Advanced Driver Assistance Systems for Road Environments

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- Ph.D. David Martín (yet to formalize)
Outline

- Introduction
- State of the art
- Work done
- Work in progress
- Work to do
- Conclusions
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Introduction

Drivers, Especially Women, Wary of Autonomous Cars

BY ANGELA MOSCARITOLO  JUNE 9, 2015 04:05PM EST  9 COMMENTS

Fifty percent of respondents wouldn’t pay extra for a self-driving car and 46 percent don’t think they’re safe.

Google’s Self-Driving Cars ‘Grandma’

Robert Hackett / Fortune | June 1, 2015

But that’s probably a good thing

Slow and steady may win the race when it comes to autonomous vehicles.

A self-declared Mountain View, California, resident was quick to point out that the disadvantages of autonomous cars are not as great as they seem.

The slow speed, for example, makes cars more efficient and less likely to get into accidents. The fact that you have a driver onboard means there’s someone in case of a problem. And there’s no problem with ‘Grandma’ getting a seat at the table.

The perks of autonomous cars include the ability to drive without a license, the ability to park without a parking space, and the ability to drive in the carpool lane.

But don’t expect to see too many of these cars on the road anytime soon. The technology is still in its infancy, and there are many technical and legal hurdles to overcome before self-driving cars become a reality.

In the meantime, it’s best to focus on improving the safety of traditional cars and driving habits. This will go a long way in reducing the number of accidents on the road, and ultimately, save lives.

References:

- National Highway Traffic Safety Administration
- Insurance Institute for Highway Safety
- National Safety Council

Further Reading:

- Self-Driving Car News
- The Future of Transportation
- Autonomous Vehicles Today

Stay tuned for more updates on the latest developments in autonomous cars.
“Automating the vehicle is a long continuum”
“Really automatic, as for a blind driver? 50 years”
J. Desens, Daimler engineer (2014)

My PhD topics:

- ADAS-ROAD: Advanced driver assistance system for rural and intercity environments
- Focused on single-carriageways
- Poorly structured environments / more variability
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Future research foci

Klaus Bengler  
Technische Universität München

Klaus Dietmayer  
Universität Ulm

Berthold Färber  
Universität der Bundeswehr München

Markus Maurer  
Technische Universität Braunschweig

Christoph Stiller  
Karlsruher Institut für Technologie

Hermann Winner  
Technische Universität Darmstadt

- “Machine cognition and situational awareness are still in their infancy”

State of the art

- **Machine perception - Future research foci**
  - Improvement of sensor HW and SW
  - Generation of local dynamic maps
  - Improved algorithms for vehicle *situational awareness in complex traffic scenarios*
  - Development of methods and algorithms to acquire *situational awareness* at a safety-relevant level
  - Intention and behavior models to predict the behavior of the driver and other traffic participants

State of the art

- Machine perception - Future research foci

Scene understanding

- Estimating the road layout $\mathcal{R}$ from the image evidence $\mathcal{E}$, given a set of parameters $\Theta$

$$p(\mathcal{E}, \mathcal{R}|\Theta) = p(\mathcal{R}|\Theta) \prod_{i=1}^{N_t} p(t_i|\mathcal{R}, \Theta) \prod_{i=1}^{N_v} p(v_i|\mathcal{R}, \Theta) \prod_{i=1}^{N_s} p(s_i|\mathcal{R}, \Theta) \prod_{i=1}^{N_f} p(f_i|\mathcal{R}, \Theta) \prod_{i=1}^{N_o} p(\rho_i|\mathcal{R}, \Theta)$$

Traffic behavior

- Recognition of dangerous situations at roundabouts from stereo vision

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- Bumblebee XB3 driver for ROS

FRANKE, U.; GEHRIG, S. How cars learned to see. Proceedings of 54th Photogrammetric Week, 2013, p. 3-10.
- Bumblebee XB3 driver for ROS

\[ \epsilon_Z = \frac{fB}{d} - \frac{fB}{d + \epsilon_d} \approx \frac{Z^2}{fB} \cdot \epsilon_d \]

**Baseline = 120 mm**

**Baseline = 240 mm**

**Accuracy 20 m @ 100 m**

**Accuracy 10 m @ 100 m**

Point Grey Research
Stereo Accuracy
- Bumblebee XB3 driver for ROS + BM disparity

Work done

- Bumblebee XB3 driver for ROS + SGBM disparity

- Bumblebee XB3 driver for ROS + PCL
Work done

- Bumblebee XB3 driver for ROS + PCL
○ Cesar’s Road Model Algorithm on ROS

Cesar’s Road Model Algorithm on ROS

• Modular design.
• “By-products” may be useful.
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• Improvements in the Road Model Alg.

  - Road plane extraction – e.g. Basam’s road profile


• Road lines segmentation and classification by means of machine learning techniques

  David

  (M.Sc. Thesis)
Laser-Camera Calibration Alg.

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Work to do

- Side-looking cameras for the IVVİ 2.0
  - Oshkosh - Vislab’s TerraMax

Work to do

- **Optimization for high-speed roads**
  - GPU and multi-thread will come in handy

  My Final Degree Project

  GUINDEL, Carlos., MUSLEH, Basam. Algoritmo de odometría visual estéreo para sistemas de ayuda a la conducción: Implementación en GPU mediante CUDA. 2012.

  - Embedded SBCs (ODROID) might be taken into account

  Expertise gained from different R&D projects (INDIO,...)

- **And everything else...**
  - Almost everything is still to be done using these tools
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Conclusions

• New ADAS demand high-level information
• Data from many applications is available on the IVVI: An opportunity to work together
  • www.bitbucket.org/lsi
  • e.g. CAN bus
• We should benchmark against the best

IV Jornadas de Encuentros Doctorales LSI

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Thank you for your attention