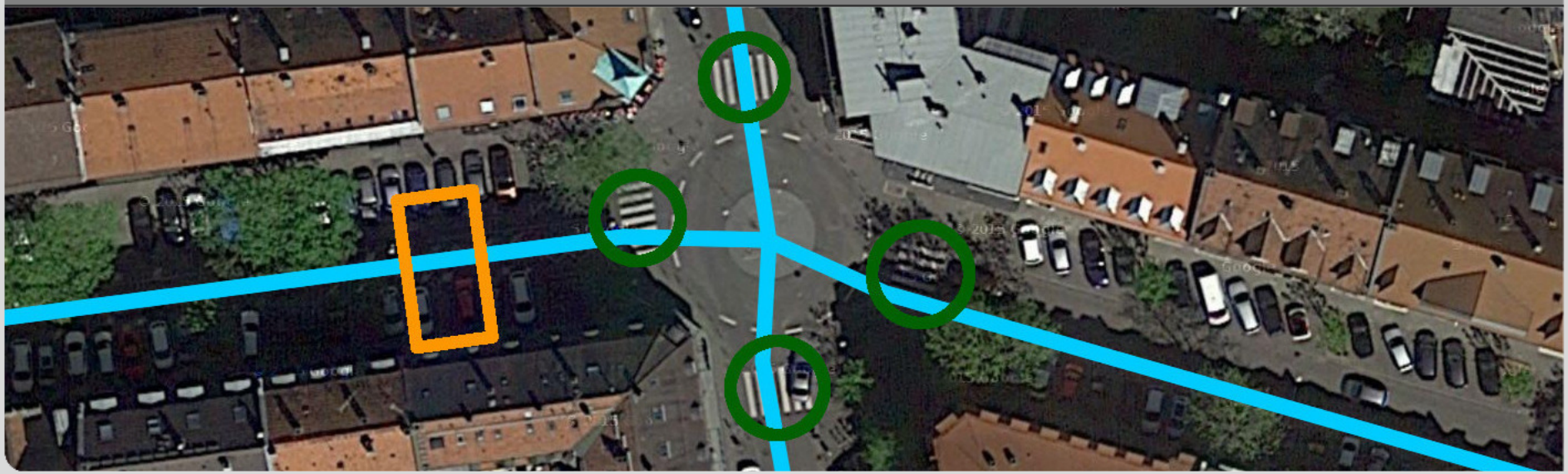
Karlsruhe Institute of Technology

Zebra Crossing Detection from Aerial Imagery Across Countries

Daniel Koester, Björn Lunt, Rainer Stiefelhagen

INSTITUTE FOR ANTHROPOMATICS AND ROBOTICS – COMPUTER VISION FOR HUMAN COMPUTER INTERACTION



Motivation

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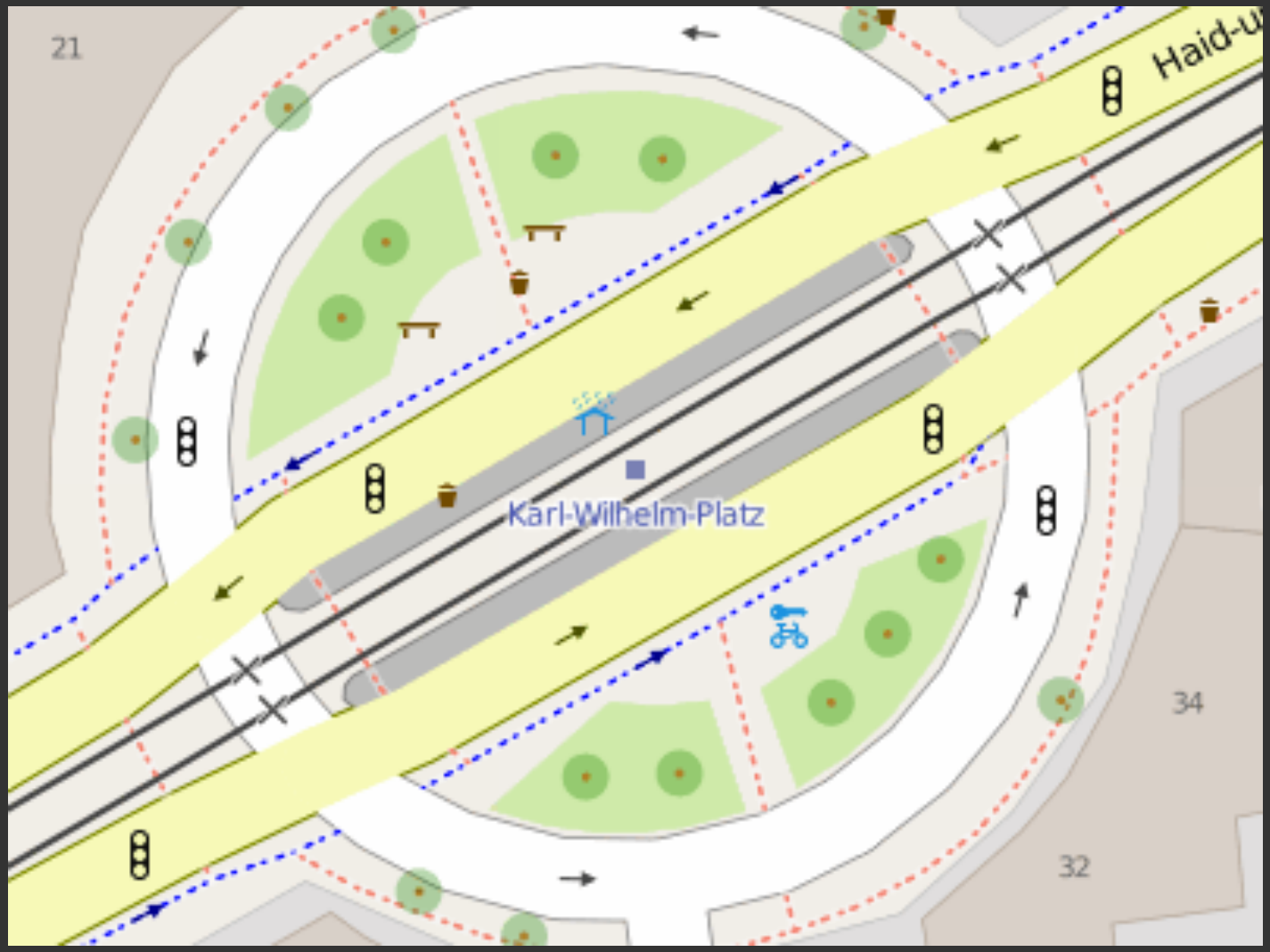
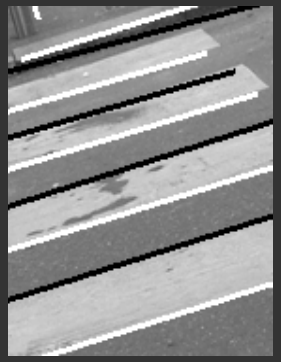


