

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

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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

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

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- 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.

Conditions

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- [New!] Just one laser.

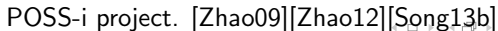
Research Groups

- 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

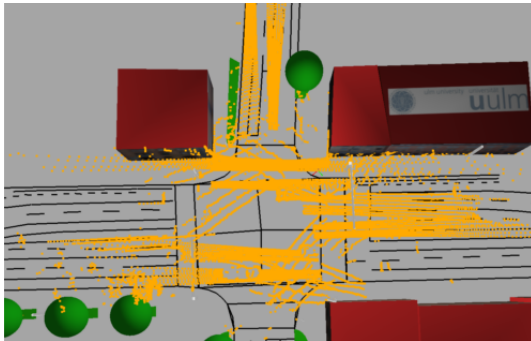
POSS-i : Monitoring a Traffic Scene through Fusion of Laser and Vision



Ko-PER

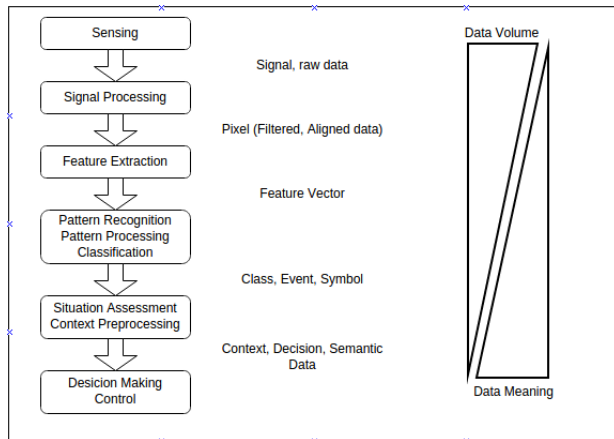
- Ko-PER from Cooperative Perception
- Included in Forschungsinitiative Ko-FAS from Bundesministerium für wirtschaft und Technologie (Germany)
- Cooperative and collaborative sensors system for perception and preventive road safety.
- Daniel Meissen from Ulm University as leader researcher.

Projects



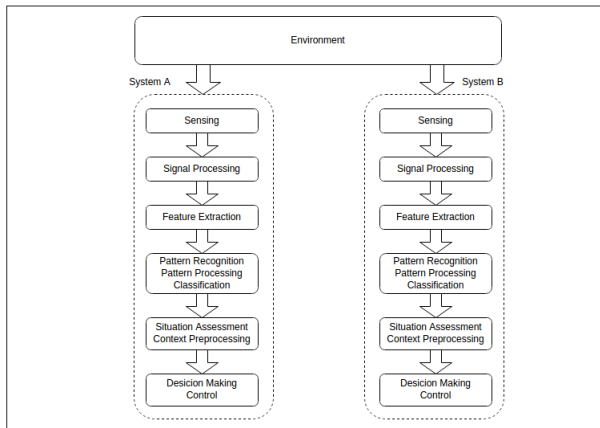
3D-recreated intersection scene with laser beams depicted [Meissner12, 13a, 13b, 13c, 14][Striegel13]

Typical System for one source of data



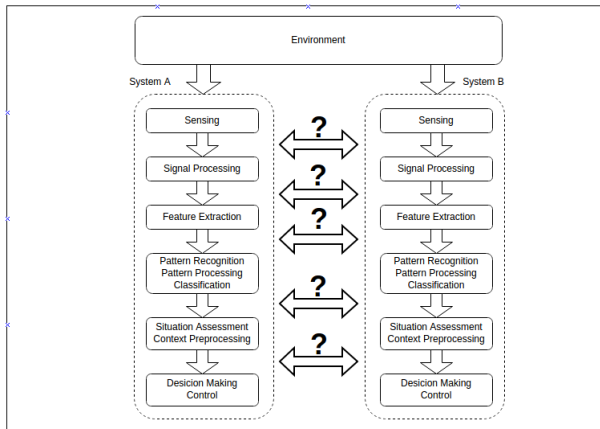
Single source system block diagram

Multisensor Data System



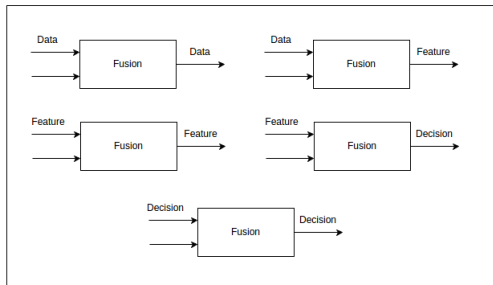
Multisensor system block diagram

How to fuse information?



