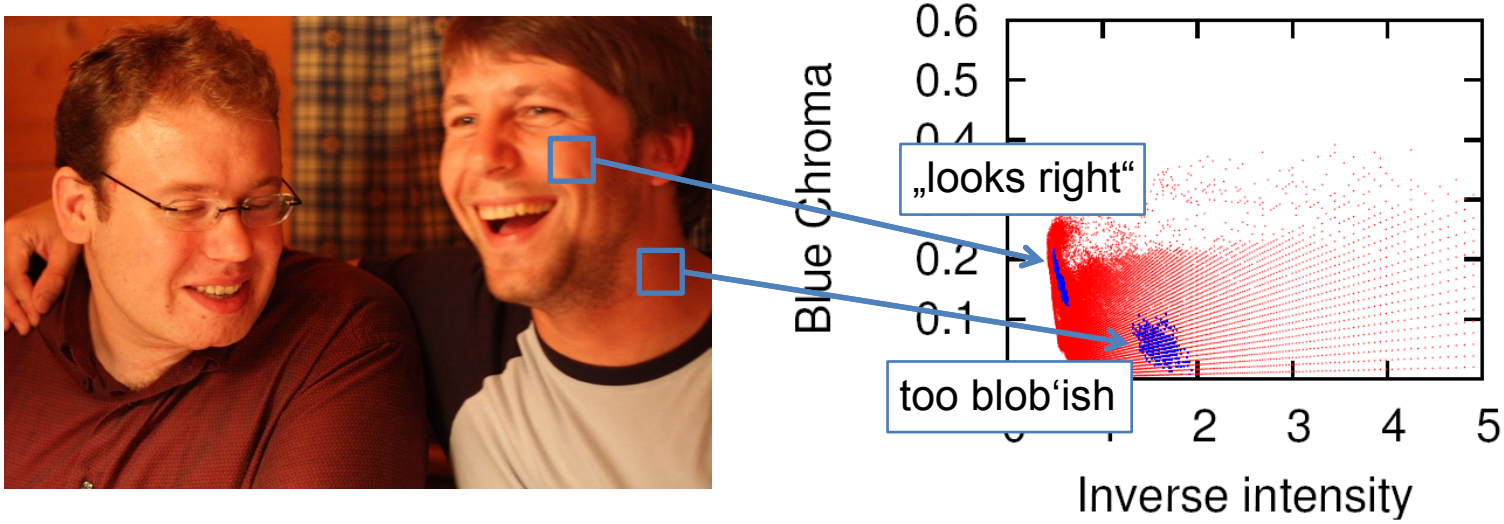


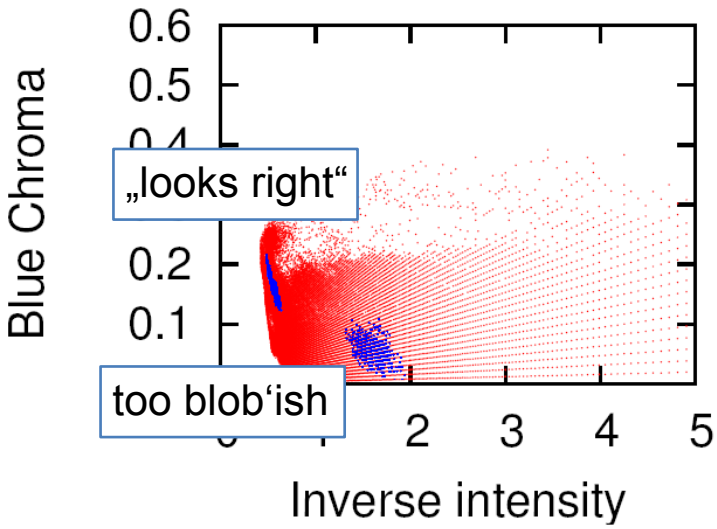
Selecting the patches in IIC space

- Eigendecomposition of the pixels in IIC space
- Eccentricity captures „blobbiness“:

$$\mathrm{ecc}(P_{\mathrm{IIC}}) = \sqrt{1 - \frac{\sqrt{\lambda_2}}{\sqrt{\lambda_1}}}$$

- Remove horizontal point distributions in IIC space: purely diffuse pixels!

(Note that an error-free selection would by the way solve specularity segmentation)



Fusing Similar Estimates

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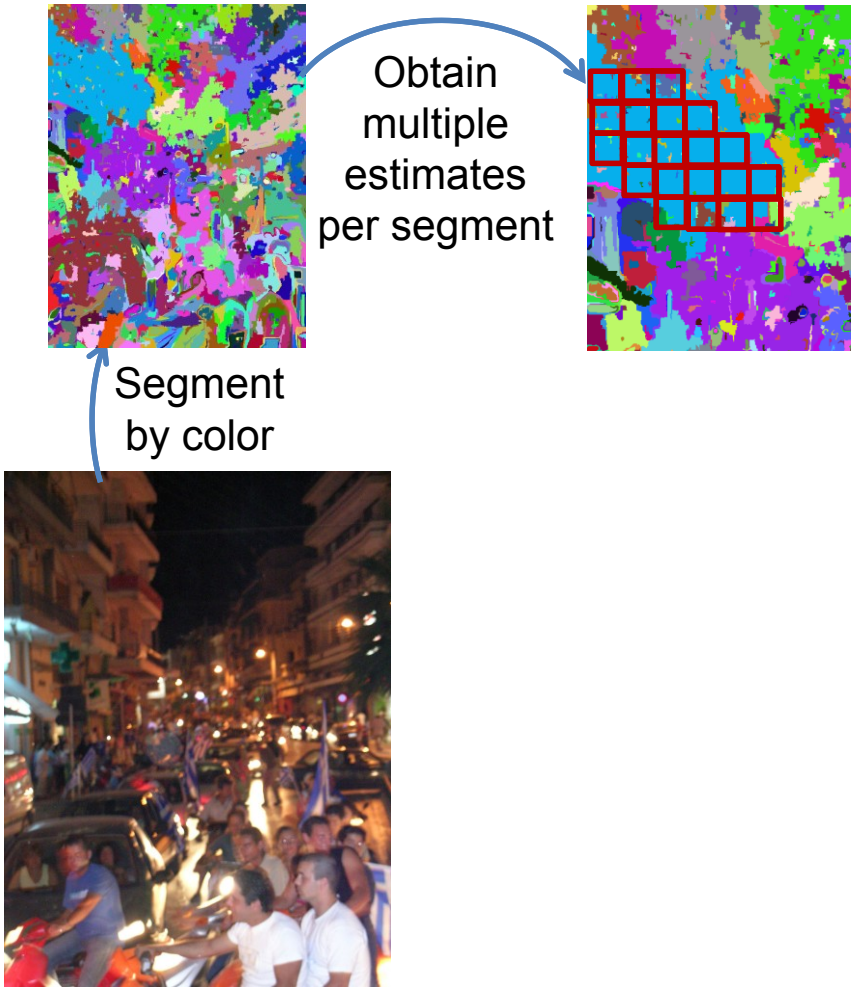
Segment
by color