Related Work



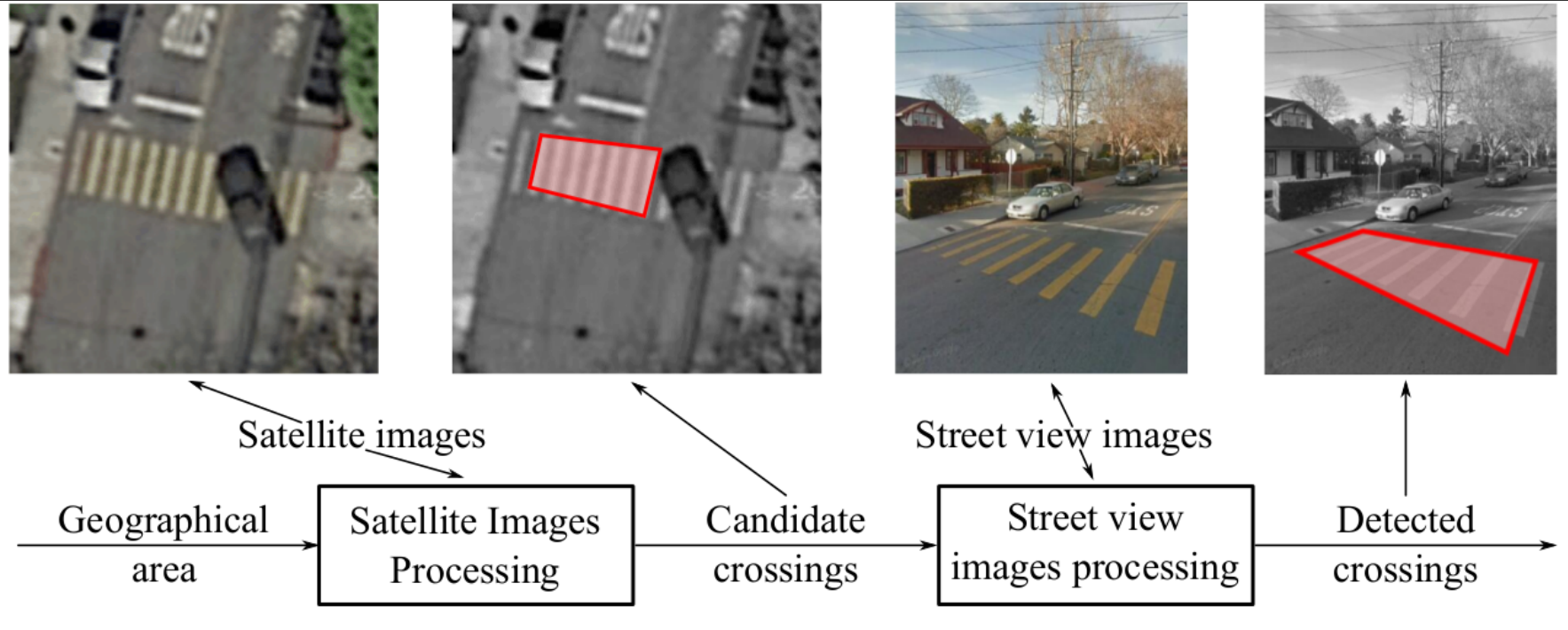
- Lynn H. Quam: Road Tracking and Anomaly Detection in Aerial Imagery. Supported by DoD/ARPA (1978)
- 1-3 feet/pixel ground resolution!

