Laser-Based Feature Extraction and Pattern Recognition in Intersection Management Systems

Gustavo Velasco-Hernández

Pattern Recognition, 2014

Context

Master's Research Project: Multisensor Architecture for a Vehicular Intersection Management System

Transportation Systems

Issues in traditional transportation systems

- Congestion
- Traffic rules violation
- Vehicle interaction

Transportation Systems

Issues in traditional transportation systems

- Congestion
- Traffic rules violation
- Vehicle interaction

Intersections are critical places in transportation systems

Intelligent Transportation Systems

Objectives of ITS

- Increase safety
- Increase efficiency
- Reduce costs

Intersection Management Systems

Tasks

- Traffic Monitoring
- Traffic Management
- Warning Advertisement

Intersection Scenario

Pedestrians, Vehicles (Cars, Two-wheeled vehicles, Big vehicles)

Recognition, Classification, Tracking

Incident detection, Intersection Management

Objectives

Objectives

- Review of the state-of-the-art of sensor fusion in IMS
- Techniques review and architecture design
- Laser and video sensor fusion implementation
- Incident detection and warnings advertisement
- Testing and Comparison

Objectives

Objectives

- Review of the state-of-the-art of sensor fusion in IMS
- Techniques review and architecture design
- Laser and video sensor fusion implementation
- Incident detection and warnings advertisement
- Testing and Comparison

For the course project:

- In blue are the tasks proposed for this course project.
- In green are the tasks proposed as plus if time allows it.

Objectives

Objectives

- Review of the state-of-the-art of Sensor Fusion in IMS
- Techniques review and architecture design
- Laser and video sensor fusion implementation
- Incident detection and warnings advertisement
- Testing and Comparison

For the course project:

- In blue are the tasks proposed for this course project.
- In green are the tasks proposed as plus if time allows it.

Objectives

Objective 1. Review of the state-of-the-art of Sensor Fusion in IMS

- Intelligent Transportation Systems (ITS)
- Intersection Management Systems (IMS)
- Multisensor Data Fusion (MDF)
- Laser-Video Data Fusion
- IMS + LV-DF

Objectives

Objective 1. Review of the state-of-the-art of Sensor Fusion in IMS

- Intelligent Transportation Systems (ITS)
- Intersection Management Systems (IMS)
- *Multisensor Data Fusion (MDF)*
- *Laser-Video Data Fusion*
- *IMS + LV-DF*

Objectives

Objective 2. Techniques review and architecture design

- Feature Extraction (Laser/Video)
- Pattern Recognition (Laser/Video)
- Classification (Laser/Video)
- Decision (Laser/Video)
- Low-Level, Mid-Level and High-Level Fusion

Objectives

Objective 2. Techniques review and architecture design

Feature Extraction (Laser/Video)

Pattern Recognition (Laser/Video)

Classification (Laser/Video)

Decision (Laser/Video)

Low-Level, Mid-Level and High-Level Fusion

Objectives

Objective 3. Laser and video sensor fusion implementation

- Implement choosen techniques for laser and video data
- Integrate developed modules to the designed architecture for sensor fusion

Objectives

Objective 3. Laser and video sensor fusion implementation

Implement choosen techniques for laser and video data

Integrate developed modules to the designed architecture for sensor fusion

Objective 4. Incident detection and warnings advertisement

Objective 5. *Testing and Comparison*

Objective 4 is out of the scope of this class.

Main Objective

To develop a feature extraction and pattern recognition laser-based module for an intersection management system

Sub-objectives

Review of laser-based feature extraction and pattern recognition in ITS and IMS

Sub-objectives

Review of laser-based feature extraction and pattern recognition in ITS and IMS

Evaluate pros and cons of the reviewed methods

Sub-objectives

Review of laser-based feature extraction and pattern recognition in ITS and IMS

Evaluate pros and cons of the reviewed methods

Implement at least one method

Sub-objectives

Review of laser-based feature extraction and pattern recognition in ITS and IMS

Evaluate pros and cons of the reviewed methods

Implement at least one method

Evaluate implemented module and compare it with similar developments

Conditions

The information source will be a dataset.

Research Groups

PKU Omni Smart Sensing (POSS) Research group at Peking University (POSS-i project)

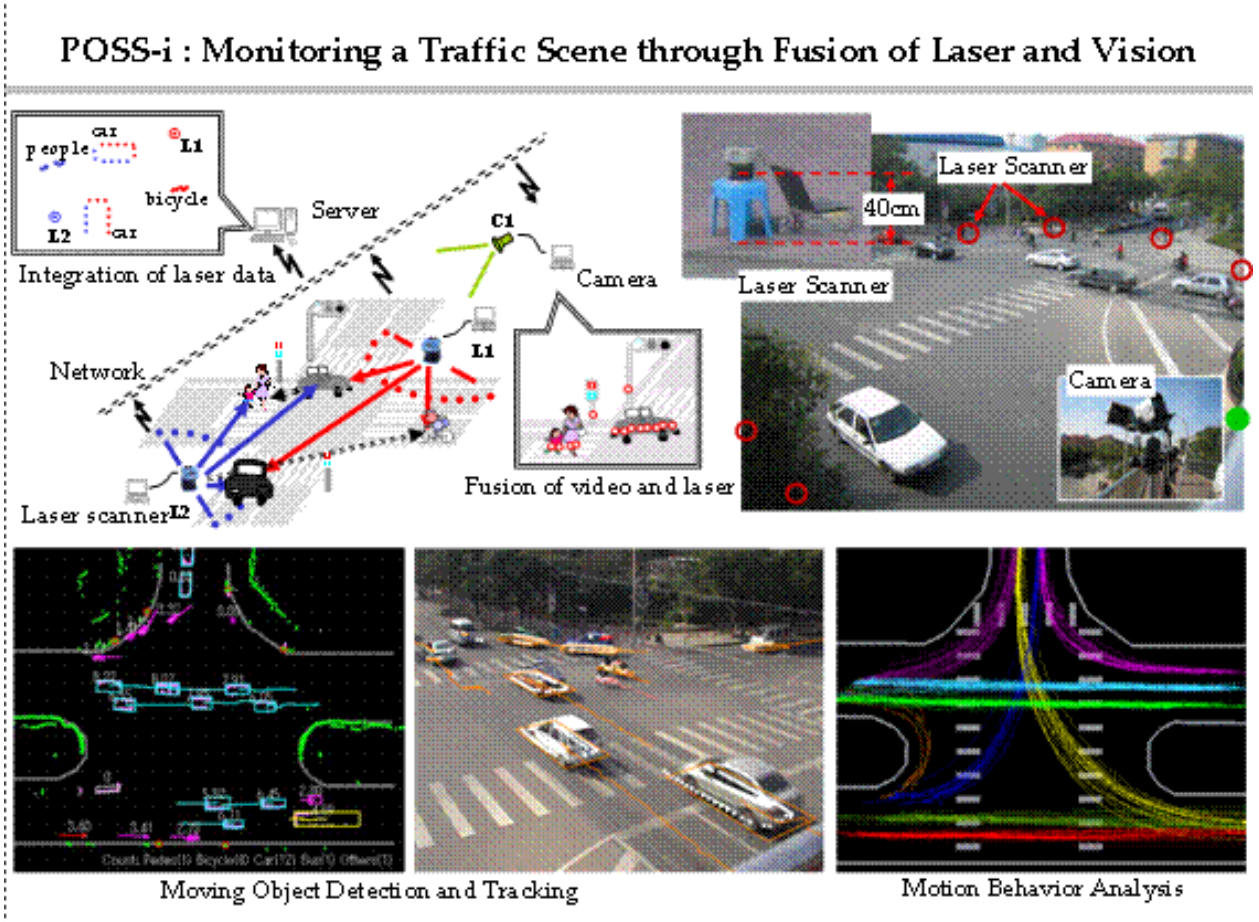
Institute of Measurement, Control and Microtechnology at Ulm University (Ko-PER program)

PKU Omni Smart Sensing (POSS)

POSS is leaded by Prof. Huijing Zhao, Ph.D.

Focus on perception technologies using an intelligent vehicle, a network sensing system or a collaboration of them

POSS-i



POSS-i project. [Zhao09][Zhao12][Song13b]

Ko-PER

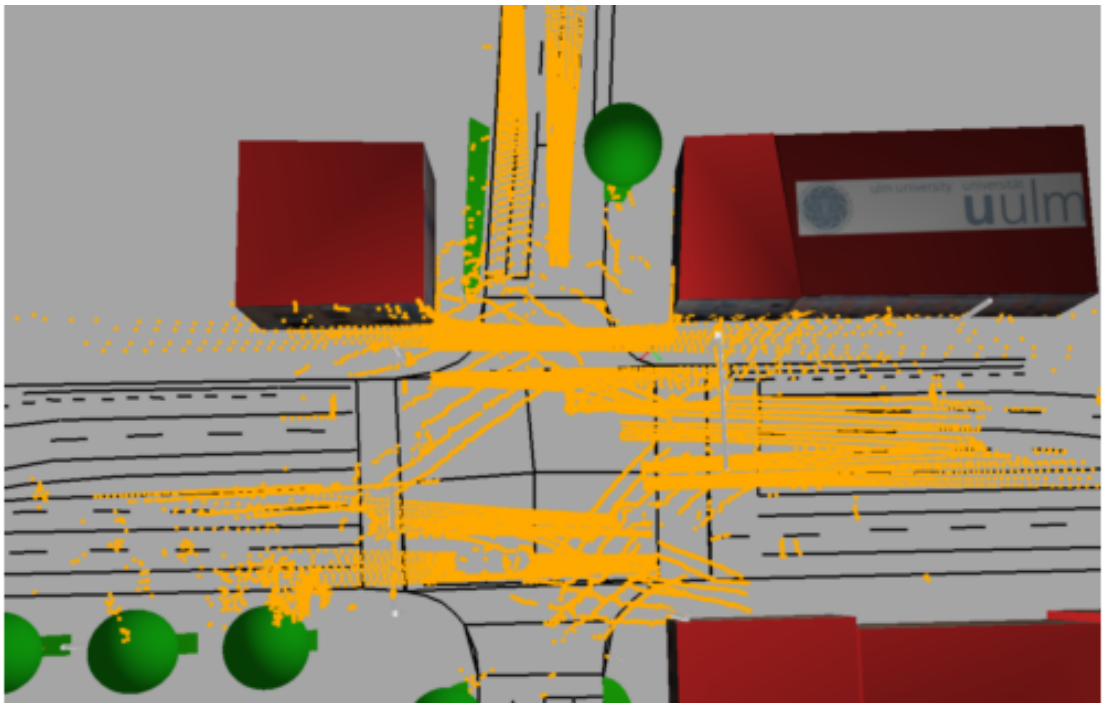
Ko-PER from Cooperative Perception

Included in Forschungsinitiative Ko-FAS from Bundesministerium für wirtschaft und Technologie (Germany)

Cooperative and collaborative sensors system for perception and preventive road safety.

Daniel Meissen from Ulm University as leader researcher.

Projects



3D-recreated intersection scene with laser beams depicted [Meissner12, 13a, 13b, 13c, 14][Striegel13]

Applications, Methods and Techniques

Project	POSSi	Ko-PER
Applications	Recognition, Classification and Tracking of Vehicles and Pedestrians	
Methods and Techniques	- Clustering - Markov Chains - Kalman Filtering - AdaBoost	- DBSCAN - Multi-object Bayes Filter - Sequential Monte Carlo Methods - Dempster-Shafer Theory - Multiple-Model Probability Hypothesis Density Filter (in Gaussian Mixture representation)

POSSi and PKU projects comparison

References

Goldhammer12 Goldhammer, M. et al, **Cooperative multi sensor network for traffic safety applications at intersections**. *2012 15th International IEEE Conference on Intelligent Transportation Systems (pp. 1178–1183)*. 2012.

Meissner10 Meissner, D. and Dietmayer, K. **Simulation and calibration of infrastructure based laser scanner networks at intersections**.*2010 IEEE Intelligent Vehicles Symposium, 670–675*. 2010.

Meissner12 Meissner, D., Reuter, S., and Dietmayer, K. **Real-time detection and tracking of pedestrians at intersections using a network of laserscanners**. *2012 IEEE Intelligent Vehicles Symposium, 630–635*. 2012.

Meissner13a Meissner, D., Reuter, S., and Dietmayer, K. **Road user tracking at intersections using a multiple-model PHD filter**. *2013 IEEE Intelligent Vehicles Symposium (IV), (Iv), 377–382*. 2013.

References

Meissner13b Meissner, D. et al. **Road User Tracking Using a Dempster-Shafer Based Classifying Multiple-Model PHD Filter**. *Information Fusion (FUSION), 2013 16th International Conference on (Vol. 32, pp. 1236–1242)* 2013.

Meissner13c Meissner, D., Reuter, S., and Dietmayer, K. **Combining the 2D and 3D world: a new approach for point cloud based object detection**. *IET Intelligent Signal Processing Conference 2013 (ISP 2013) (pp. 4.1–4.1)*. 2013.

Meissner14 Meissner, D. et al. **Intersection-Based Road User Tracking Using a Classifying Multiple-Model PHD Filter**. *IEEE Intelligent Transportation Systems Magazine, 6(April 2014), 21–33*.2014.

Song08 Song, X. et al. **Bayesian fusion of laser and vision for multiple People Detection and tracking**. *2008 SICE Annual Conference, 3014–3019*. 2008.

References

Song13a Song, X. et al. **Laser-based tracking of multiple interacting pedestrians via on-line learning**. *Neurocomputing, 115, 92–105*. 2013.

Song13b Song,X. et al. **An Online System for Multiple Interacting Targets Tracking: Fusion of Laser and Vision, Tracking and Learning**. *ACM Transactions on Intelligent Systems and Technology*. 2013.

Strigel13 Strigel, E., Meissner, D., and Dietmayer, K. **Vehicle detection and tracking at intersections by fusing multiple camera views**. *2013 IEEE Intelligent Vehicles Symposium (IV) (pp. 882–887)*. 2013.

Zhao06 Zhao, H., and Shibasaki, R. **Joint tracking and classification of moving objects at intersection using a single-row laser range scanner**. *In Proceedings of the IEEE Intelligent Transportation Systems Conference (pp. 287–294)*. 2006.

References

Zhao08 Zhao, H. et al. **Monitoring an intersection using a network of laser scanners**. *Proceedings of the11th International IEEE Conference on Intelligent Transportation Systems (pp. 428–433)*. 2008.

Zhao09 Zhao, H., Cui, J., and Zha, H. **Sensing an Intersection Using a Network of Laser Scanners and Video Cameras**. *IEEE Intelligent Transportation Systems Magazine, 31–37*. 2009.

Zhao12 Zhao, H. et al. **Detection and Tracking of Moving Objects at Intersections Using a Network of Laser Scanners**. *IEEE Transactions on Intelligent Transportation Systems, 13(2), 1–16*. 2012.