Lane Modelling Algorithm for Video-Based Driver Assistance System

Norbert Bogya [1]

Judit Nagy-György [1]

Róbert Fazekas [1,2]

Zsolt Vizi [1,2]

[1]Bolyai Institute, University of Szeged, Hungary

[2]Robert Bosch Kft., Budapest, Hungary

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Invented for life

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Team

University of Szeged
Where knowledge and challenge meet

BOSCH

Norbert Bogya

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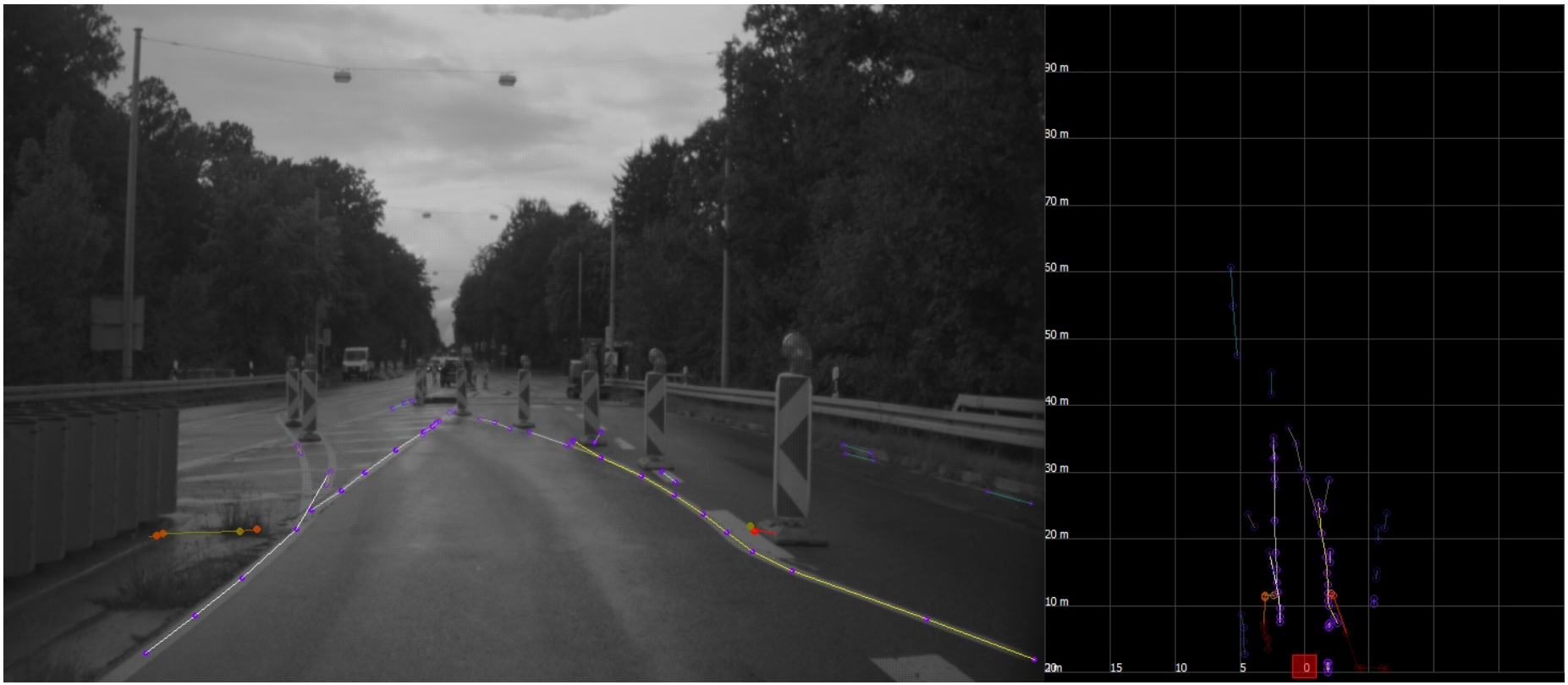
Zsolt Vizi

Our goal

... was to construct an algorithm to build a lane model using data of a stereo camera (only) when the environment is quite chaotic.