Related Work – Street Level

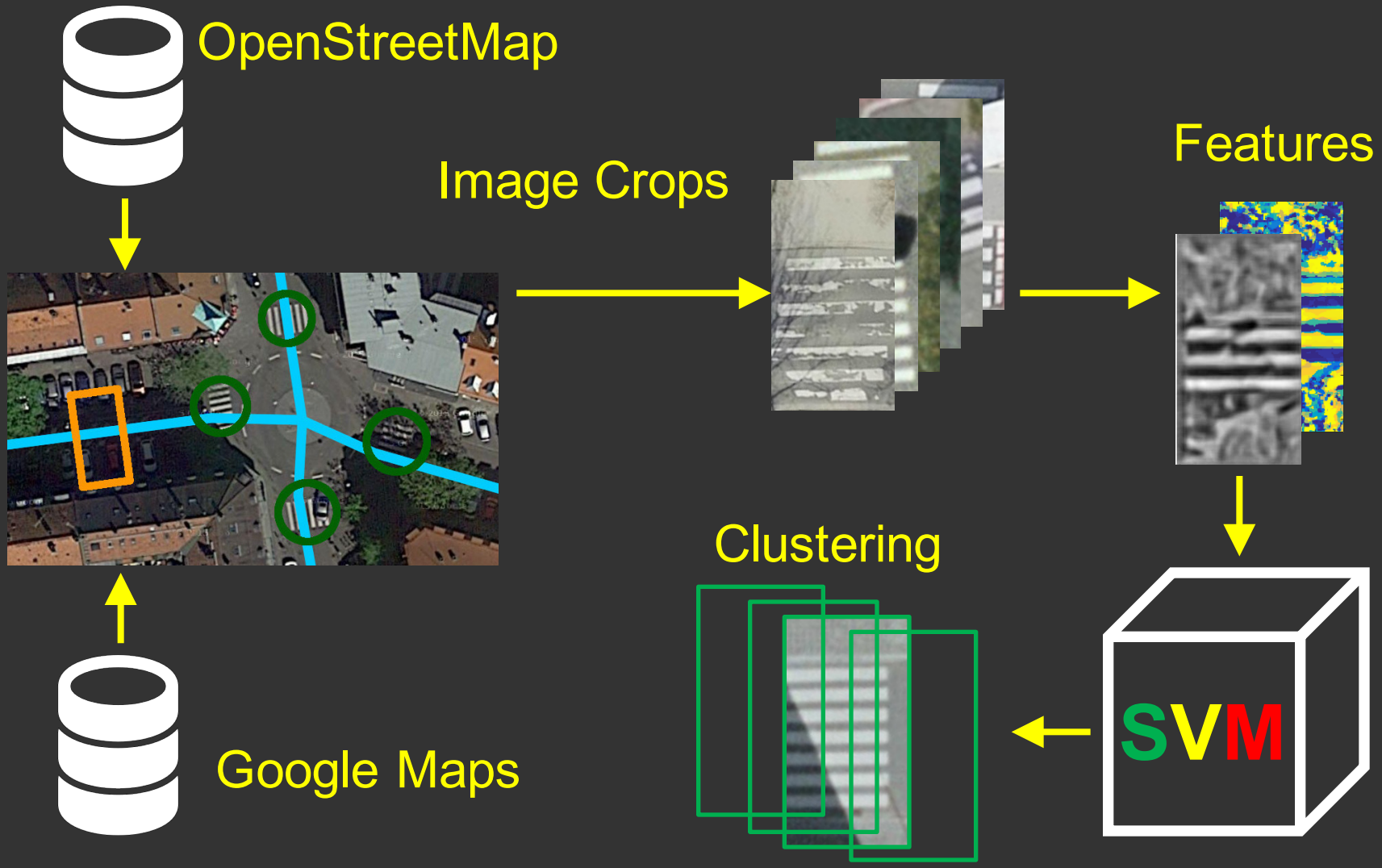
- Stepehen Se: Zebra-Crossing Detection for the Partially Sighted (CVPR 2000)
- Coughlan et al.: A Fast Algorithm for Finding Crosswalks Using Figure-Ground Segmentation (ECCVW 2006)
- Ivanchenko et al.: Detecting and Locating Crosswalks Using a Camera Phone (CVPRW 2008)
- Ahmetovic et al.: Zebralocalizer: Identification and Localization of Pedestrian Crossings (MobileHCI 2011)

Related Work – Aerial Imagery

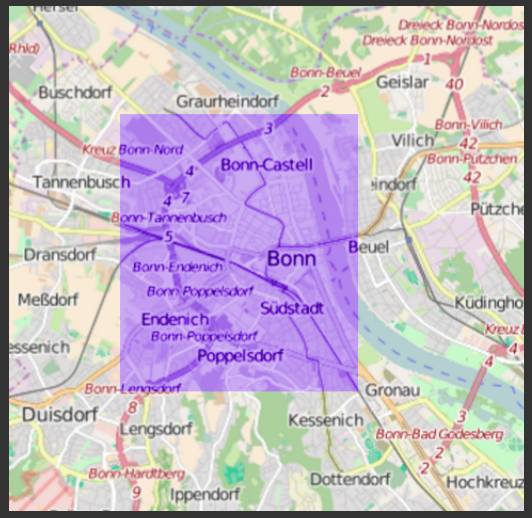


- Ahmetovic et al.: Zebra Crossing Spotter: Automatic Population of Spatial Databases for Increased Safety of Blind Travelers (ASSETS 2015)