Multisensor system block diagram

Fusion Levels

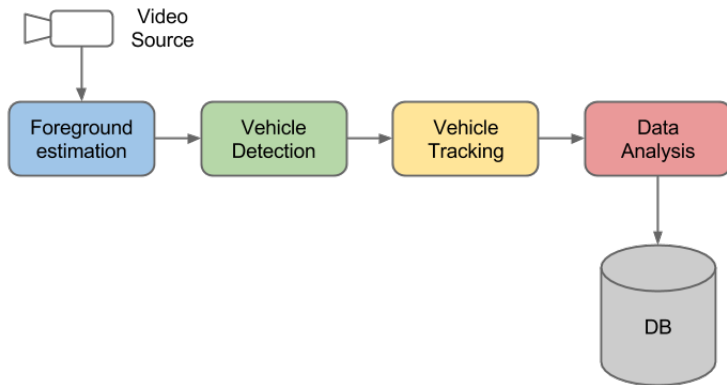


Fusion Levels [Luo11]

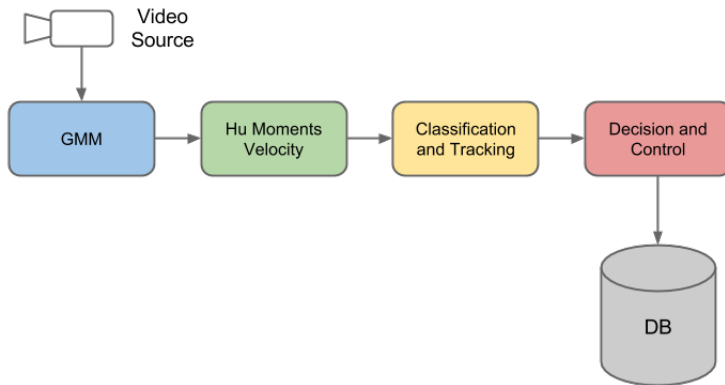
Classification of Fusion Algorithms [Luo11]

Low level fusion		Medium level fusion	High level fusion
Estimation methods		Classification methods	Inference methods
Recursive: <ul style="list-style-type: none"> • Kalman filter • Extended Kalman filter Non-recursive: <ul style="list-style-type: none"> • Weighted average • Least squares 	Covariance-based: <ul style="list-style-type: none"> • Cross covariance • Covariance intersection • Covariance union 	<ul style="list-style-type: none"> • Parametric templates • Cluster analysis • K-means clustering • Learning vector quantization • Kohonen feature map • Artificial neural network • Support vector machines 	<ul style="list-style-type: none"> • Bayesian inference • Particle filters • Dempster-Shafer theory • Expert system • Fuzzy logic

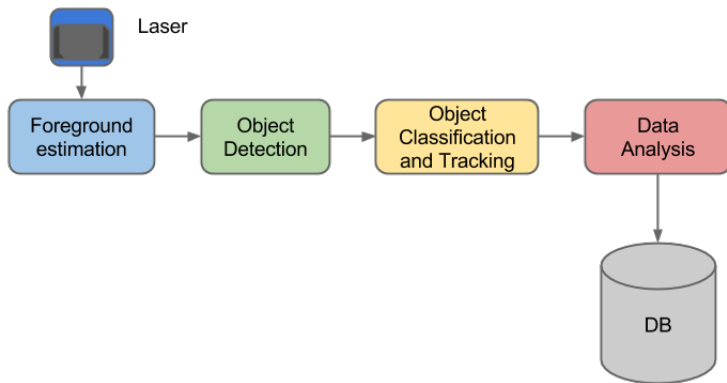
Video-Based System Block Diagram



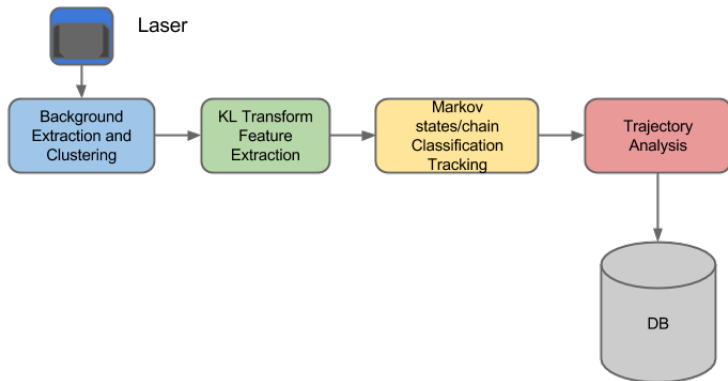
Video-Based System Block Diagram



Laser-Based System Block Diagram



Laser-Based System Block Diagram



Based on [Zhao06]

Background Extraction

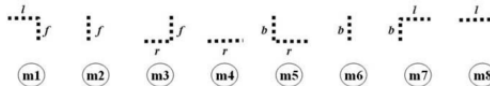
- Histogram-based background extraction
- Done for each angle
- When a pick value is detected, tells that an object is detected

Classification

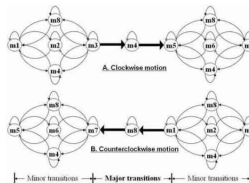
- Classes are proposed based on distribution of points in clusters
- Karhunen-Loeve Transform to detect number of axis

Objects in cross road	Example of laser data					Class definition
	t_1	t_2	t_3	t_4	t_5	
car						2-axis
bicycle						1-axis
pedestrian						0-axis

Markov States



There are 8 patterns that can happen



Possible transitions

Features

- Normal Vectors
- Number of axis
- Axis lengths
- Directional vector, Motion speed
- Markov States

Dataset



Capture of application [Zhao06]

Next Steps

- Implement Dataset handler
- Implement Clustering and KL Transform to classify in 0, 1 or 2 axis object
- Get features from objects and obtain trajectory

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