

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

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Pattern Recognition, 2014

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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

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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.

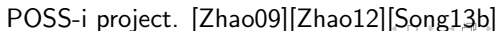
Research Groups

- 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

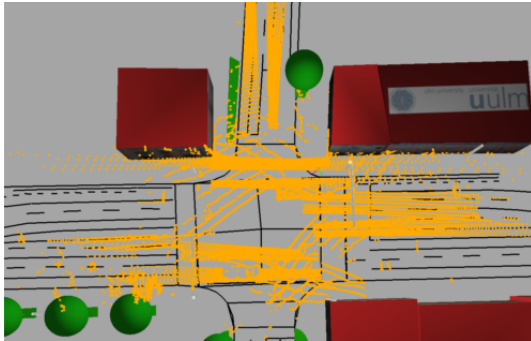
POSS-i : Monitoring a Traffic Scene through Fusion of Laser and Vision



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]

Applications, Methods and Techniques

Project	POSSi	Ko-PER
Applications	Recognition, Classification and Tracking of Vehicles and Pedestrians	
Methods and Techniques	<ul style="list-style-type: none"> - Clustering - Markov Chains - Kalman Filtering - AdaBoost 	<ul style="list-style-type: none"> - DBSCAN - Multi-object Bayes Filter - Sequential Monte Carlo Methods - Dempster-Shafer Theory - Multiple-Model Probability Hypothesis Density Filter (in Gaussian Mixture representation)

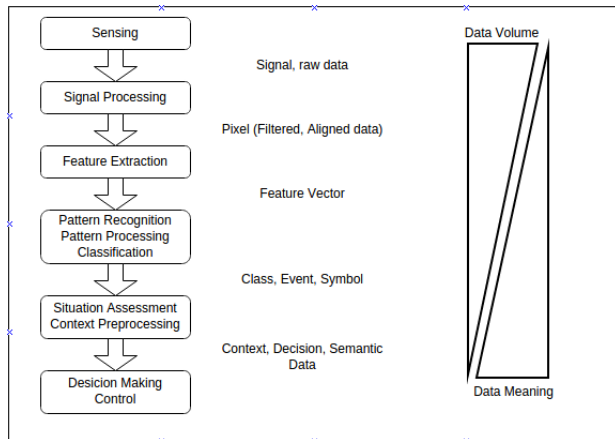
POSSi and PKU projects comparison

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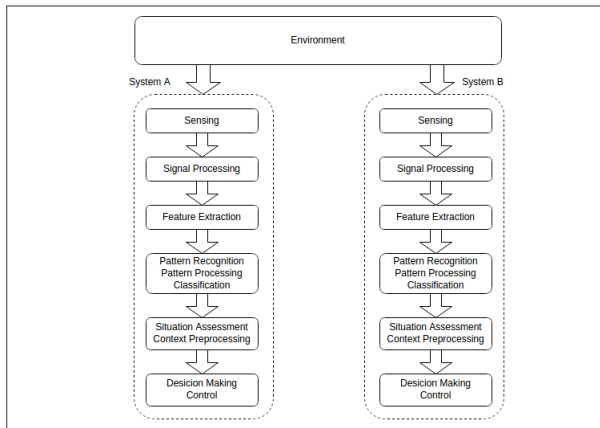
POSSi and PKU projects comparison

Typical System for one source of data



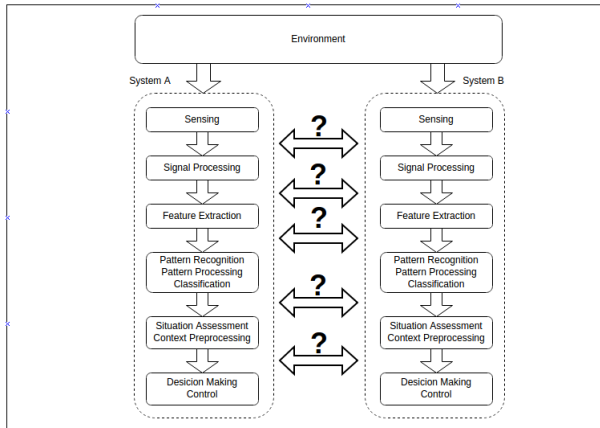
Single source system block diagram

Multisensor Data System



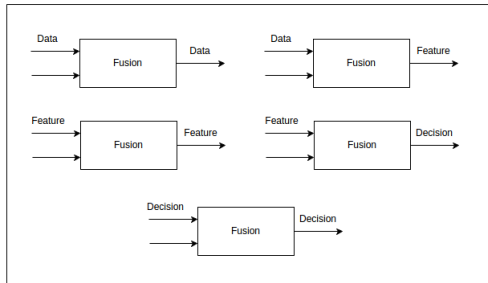
Multisensor system block diagram

How to fuse information?