Algorithm – Overview



Algorithm – Street Data



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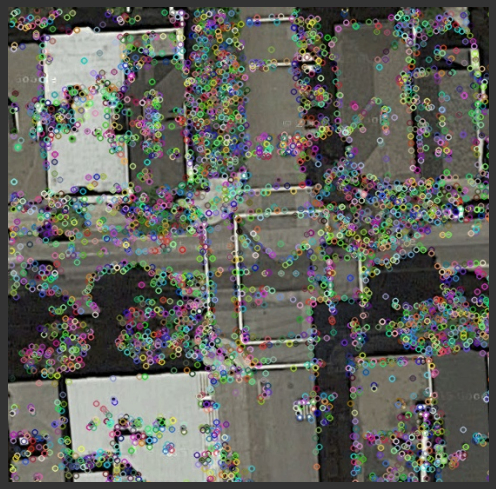
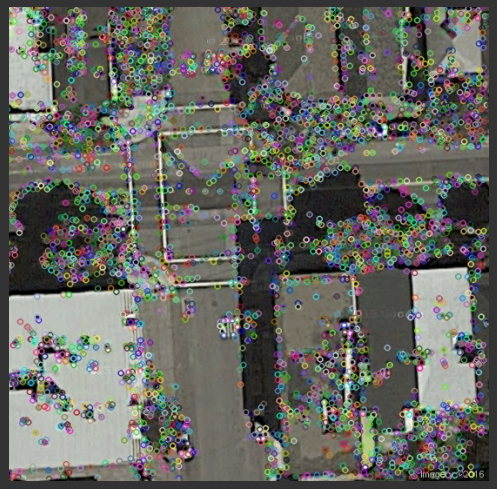
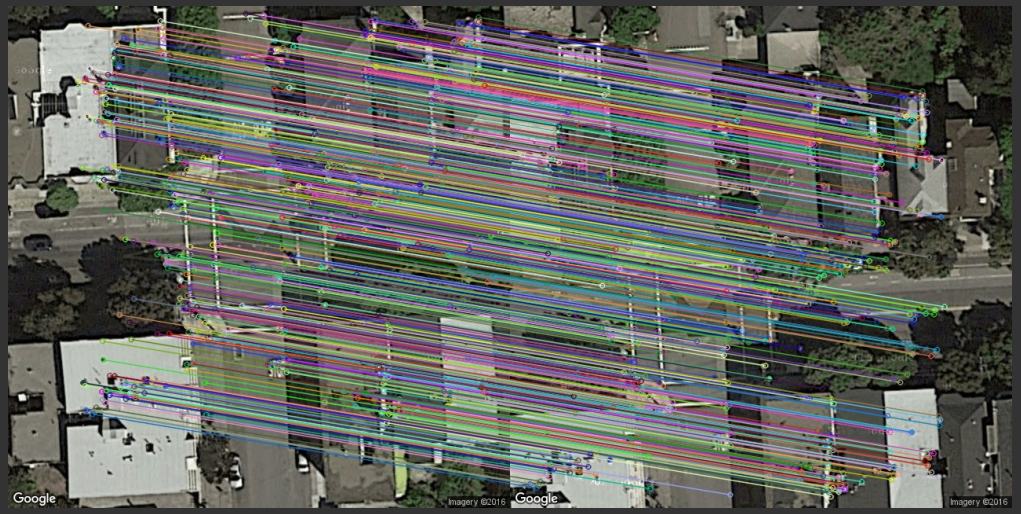
Algorithm – Geodetic Datum





