DeepLSD: Line Segment Detection and Refinement with Deep Image Gradients

THU-AM-081

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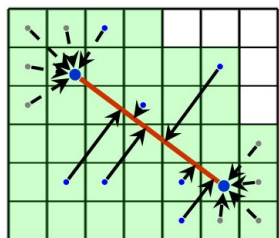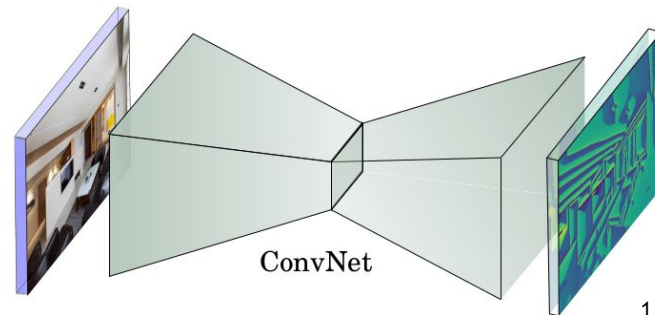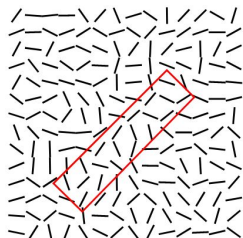Marc Pollefeys

DeepLSD: a line segment detector with …

… Robustness thanks to deep learning

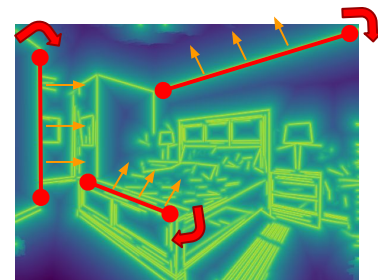⇒ An **attraction field** representation that require **no human labelling**
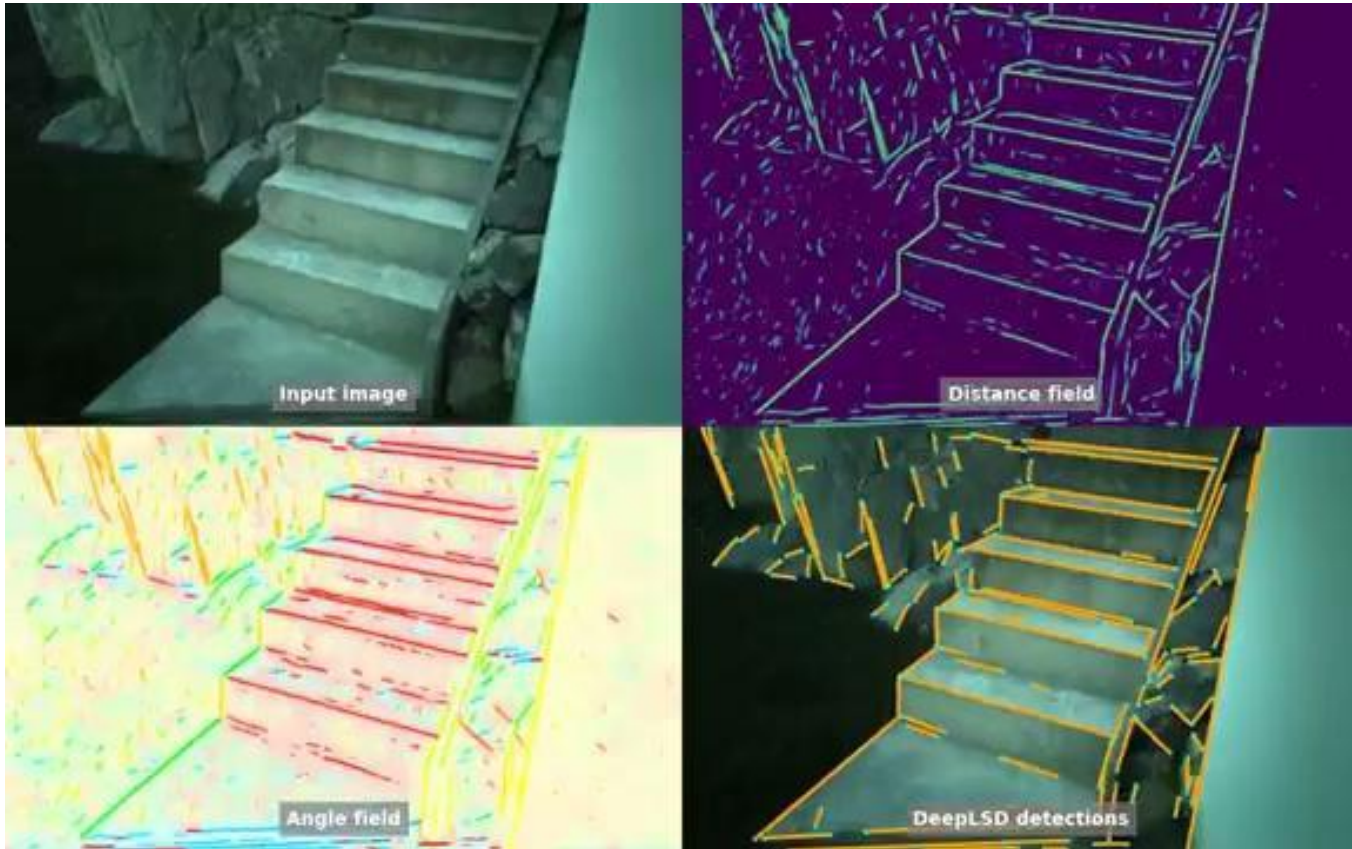