Fusing Similar Estimates



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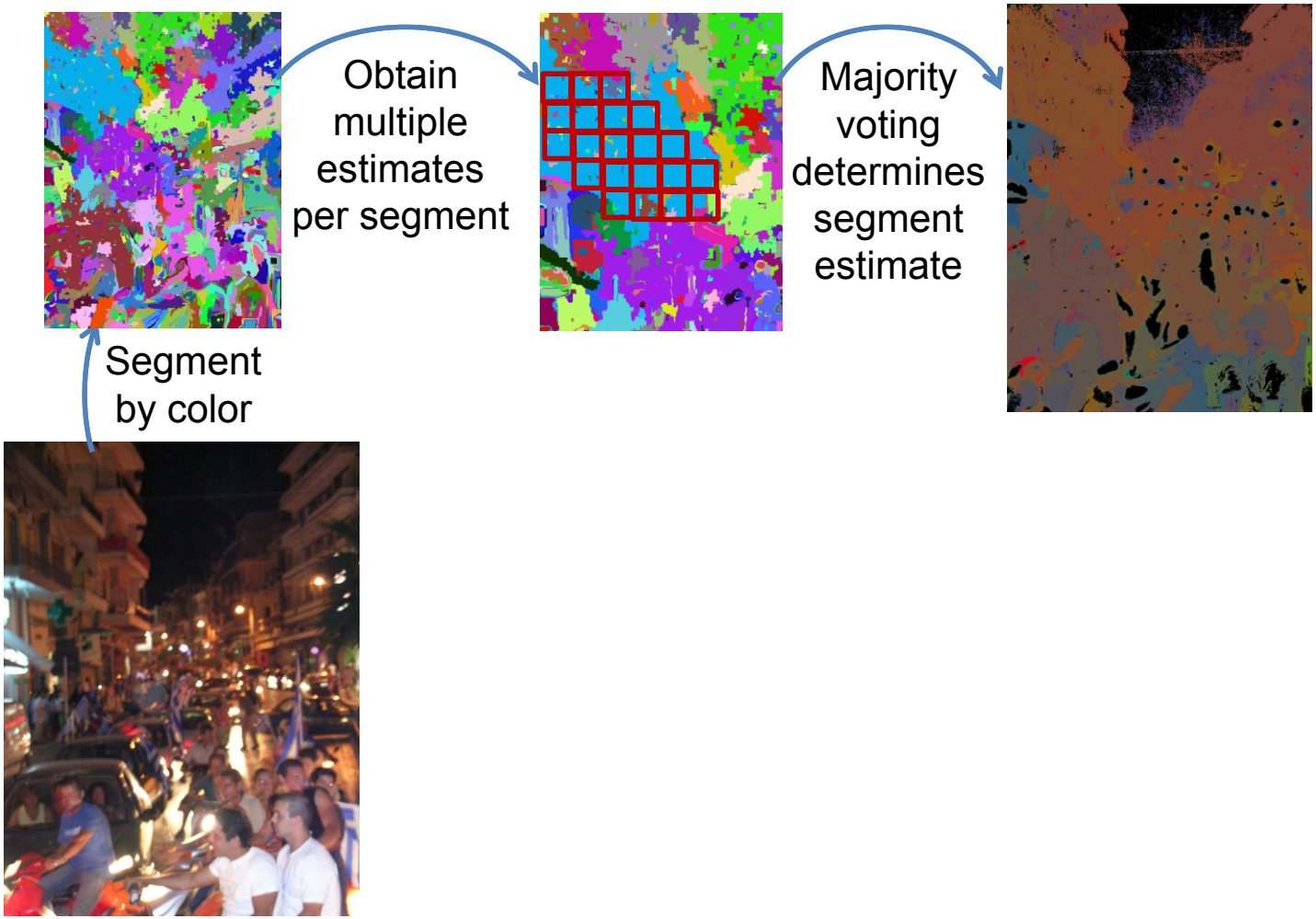

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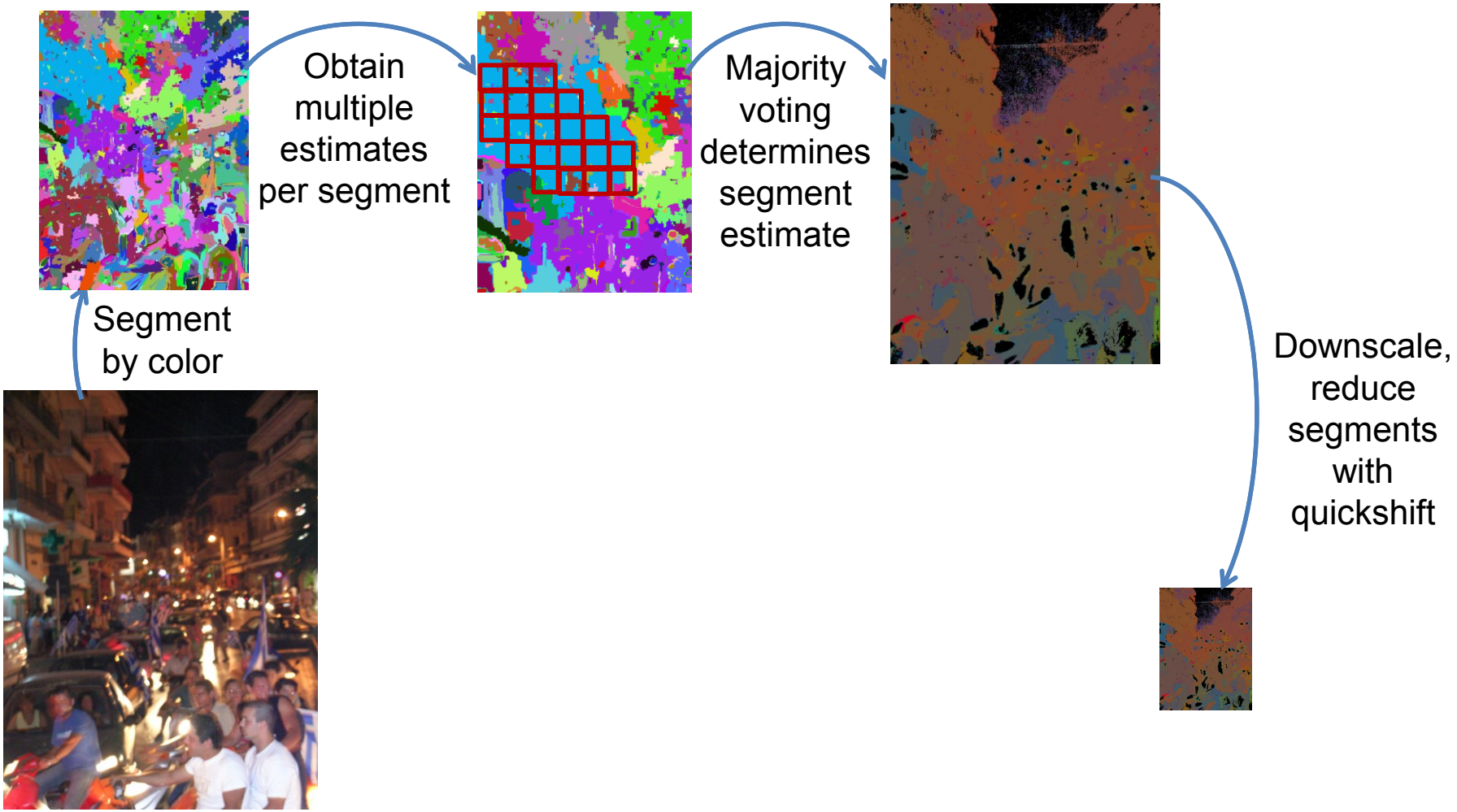