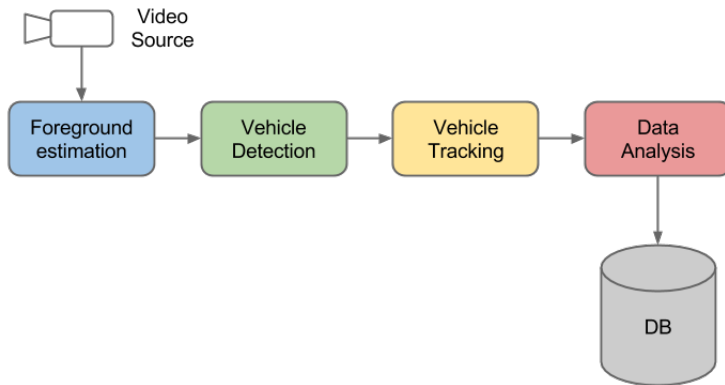
Multisensor system block diagram

Fusion Levels

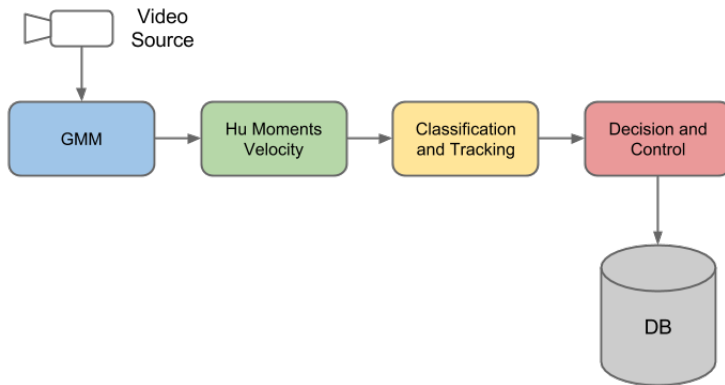


Fusion Levels [Luo11]

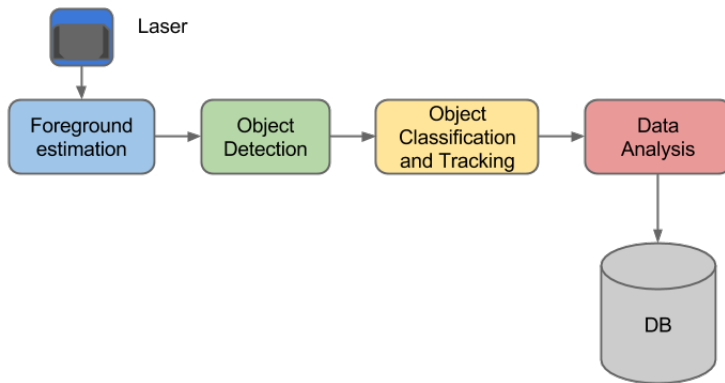
Video-Based System Block Diagram



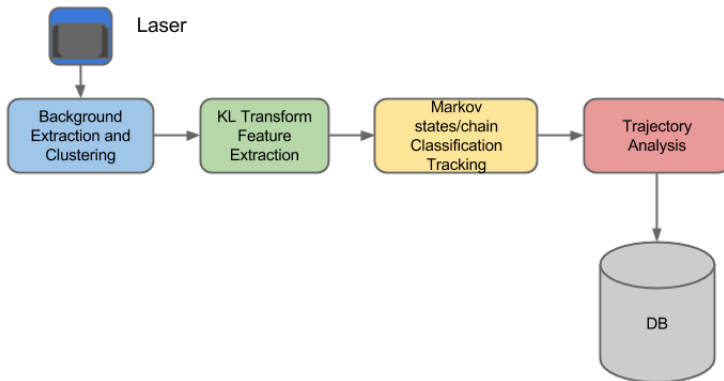
Video-Based System Block Diagram



Laser-Based System Block Diagram



Laser-Based System Block Diagram



Based on [Zhao06]

Dataset

- Although datasets for both projects are available, POSS-i dataset was chosen.
- It includes laser readings from 6 laser-scanner located in different corners in an intersection.
- The duration of scanning is approximately 10 minutes.
- A background model for each laser is provided

Dataset



Capture of dataset viewer application [Zhao06]

Background Extraction

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

Clustering

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

Clustering

More on clustering in ...

More on clustering in ...

UNSUPERVISED LEARNING

Clustering

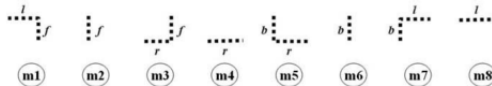


Classification

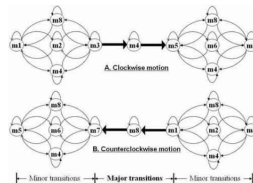
- Classes are proposed based on distribution of points in clusters
- Karhunen-Loeve Transform to detect number of axis

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

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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