… Accuracy through low-level strategies

⇒ Extract line segments with **handcrafted** methods

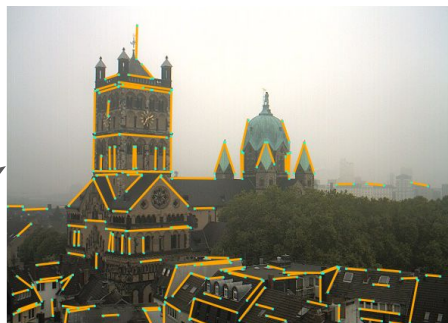## … Additional accuracy and repeatability

⇒ **Line refinement** through **optimization**
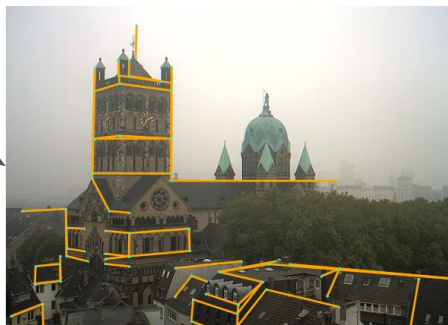
DeepLSD demo

Motivation

Handcrafted

Learned

- Fast
- Well localized

- Not robust to image changes

- Robust
- Can target specific lines

- Poorly localized
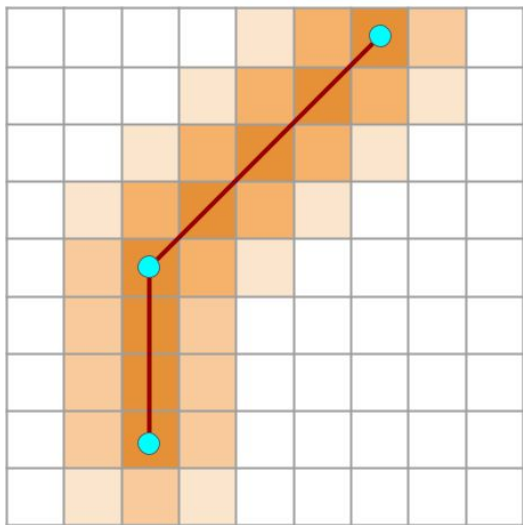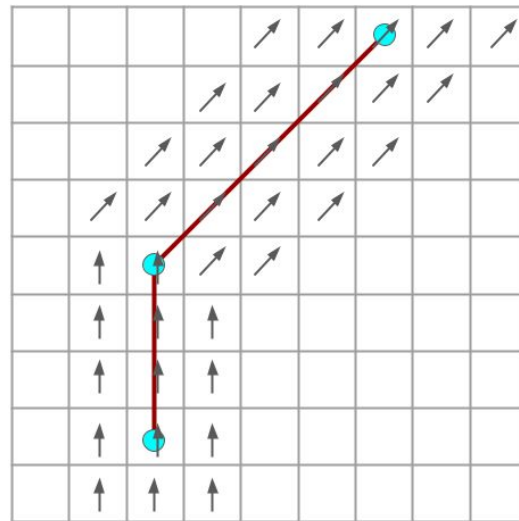- Often require human labels