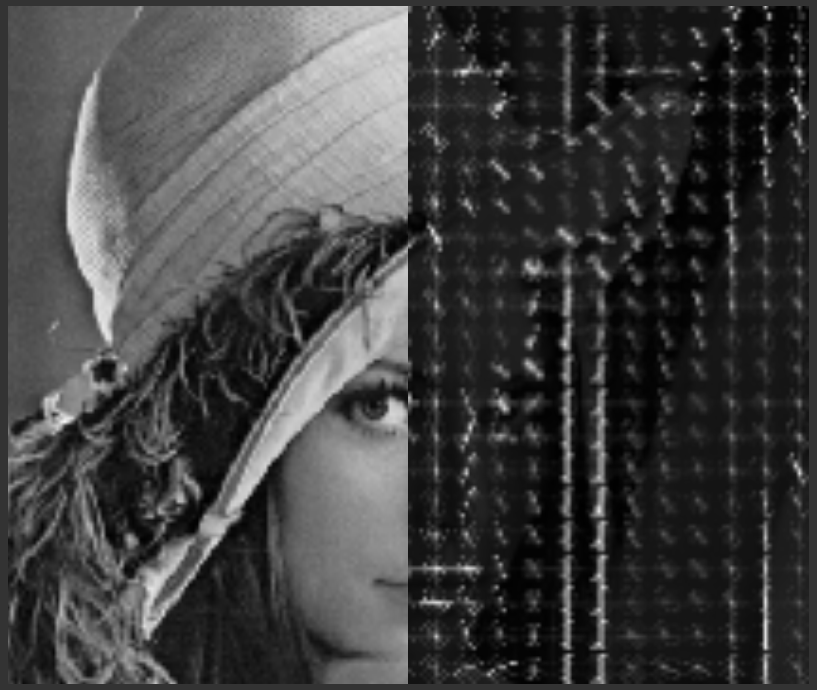
Specify Coordinate-Δ

Calculate Features

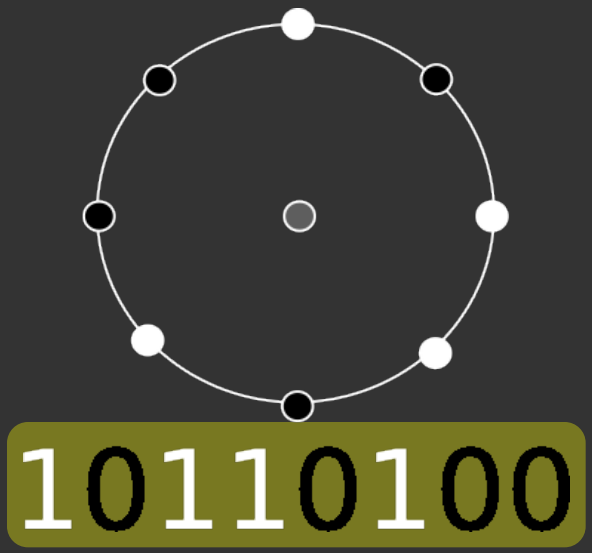


Match Features

Algorithm – HOG and LBP

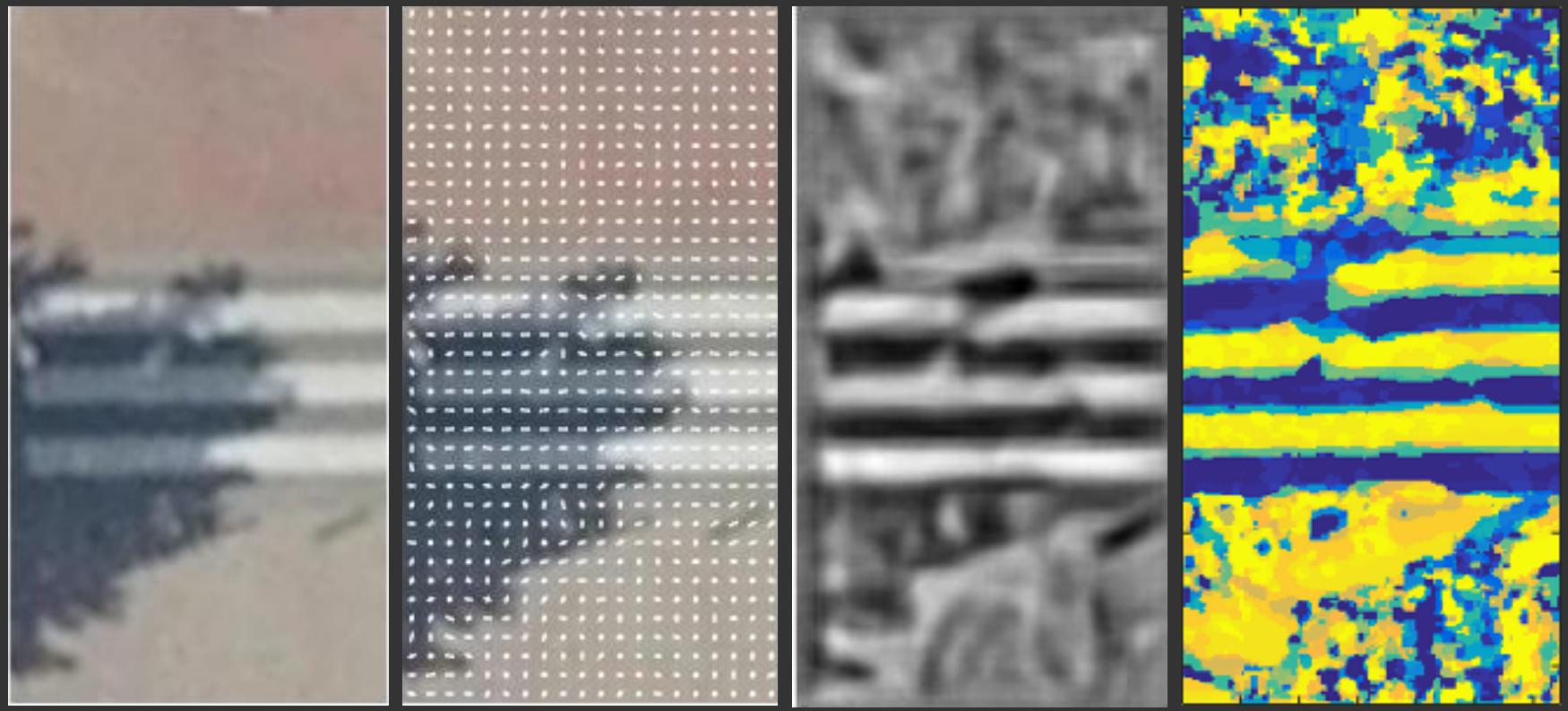


Histogramm of Oriented Gradients



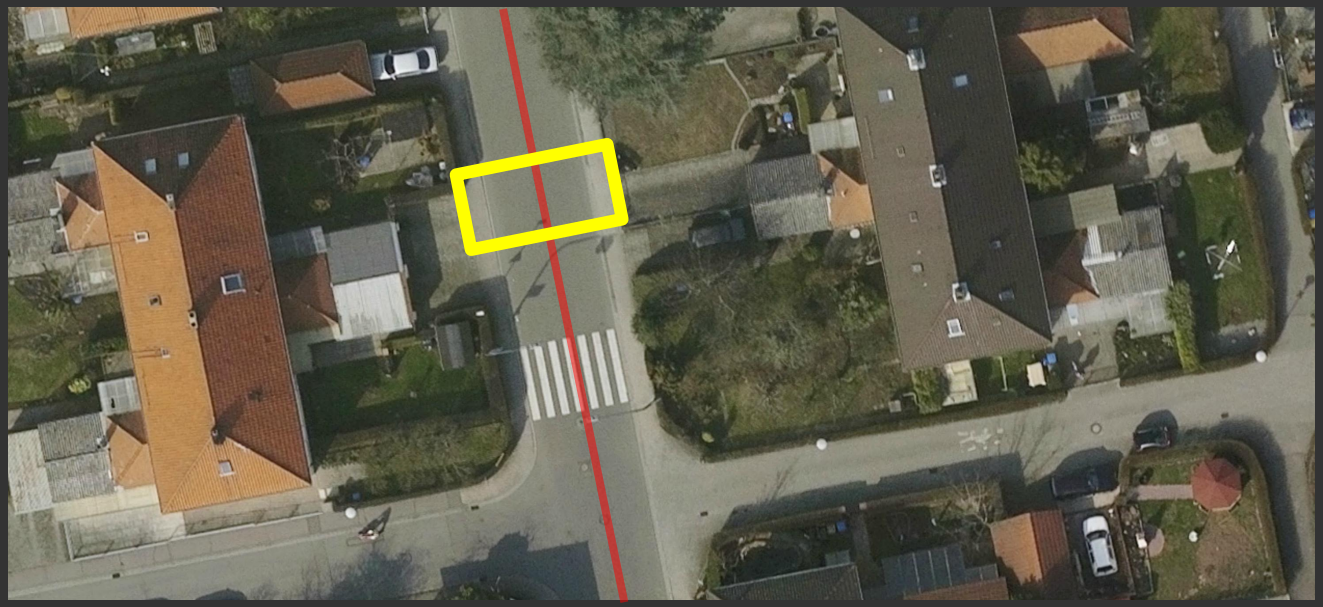
Local Binary Patterns

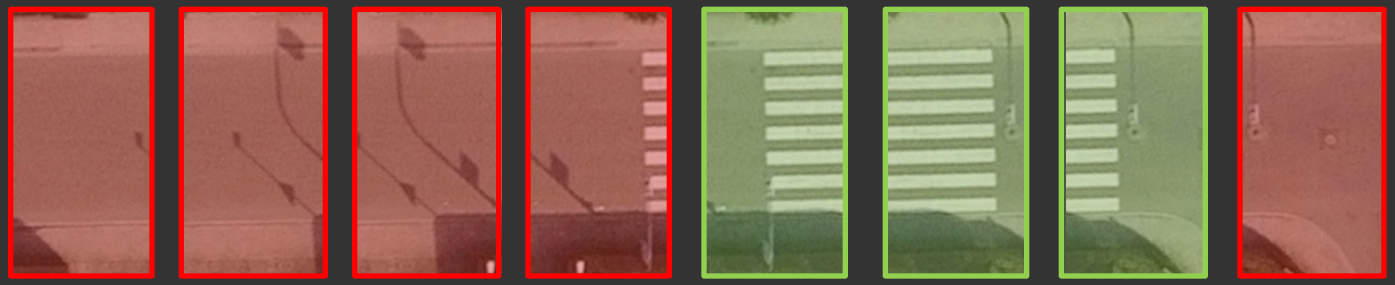
Algorithm – Feature Space



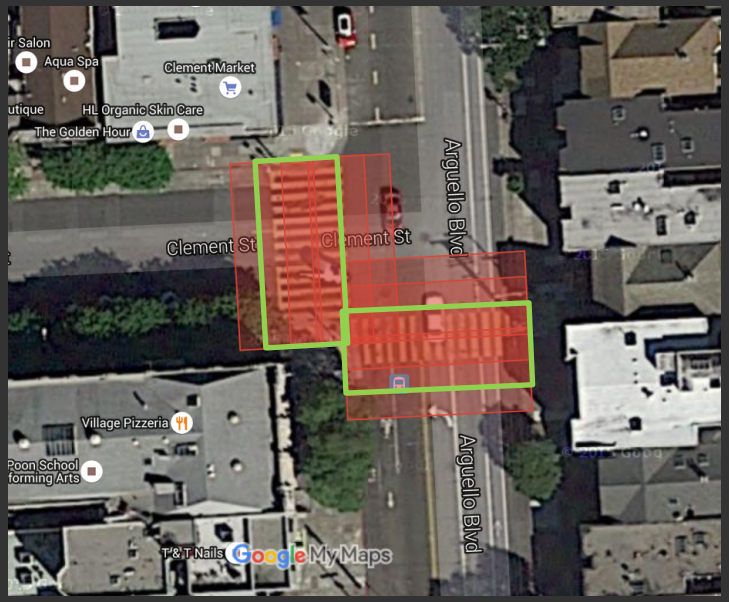
Original HOG HOGgles LBP

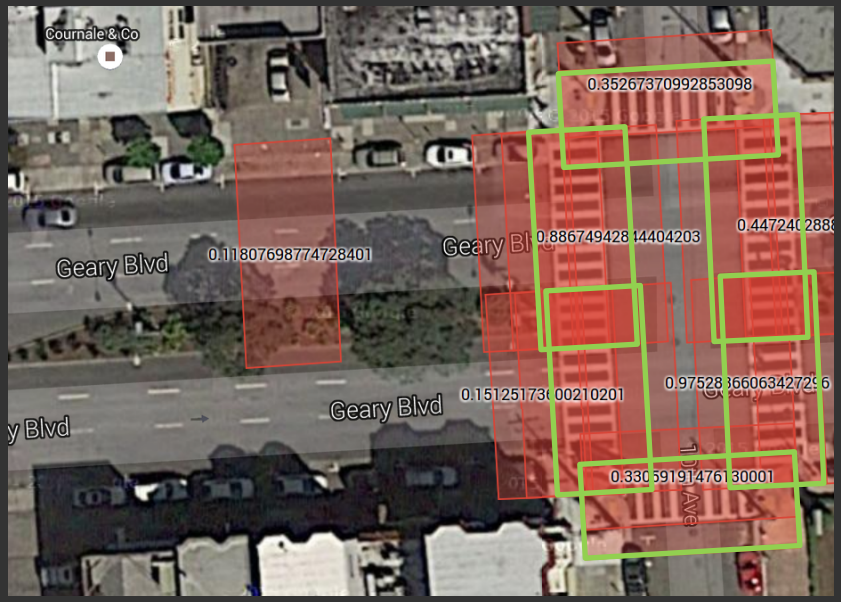