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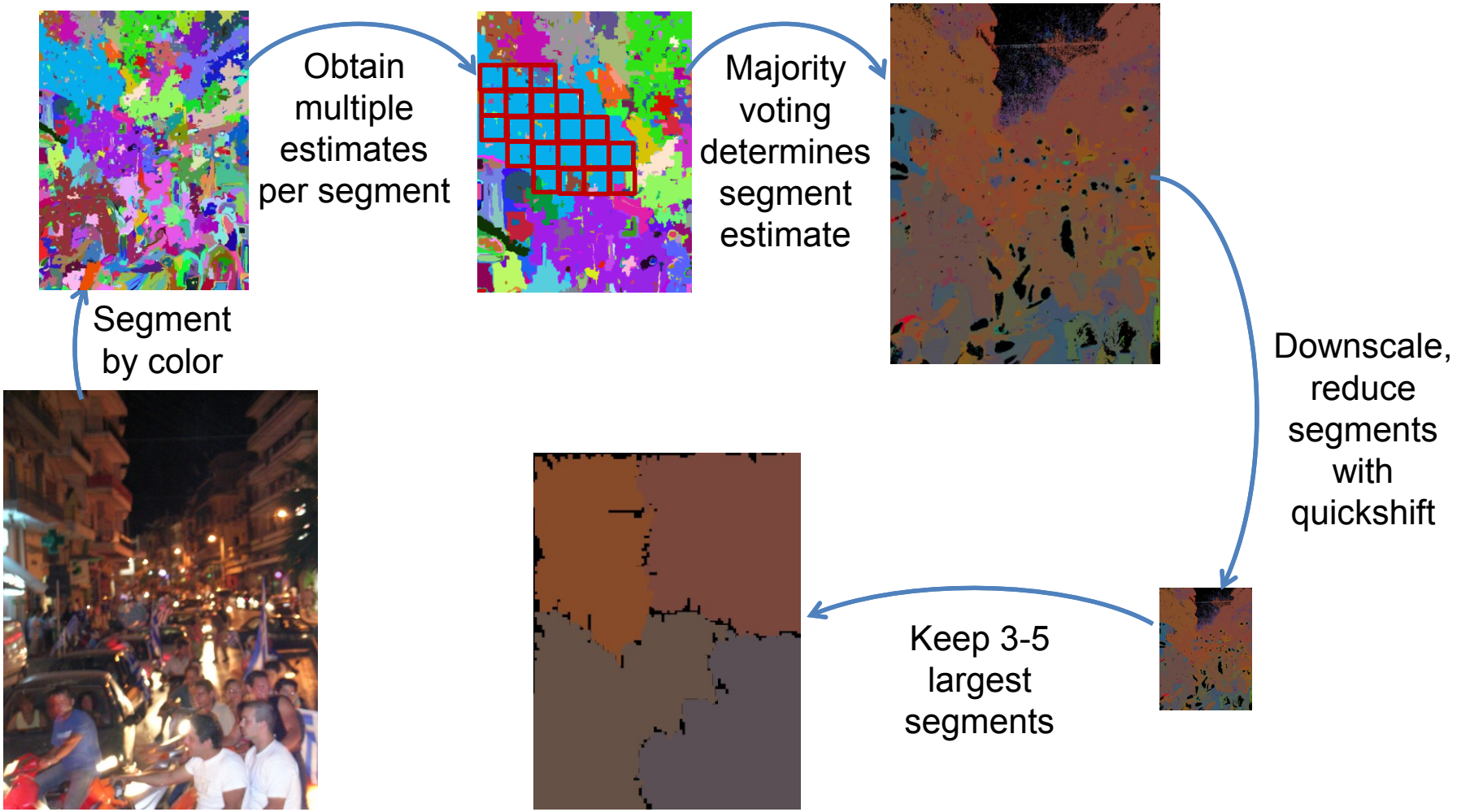

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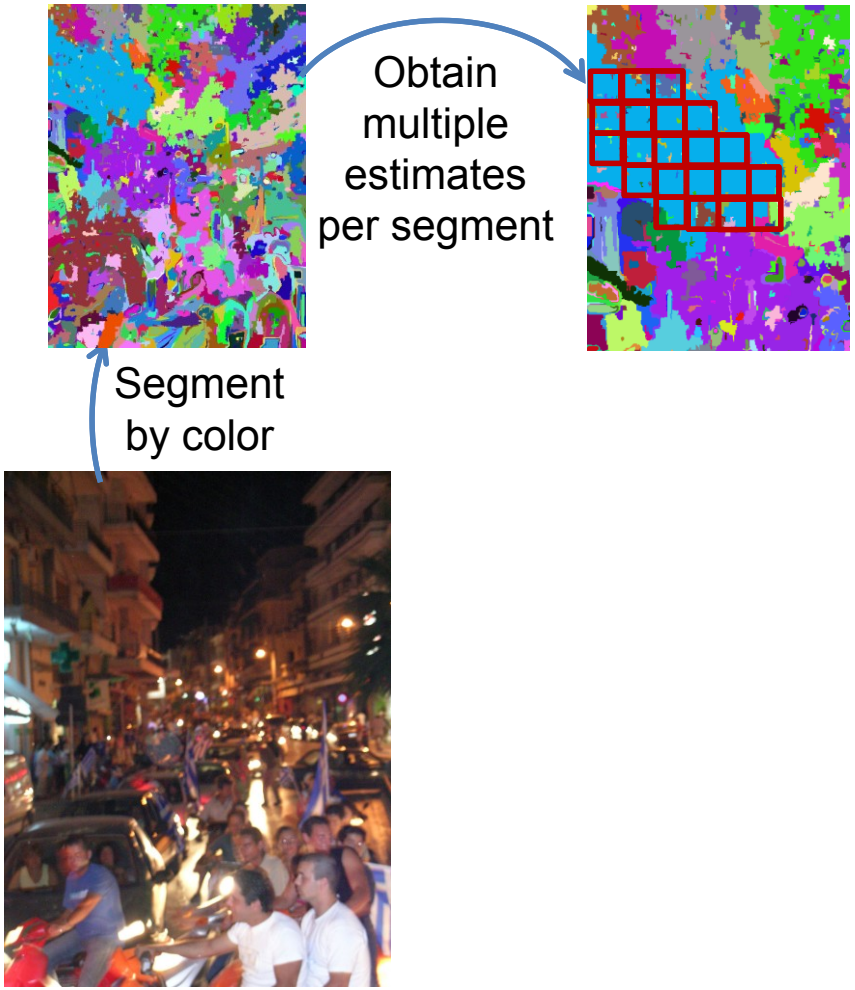
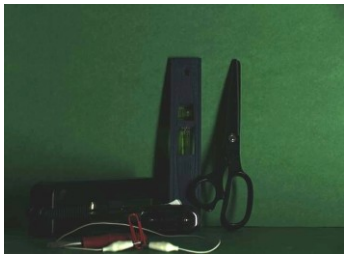