Motivation

DeepLSD

- Robust
- Well localized
- No human labels required

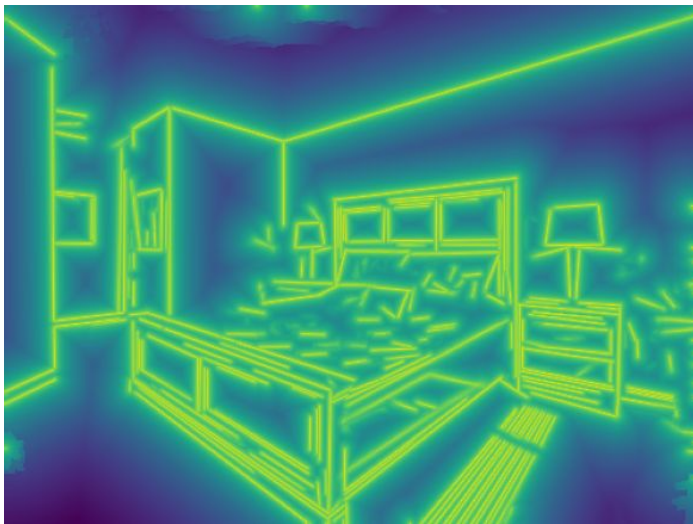# A line representation suitable for deep learning
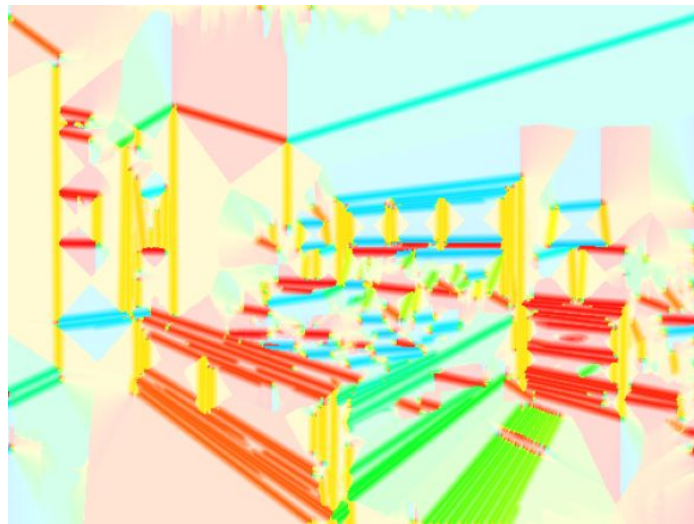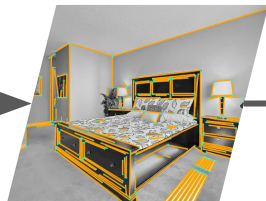

Line distance field

Line angle field

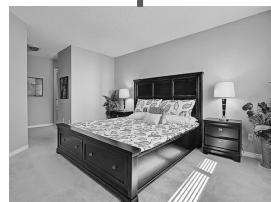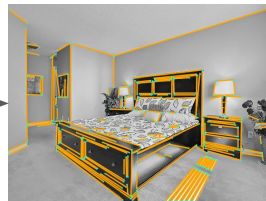# A line representation suitable for deep learning

Line distance field

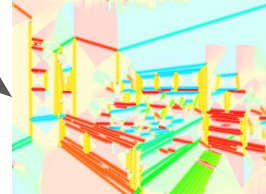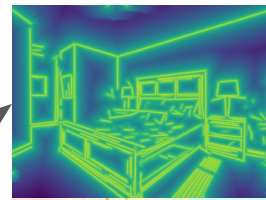
Line angle field

Line ground truth generation

Warp
+
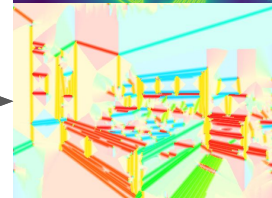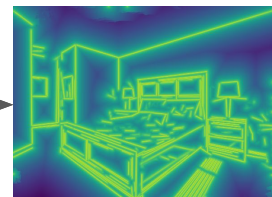LSD[1]