Algorithm – Detection





Algorithm – Clustering



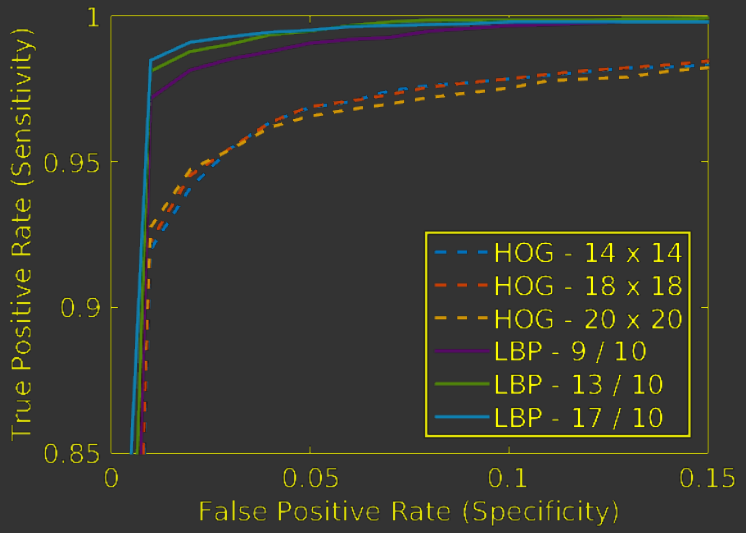


- Simple clustering algorithm:
  - direction of subsequent detections
  - distance of subsequent detections
  - detection score
- Removes most outliers and separates zebra crossings nicely!

Evaluation

- Collected dataset:
  - various urban and rural German regions
  - ~10km of road surface
  - ~3100 zebra crossings
  - various defects: shadows, occlusions, deteriorations, illumination changes