Voting on all segments gives a single-illuminant estimator

Quantitative results for single-illuminant estimation

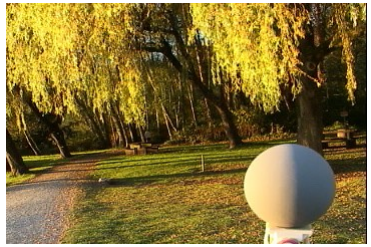
Database by Barnard et al.

Method	Median e
Gamut mapping	**3.1**
Gray world	8.8
White patch	5.0
Color by correlation	8.6
Original IIC method	-
Proposed method	*4.4*



Database by Ciurea and Funt

Method	Median e
Gamut mapping	5.7
Gray world	7.0
White patch	6.7
Color by correlation	6.5
1st-order gray edge	5.2 (*)
2nd-order gray edge	5.4 (*)
Original IIC method	5.1 (*)
Proposed method	***4.4***

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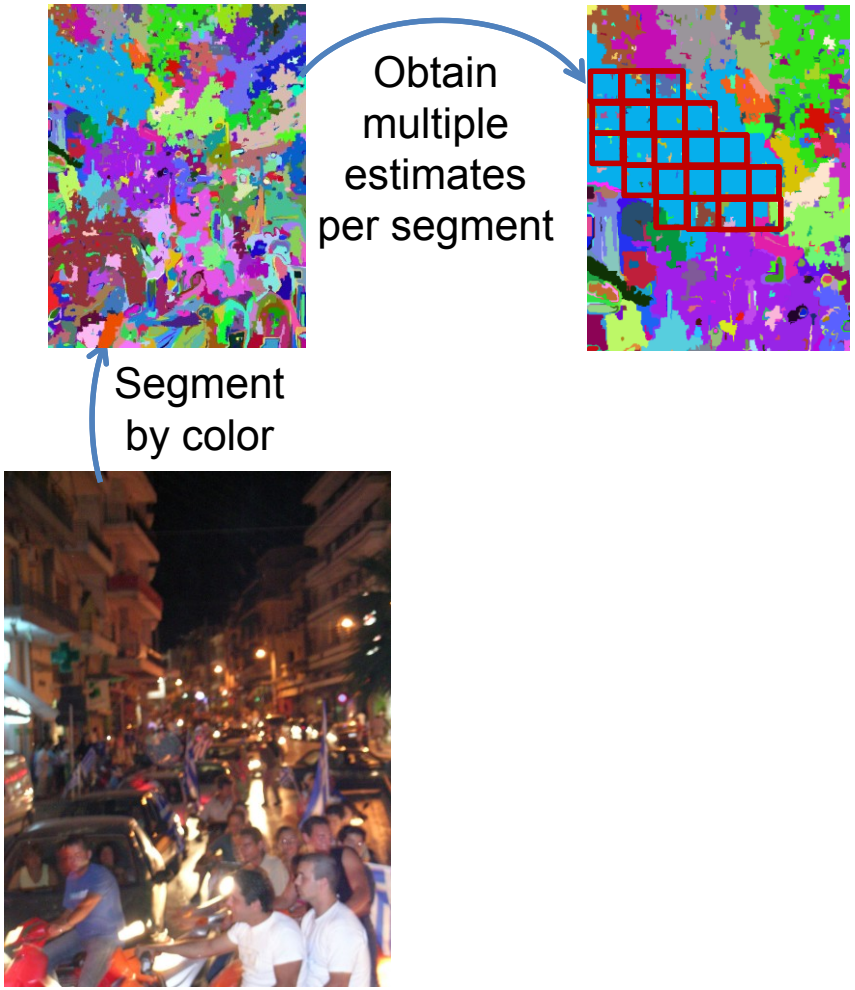