Warp
back

Convert to
attraction field

Aggregate

1 R. Grompone von Gioi et al., LSD: A fast line segment detector with a false detection control, PAMI 2008

JUNE 18-22, 2023

CVPR

VANCOUVER, CANADA
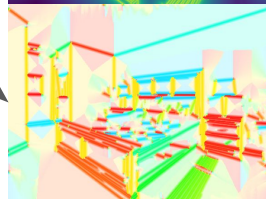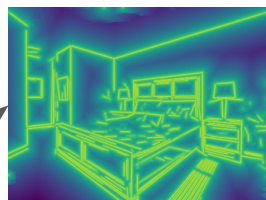
Attraction field inference

3x3 Conv 2x2 Avg pooling Skip connection

1x1 Conv Bilinear upsampling

⇒ **Robustness**
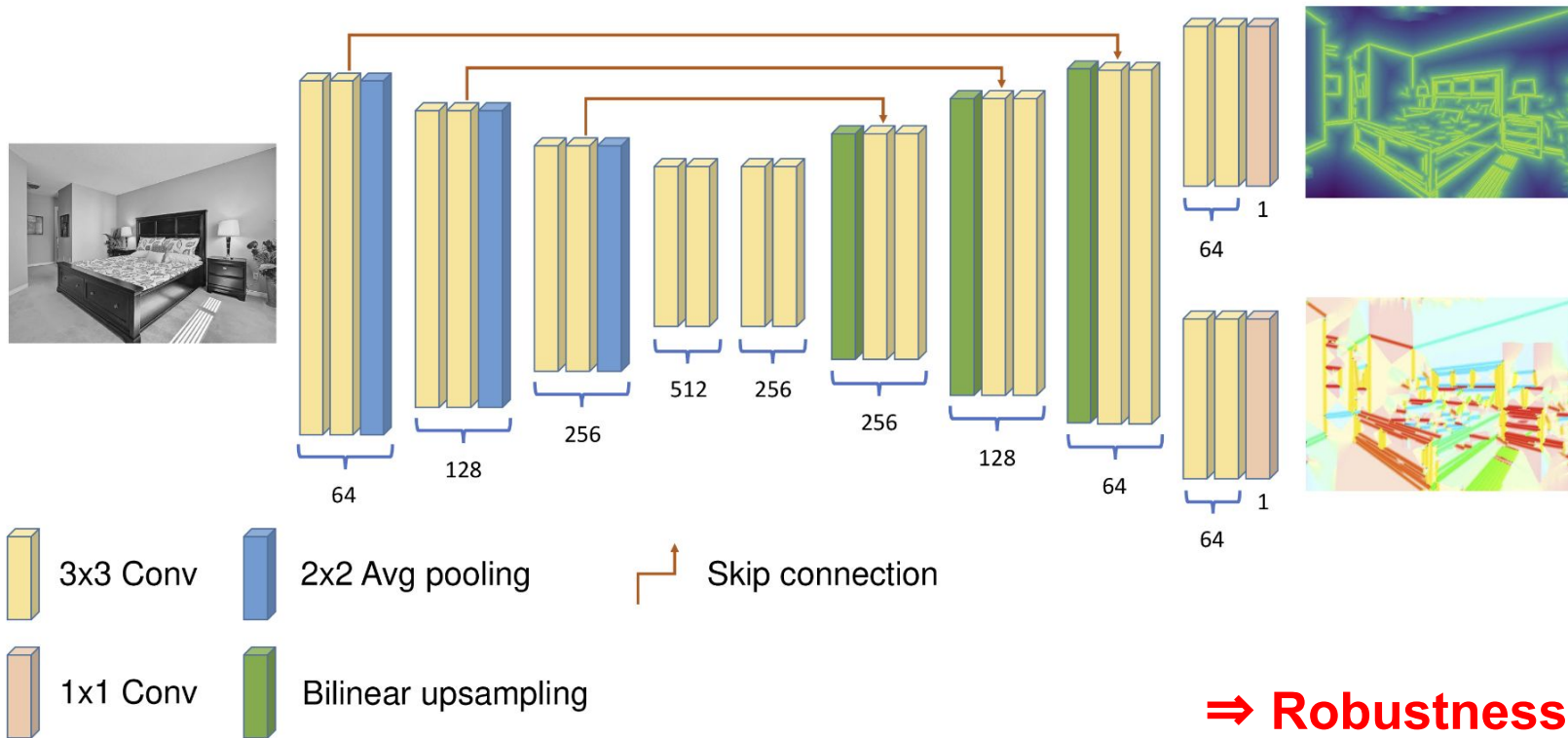
From attraction field to line segments
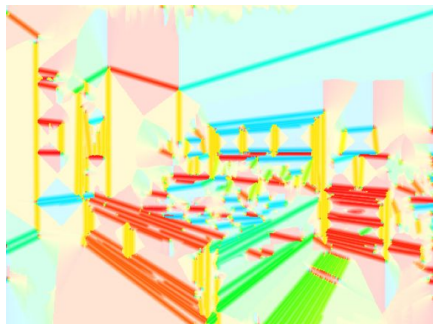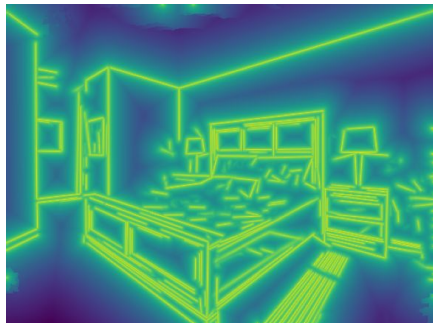
Attraction field
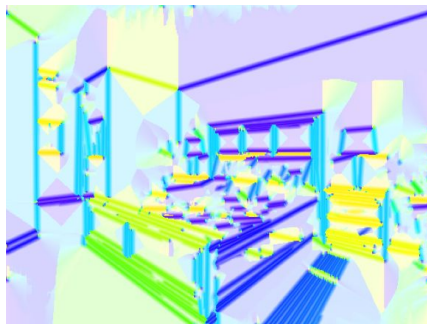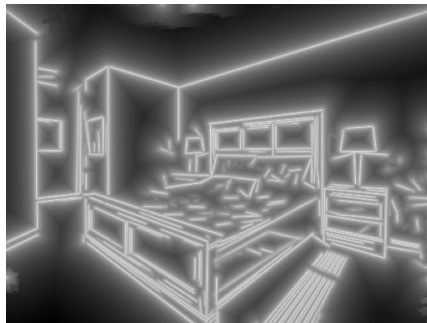
Deep image gradient