- Highway model (*easy*) $\longleftrightarrow$ Road construction (*hard*)
- Fusion models $\longleftrightarrow$ Stereo camera

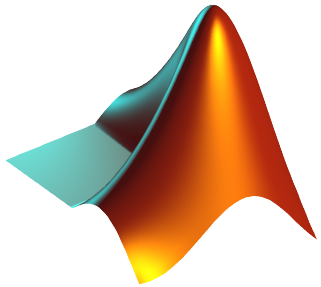
Result

Concept

- Clustering of the line segments defines different road markings
- What to use for clustering?
  - Similarity function $\rightarrow$ Edge-weighted graph ($W_{i,j}$ weight matrix)
  - Partition of vertices $\rightarrow$ Clusters

Algorithms

- Naive algorithm with *threshold*
- *Spectral clustering*



MATLAB

Algo #1 — Naive threshold algorithm

Thresholded adjacency matrix

$$A_{i,j} := \begin{cases} 1, & \text{if } W_{i,j} \geq \varepsilon \\ 0, & \text{otherwise} \end{cases}$$

$$\varepsilon = \mu + \sigma - h$$

$$\mu = \frac{1}{N} \sum_{i=1}^{n} \sum_{j=1}^{n} W_{i,j} \qquad \sigma^2 = \frac{1}{N} \sum_{i=1}^{n} \sum_{j=1}^{n} (\mu - W_{i,j})^2 \qquad h = -\frac{1}{N} \sum_{i=1}^{n} \sum_{j=1}^{n} W_{i,j} \log_2 W_{i,j}$$

Algo #2 — Spectral clustering

- Embedding a graph “nicely” into $\mathbb{R}^k \Longrightarrow$ clustering of vertices with k-means method
- Laplacian matrix, Courant–Fisher theorem, numeric eigenvalue and eigenvector computations, minimization problem arisen from normalised cut, ...

Comparison

Table: Run time of algorithms.

	Drive #1	Drive #2	Drive #3	Drive #4
Algo #1	0.0179	0.0306	0.0379	0.0400
Algo #2 for 5 cl.	0.0273	0.0373	0.0440	0.0472
Algo #2 for 8 cl.	0.0285	0.0374	0.0476	0.0461
	Drive #5	Drive #6	Drive #7	Drive #8
Algo #1	0.0440	0.0643	0.0666	0.0654
Algo #2 for 5 cl.	0.0509	0.0711	0.0717	0.0729
Algo #2 for 8 cl.	0.0559	0.0723	0.0761	0.0744

Table: Comparison of algorithms.

Algo #1 won	Tie	Algo #2 won
27%	40%	33%

Outputs of the miniproject

- **Master thesis**:

  Róbert Fazekas: Forgalmi sávok modellezése videó alapú vezetést támogató rendszerekben

  thesis defence: 30 May 2018 (grade: excellent)

- **Conference talk**:

  Róbert Fazekas: Lane modelling algorithm for video-based driver assistance system

  CSM - The 5th Conference of PhD Students in Mathematics

  Szeged, Hungary, June 25 - June 27, 2018

- **Poster**:

  The 20th European Conference on Mathematics for Industry

  18-22 June 2018, Budapest, Hungary

Outputs of the miniproject

- **Scientific paper**:

  Clustering algorithm exploring road geometry in a video-based driver assistant system; submitted to *Mathematics in Industry*

- **ADDAcon 2019**:

  Róbert Fazekas got into a Bosch conference poster-session (after thoughtful selection).

Feedback from Bosch

- **Bosch is satisfied** with the work of our team.
- **Algorithm was benchmarked** in a concept phase of a series project and it will likely be used.

- Róbert is a full-time Algorithm Developer of Bosch (he was applied without interview due to the **quality** of his work).
- Recently, this work is a base of **further cooperation** projects.


That's all Folks!

Norbert Bogya
nbogya@math.u-szeged.hu

Judit Nagy-György
ngyj@math.u-szeged.hu

Róbert Fazekas
Robert.Fazekas@hu.bosch.com

Zsolt Vizi
zsvizi@math.u-szeged.hu

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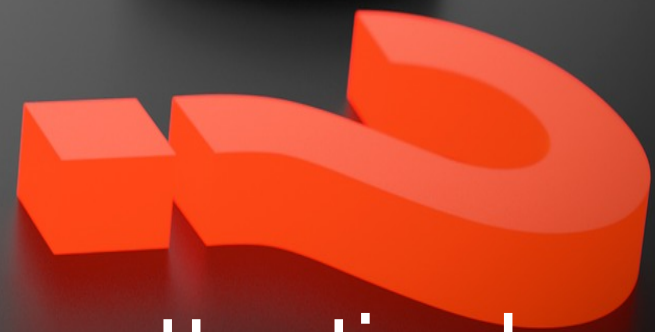

Thank you for your attention!