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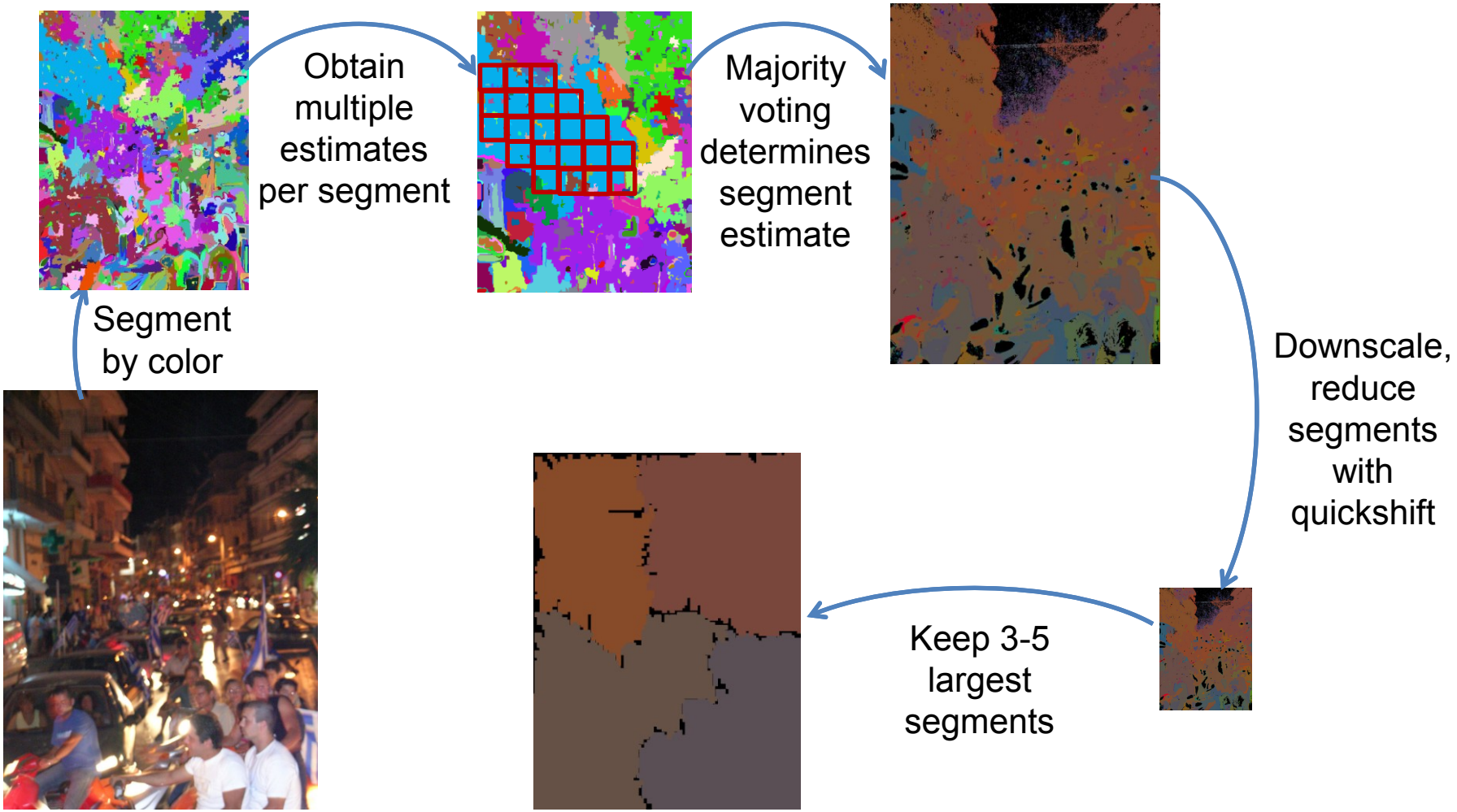
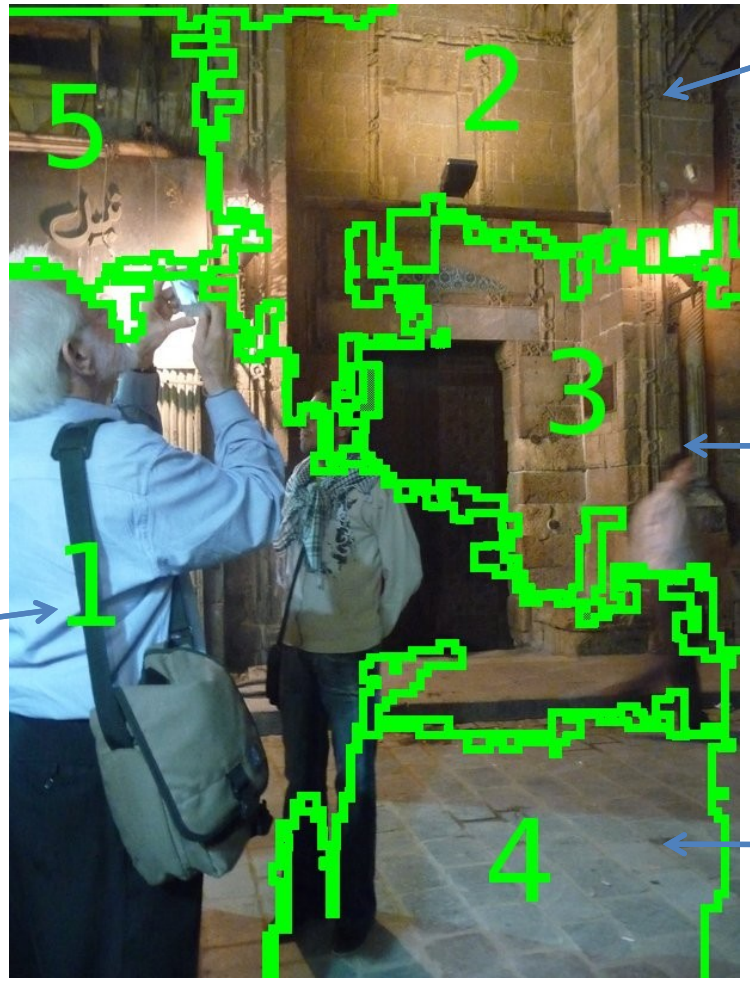


Qualitative results multi-illuminant estimation

Red / Blue:



(complete table in the paper,
or after the talk)

Qualitative results multi-illuminant estimation

Red / Blue:

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Qualitative results multi-illuminant estimation

0.797

Red / Blue:

1.32

0.878

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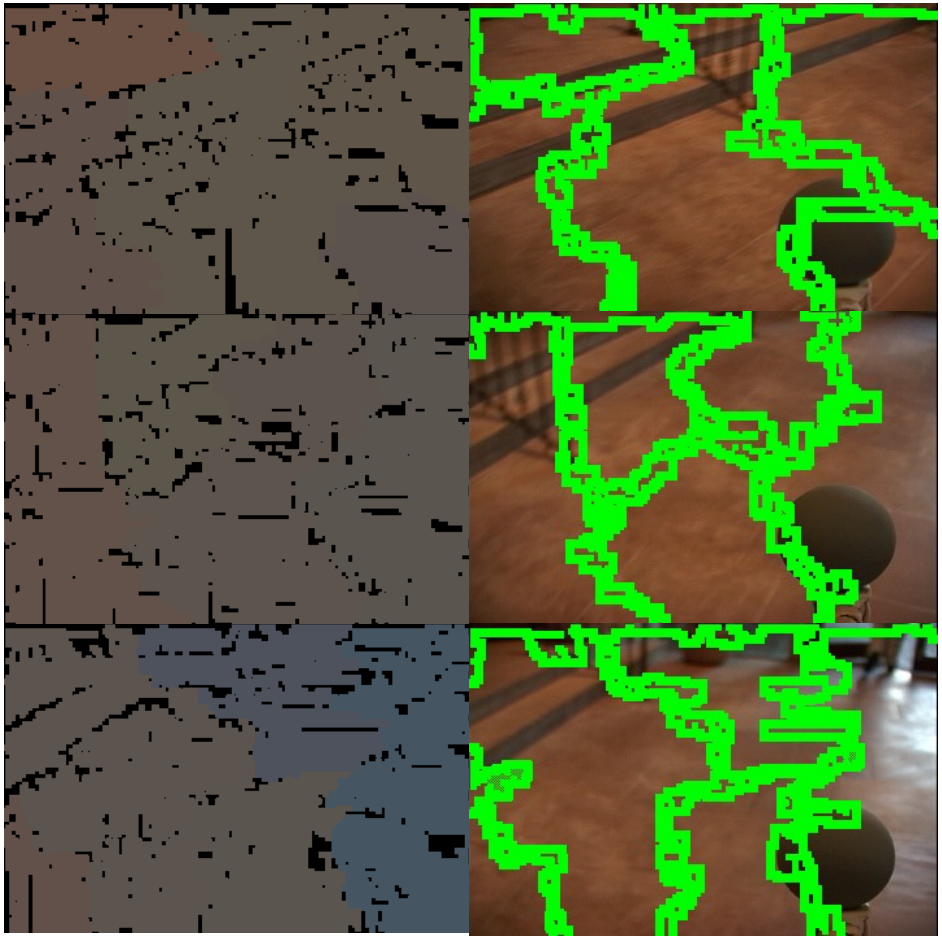
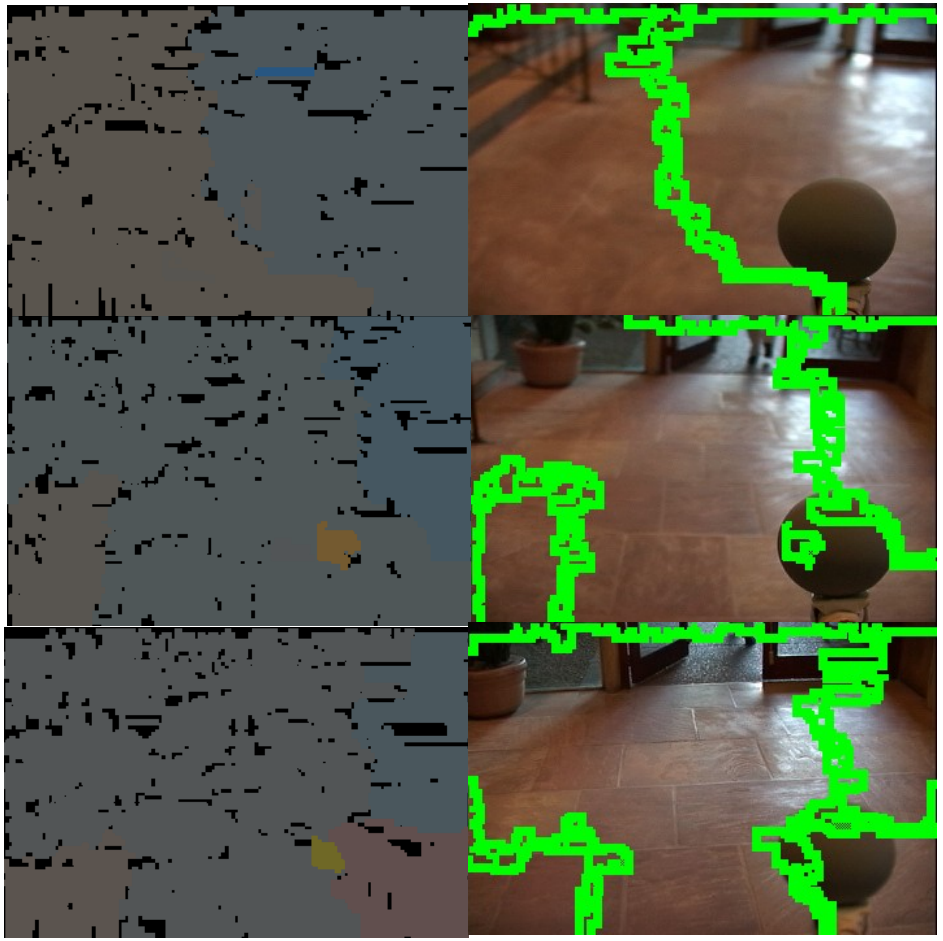
Stability over time

(ball was masked for quantitative results)





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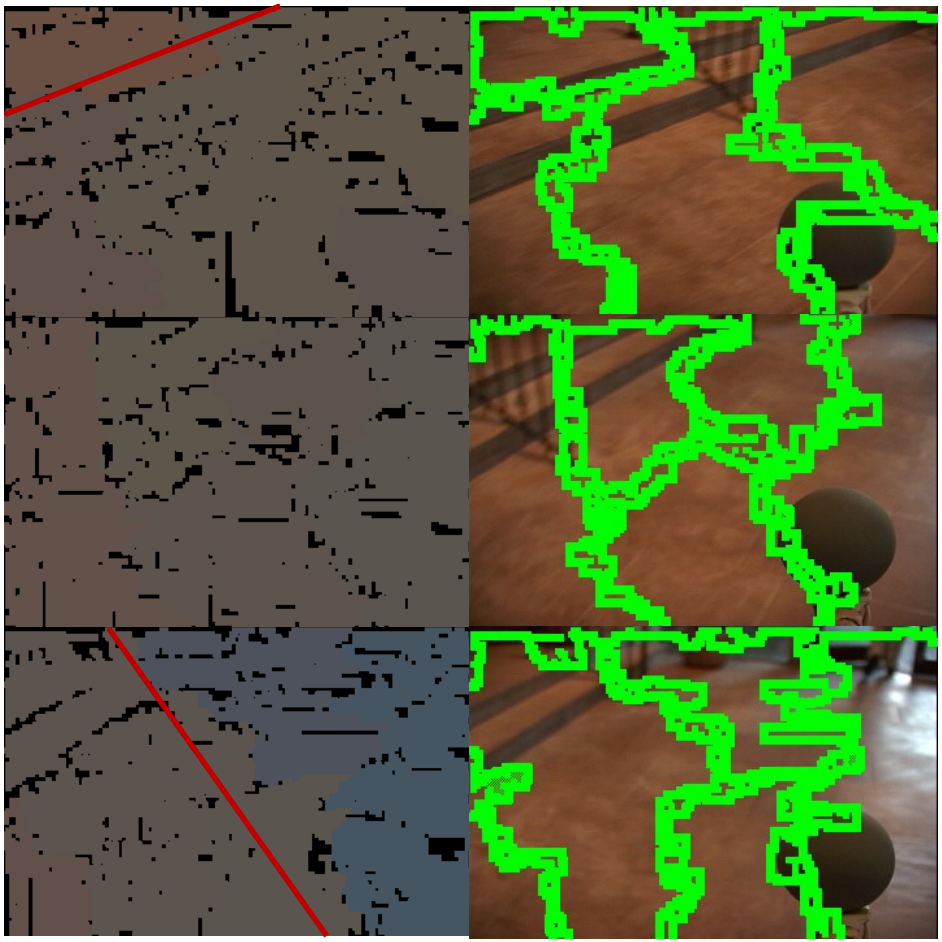

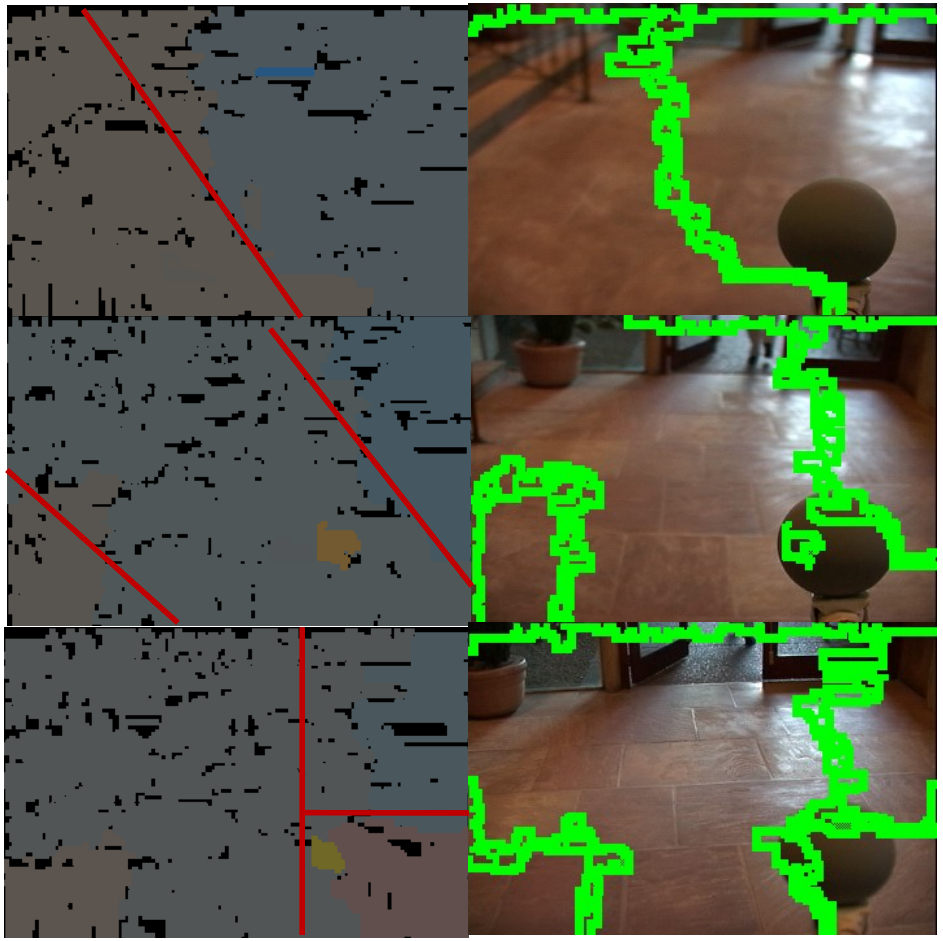

Stability over time (continued)

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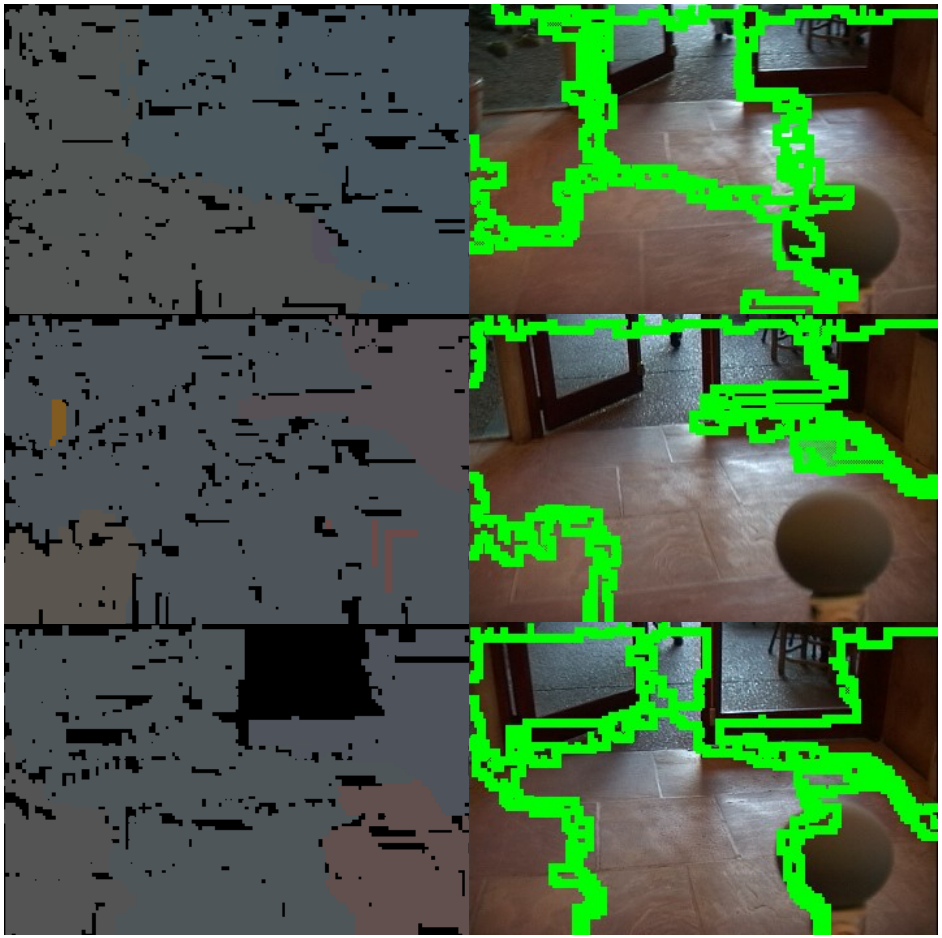

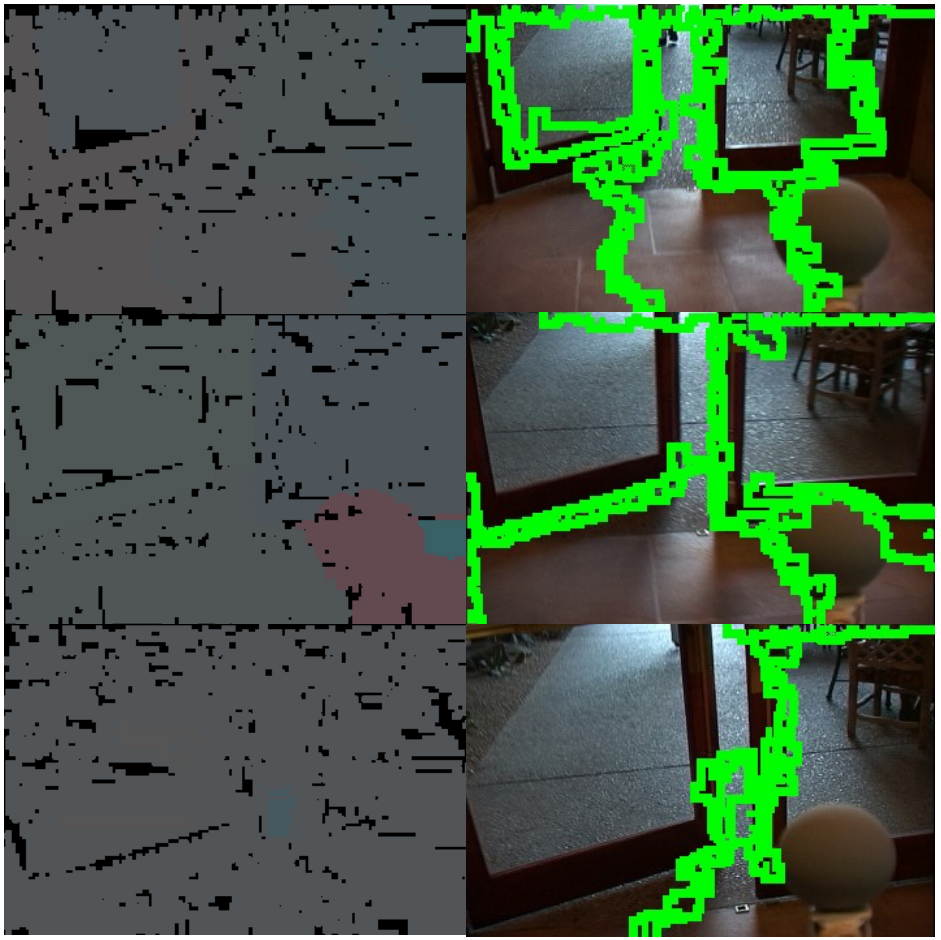

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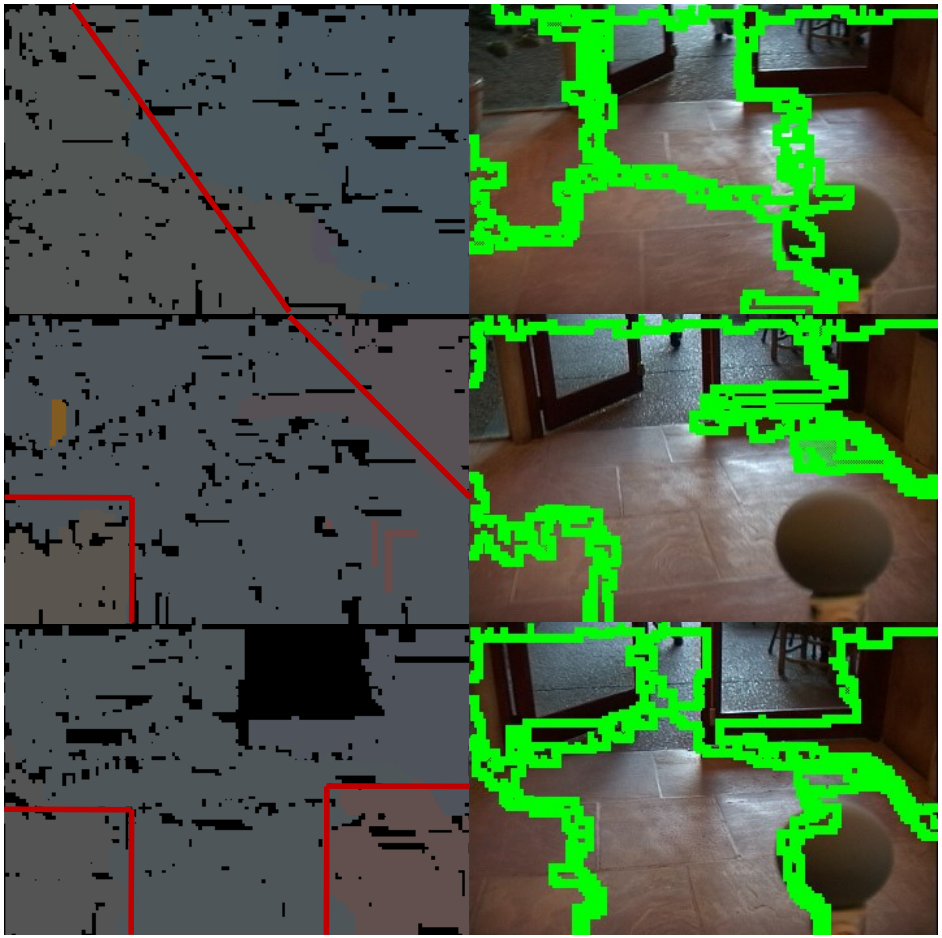

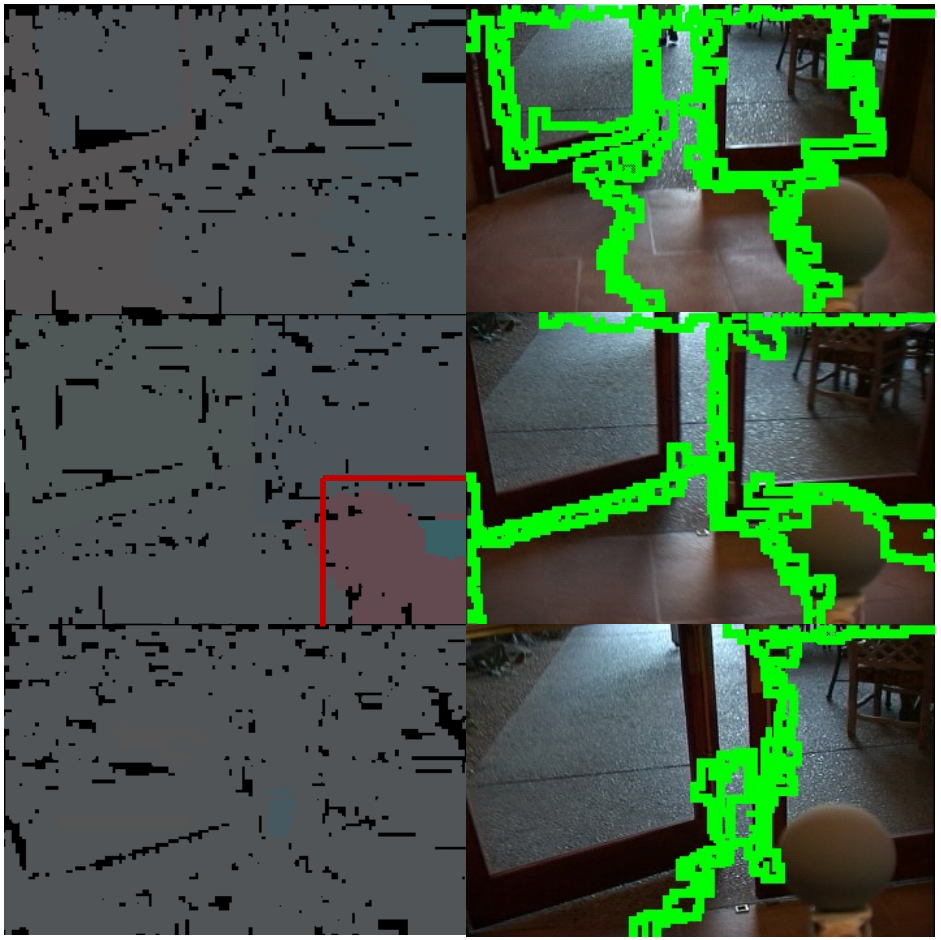

- Improved exploitation of IIC space for natural images
- IIC-based estimators require only small spatial support
- Multi-Illuminant estimation by incremental fusion of local estimates
- Ongoing research
  - Multi-Illuminant evaluation on ground-truth data
  - Refinement of the illuminant segmentation