LSD[1]

⇒ Accuracy

1 R. Grompone von Gioi et al., LSD: A fast line segment detector with a false detection control, PAMI 2008
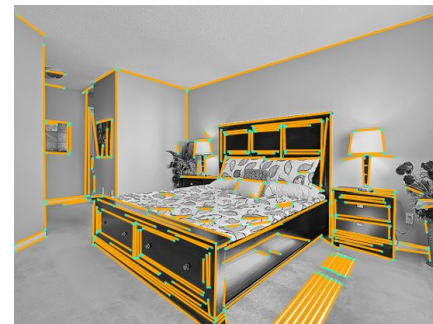
Final line refinement
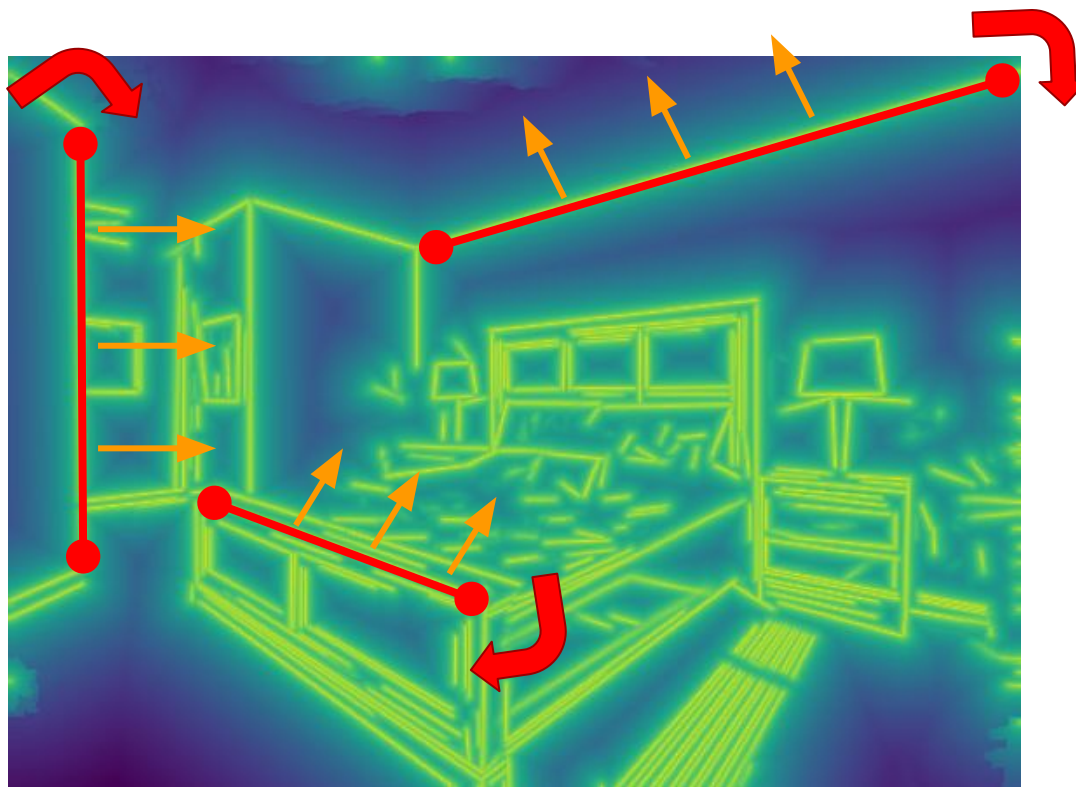
⇒ **Increased accuracy**