  - resolution varies from 5-10cm/pixel
- Train SVM on even data split
- Augmentation: mirror horizontally and vertically

Evaluation – 5-Fold Cross-Validation

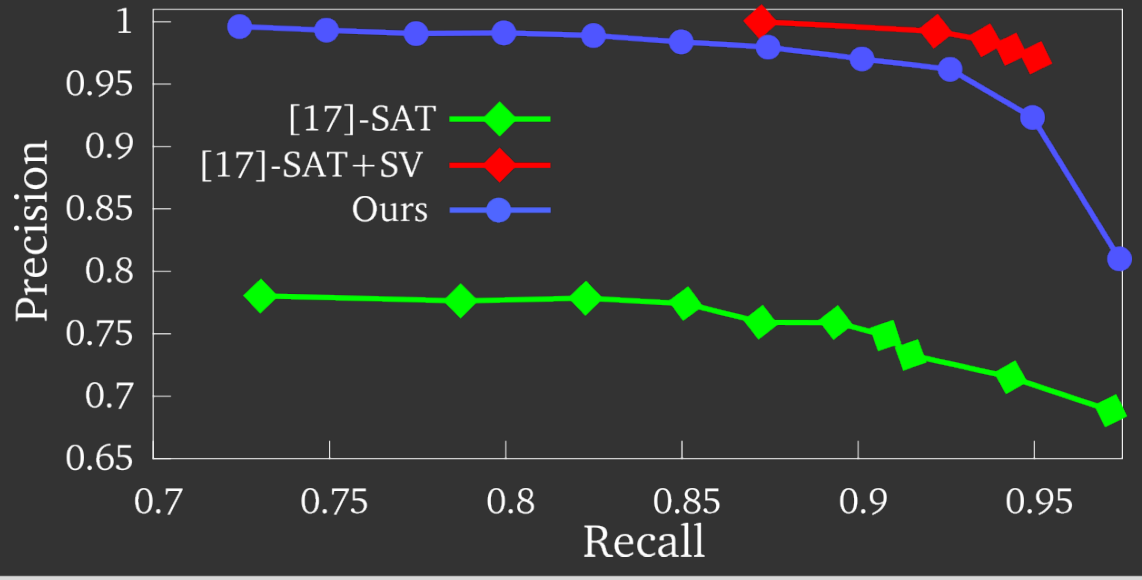


Method	Precision	Recall	Accuracy	Avg.-Prec
$HOG^{30\times30}$-lin	74.8	93.1	92.4	94.43
$HOG^{20\times20}$-RBF	95.2	96.2	**98.9**	97.99
$LBP^{17/10}$-lin	99.4	**97.4**	98.4	**99.56**
$LBP^{17/10}$-RBF	**99.7**	97.0	98.3	**99.56**

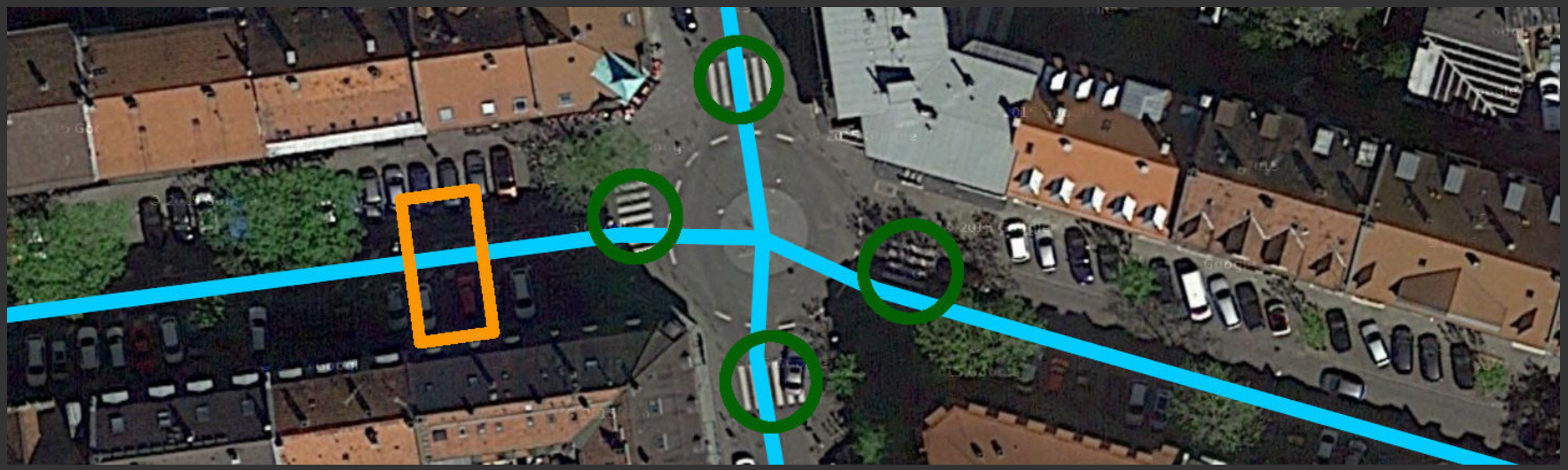
Evaluation – San Francisco

	Precision	Recall
[17]-SAT	68.8	97.2
[17]-SV	97.2	97.8
[17]-SAT+SV	97.2	95.0
Ours	96.2	95.7
Ours-PRE	98.9	38.4

[17] Ahmetovich et al.: Zebra Crossing Spotter: Automatic Population of Spatial Databases for Increased Safety of Blind Travelers

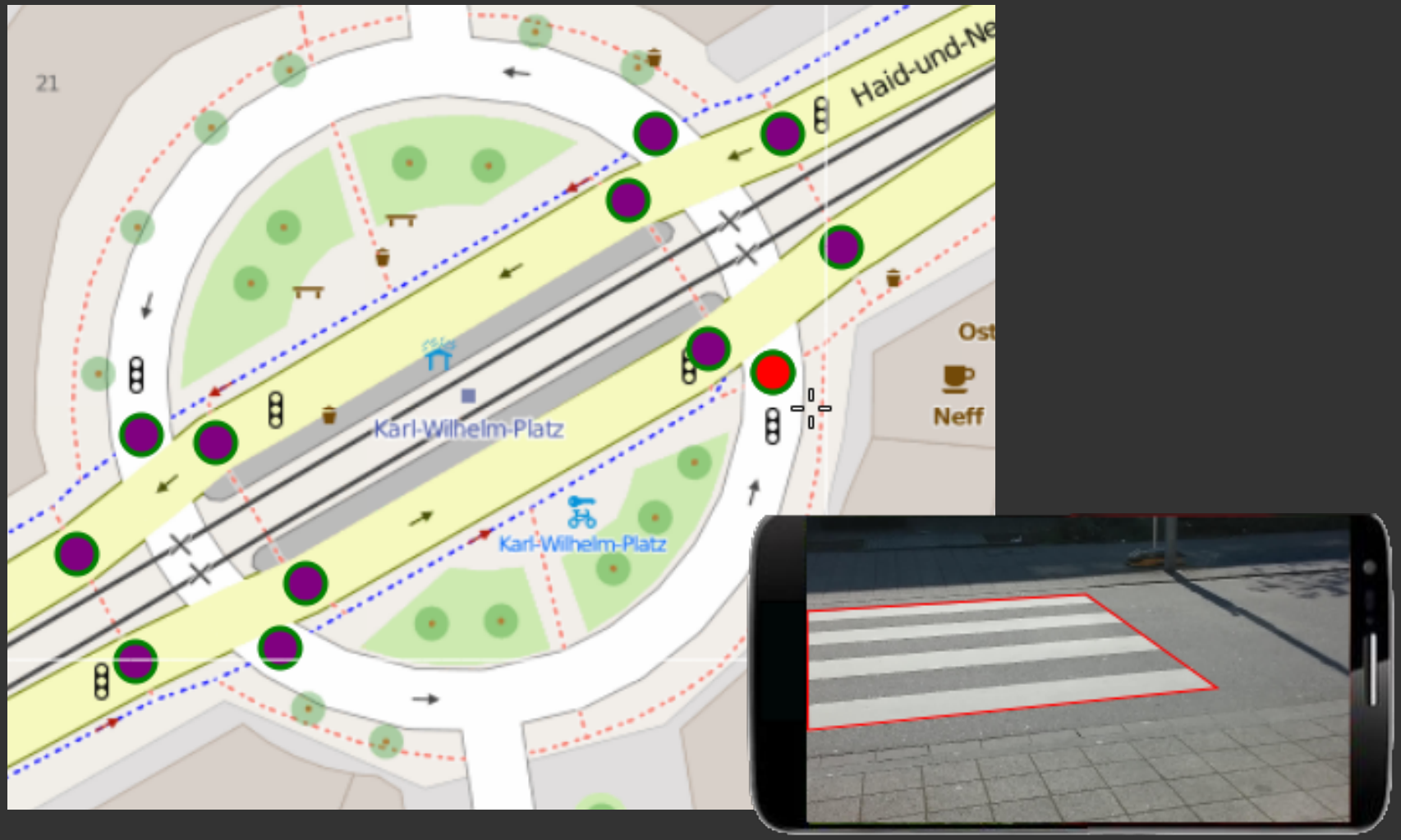


Conclusion



- Zebra crossing detection in aerial imagery
- Achieve competitive results (even across countries)
- Improvement in availability and quality of geospatial data
- Use for navigation and guidance applications

Future Work



Questions?

- Thank you for your attention!

Image Sources

- #2: “Don’t judge too quickly”, Source Unknown
- #3: https://en.wikipedia.org/wiki/Pedestrian_crossing
- #4: http://www.thebeatles.com/album/abbey-road
- #5: https://mntransportationresearch.org/2014/03/27/cell-phone-app-guides-blind-through-work-zones/
- #11: AeroWest (http://www.aerowest.de/)
- #13: http://sipi.usc.edu/database/database.php?volume=misc&image=12#top
- #22: https://1951club.wordpress.com/2011/08/28/well-cross-that-street-when-we-come-to-it/