A refinement that can be applied to any detector
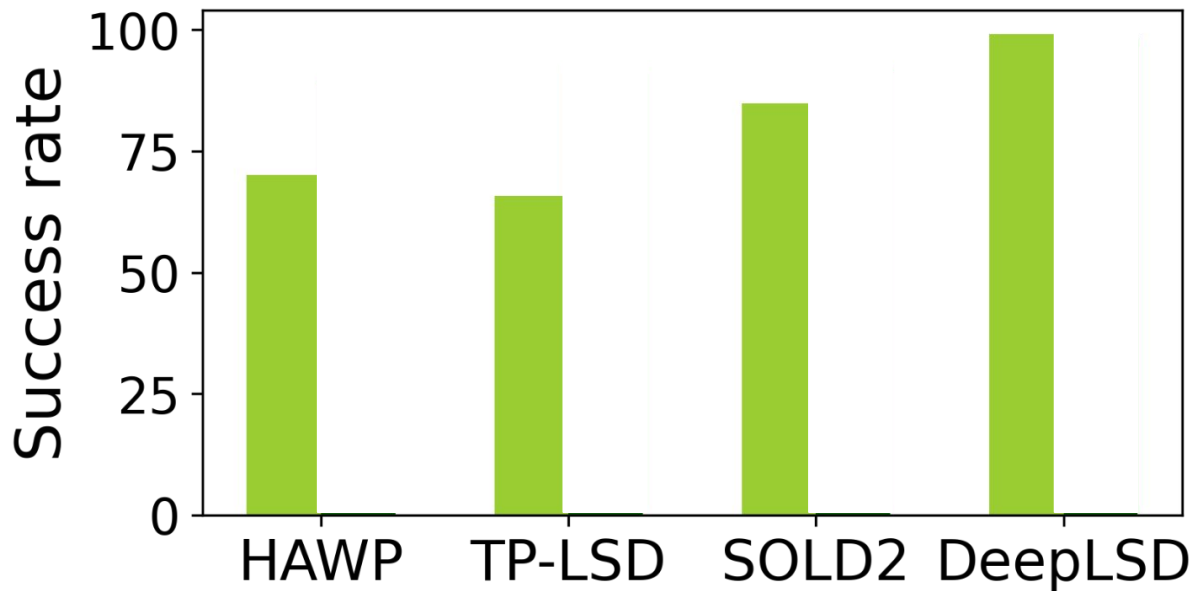
Homography estimation on the Wireframe dataset

A refinement that can be applied to any detector
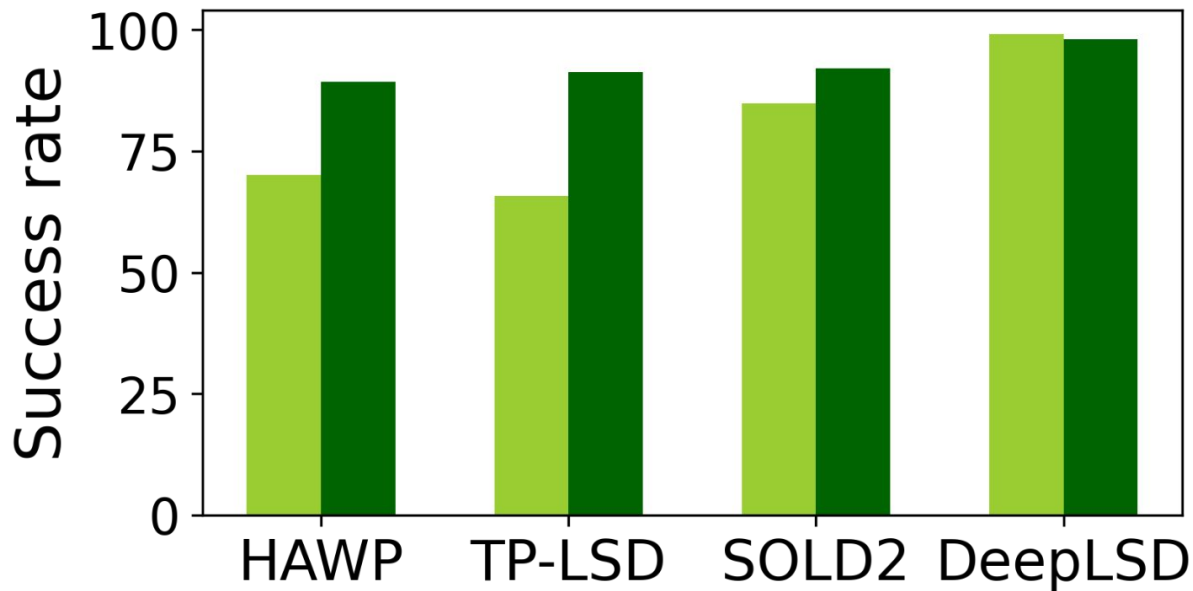
Homography estimation on the Wireframe dataset

Robustness + high accuracy = new applications[1]

1 S. Liu et al., 3D Line Mapping Revisited, CVPR 2023

Robustness + high accuracy = precise localization
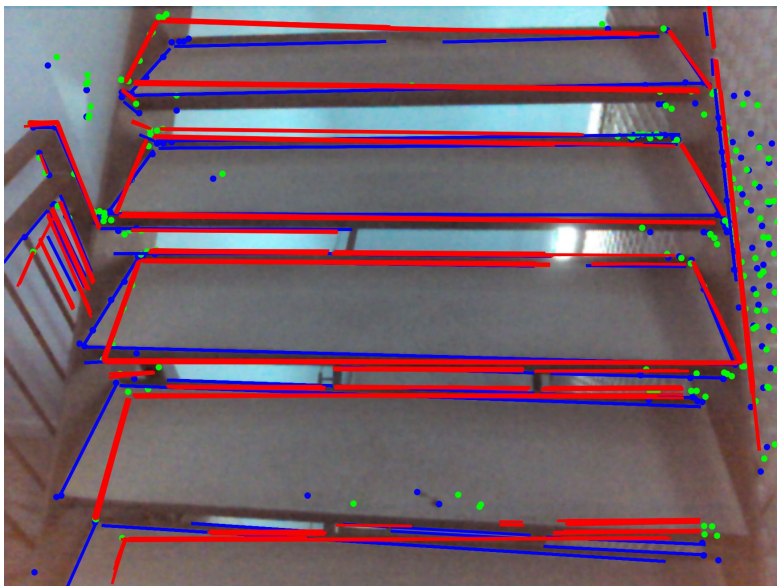
Reprojected points and lines to the
camera pose predicted by HLoc[1]

Visual localization on
7Scenes stairs:

	Trans / Rot error ↓	Accuracy ↑
HLoc	4.7 / 1.25	53.4

1 PE Sarlin et al., From Coarse to Fine: Robust Hierarchical Localization at Large Scale, CVPR 2019

Robustness + high accuracy = precise localization

Reprojected points and lines to the
camera pose predicted by our PL-HLoc

Visual localization on
7Scenes stairs:

	Trans / Rot error ↓	Accuracy ↑
HLoc	4.7 / 1.25	53.4
DeepLSD	**3.1 / 0.85**	**76.6**

+43%

DeepLSD: Conclusion

- A hybrid line detector that **requires no human labels**, is **robust** to image changes, and is **highly accurate**

- A **line refinement** that can **boost the accuracy of existing line detectors**

- Can **unlock line-based geometrical applications** and obtain **state-of-the-art** results when used in combination with points

Project page:

Paper:

Code: