interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

Frontal/Side-Rear Object Perception and all around track ID maintenance

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interactIVe final event

20th-21st November 2013

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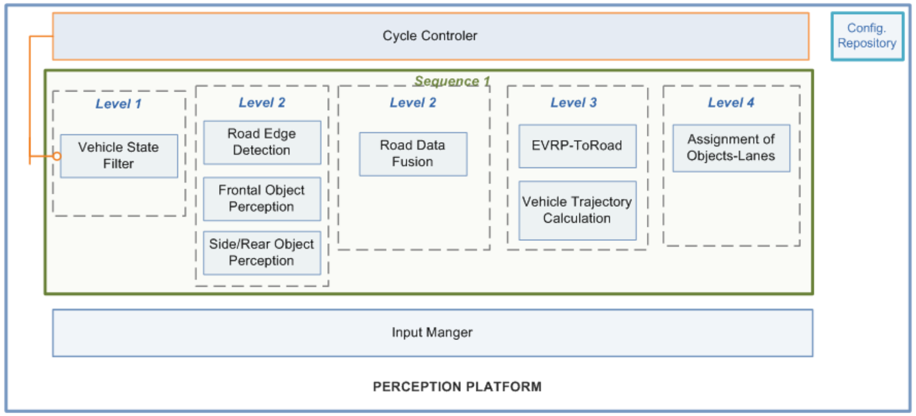
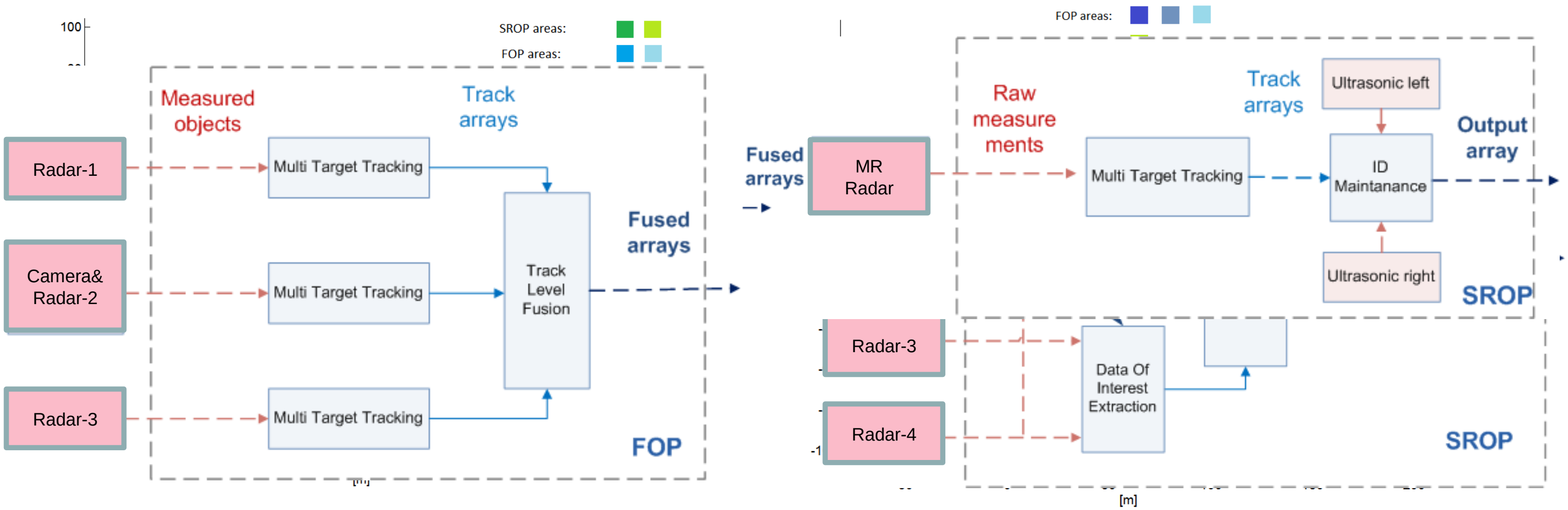
Introduction

- Multi-sensor data fusion quite mature research area
- Current active safety systems:
  - A significant amount of sensors used
  - Increased cost (luxurious vehicles)
  - Independent functions (different sensor set for each function)
- Proposed approach:
  - Same algorithms for different vehicles
  - Sensor set for different functions
  - Decreased cost
- Applicable to all type of sensors:
  - Short range radars
  - Long range radars
  - Cameras

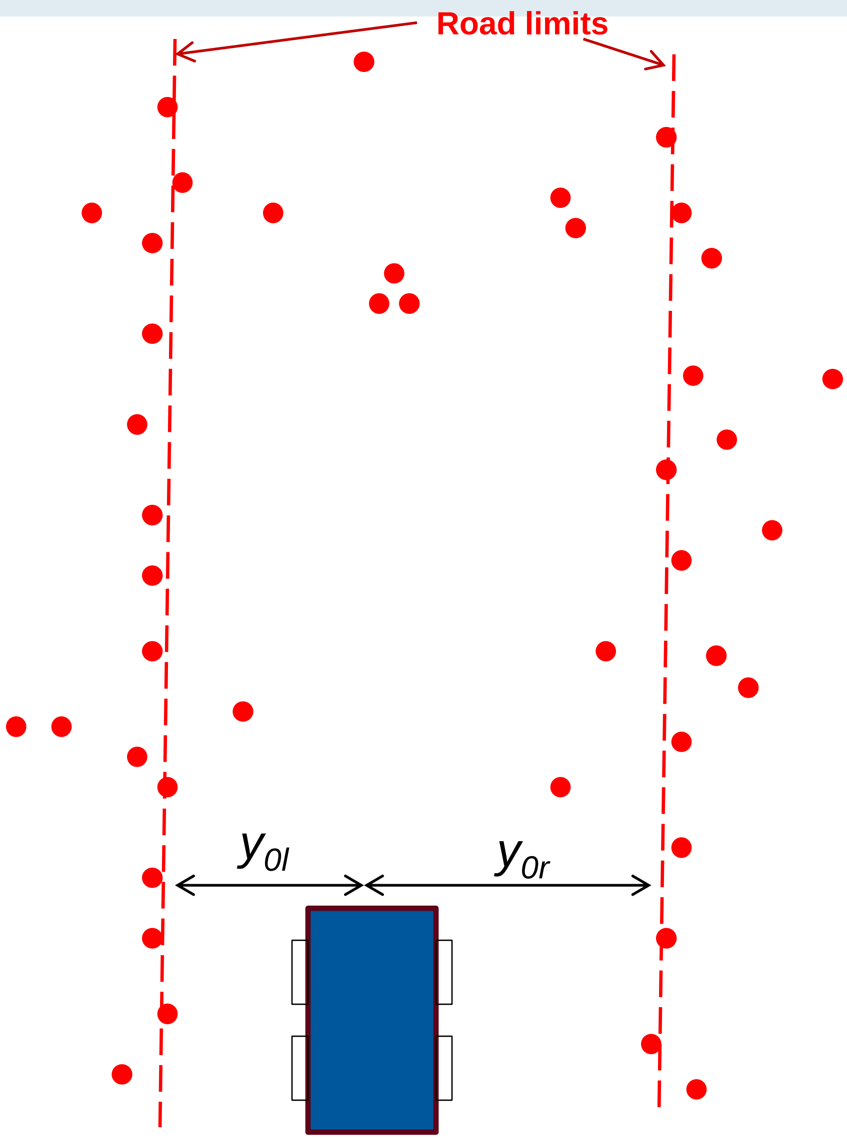


Innovation & Challenges / Module Architecture

- Multiple sensors covering all around areas
- Modular architecture to track/fuse the measurements from multiple sources and sets of sensors
- Interoperable common processing blocks for various architecture: data clustering, data association, multi-target-tracking.



Algorithmic Concept

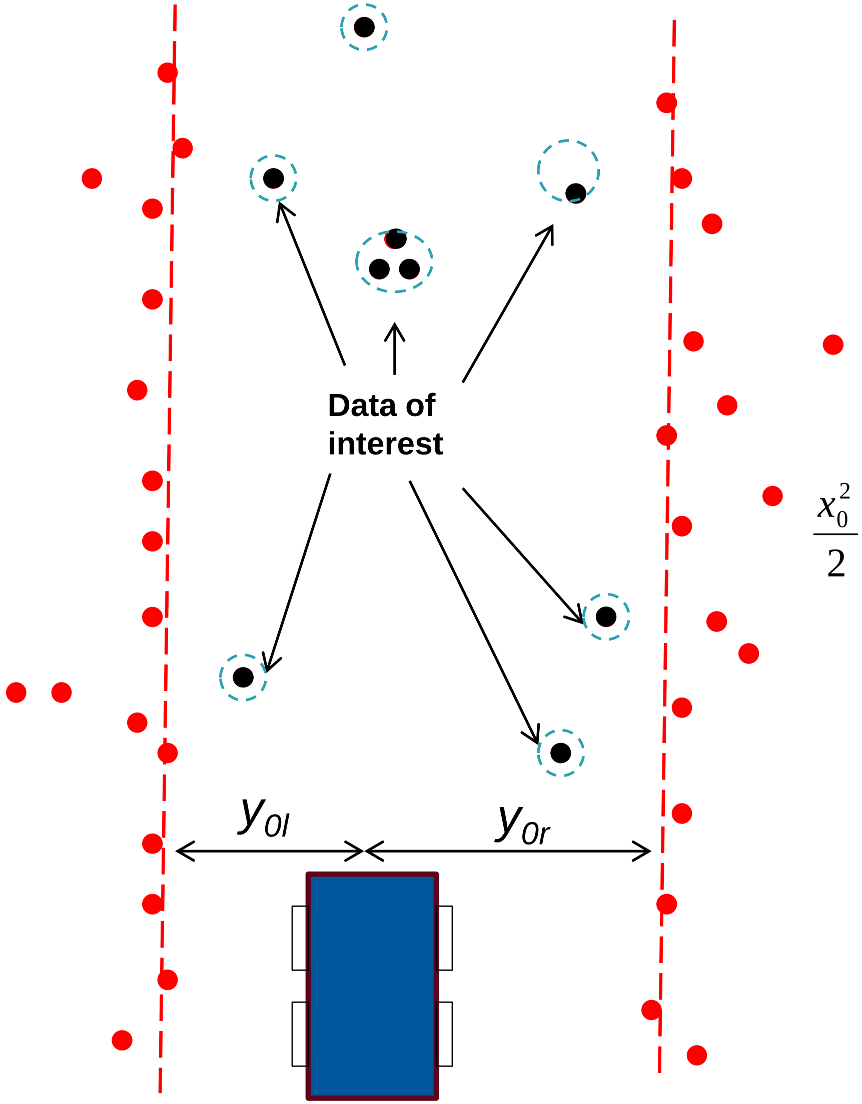


Road Limits Estimation

Curvature: c_0 $\mathbf{x}_{RB} = (c_0, c_1, y_{0l}, y_{0r})^T$

Curv. Rate: c_1 $\mathbf{y}_{RB} = (y_{1l}, \dots, y_{Nll}, y_{1r}, \dots, y_{Nrr})^T$

Algorithmic Concept



Road Limits Estimation

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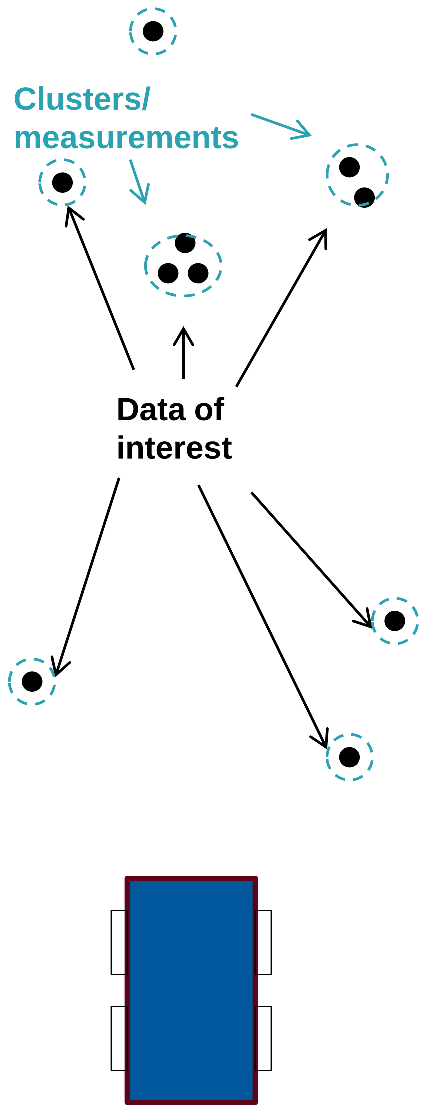
Curv. Rate: c_1 $\quad \mathbf{y}_{RB} = (y_{1l}, \ldots, y_{Nll}, y_{1r}, \ldots, y_{Nrr})^T$

Data of Interest Extraction

A measurement point $P_0\{x_0, y_0\}$ is a point of interest if:

$$\frac{x_0^2}{2} \cdot c_0 + \frac{x_0^3}{6} \cdot c_1 + y_{0R} < y_0 < \frac{x_0^2}{2} \cdot c_0 + \frac{x_0^3}{6} \cdot c_1 + y_{0L}$$



Road Limits Estimation

Curvature: c_0 $\qquad \mathbf{x}_{RB} = \left(c_0, c_1, y_{0l}, y_{0r}\right)^T$

Curv. Rate: c_1 $\qquad \mathbf{y}_{RB} = \left(y_{1l}, \ldots, y_{Nll}, y_{1r}, \ldots, y_{Nrr}\right)^T$

Data of Interest Extraction

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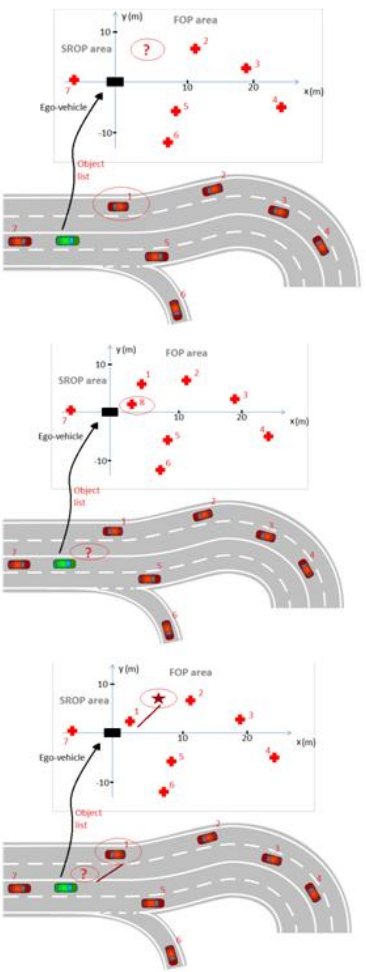
Data Clustering &Tracking

- CV motion model
- GNN data association solved with “auction algorithm”
- Rule based track management
- Kalman filtering

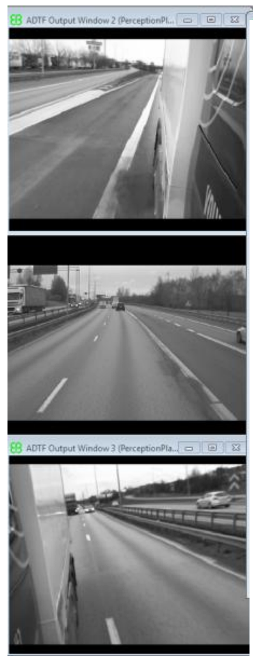
Evaluation Criteria

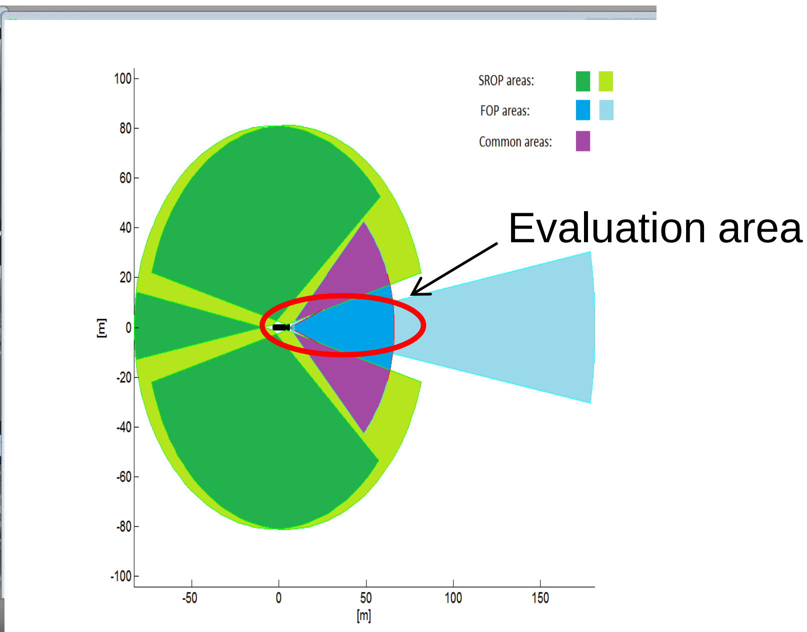


Track miss

False track

Erroneous detection





Performance Results

Scenarios

(S1) road with **no divider** and **oncoming traffic**, (337s), (5281 vehicles).
(S2) **highway** with divider and **low traffic**, (166s), (3486 vehicles).
(S3) **highway** with divider and **heavy traffic**, (295s), (12390 vehicles)

Results*

Scenarios	Failed Objects			Correct Objects (%)
	Miss (%)	False (%)	Error (%)	
S1	5.8	1.4	1.6	92.6
S2	2.6	1.5	0.3	97.1
S3	3.1	1.2	1.1	95.8

* **NOTE**: *False Targets because of sensor fault velocity measurements were not included.*

Performance example

Research Targets

Initial Objectives

1. Data clustering techniques for homogeneous sensors
2. Maintenance of Global Track ID

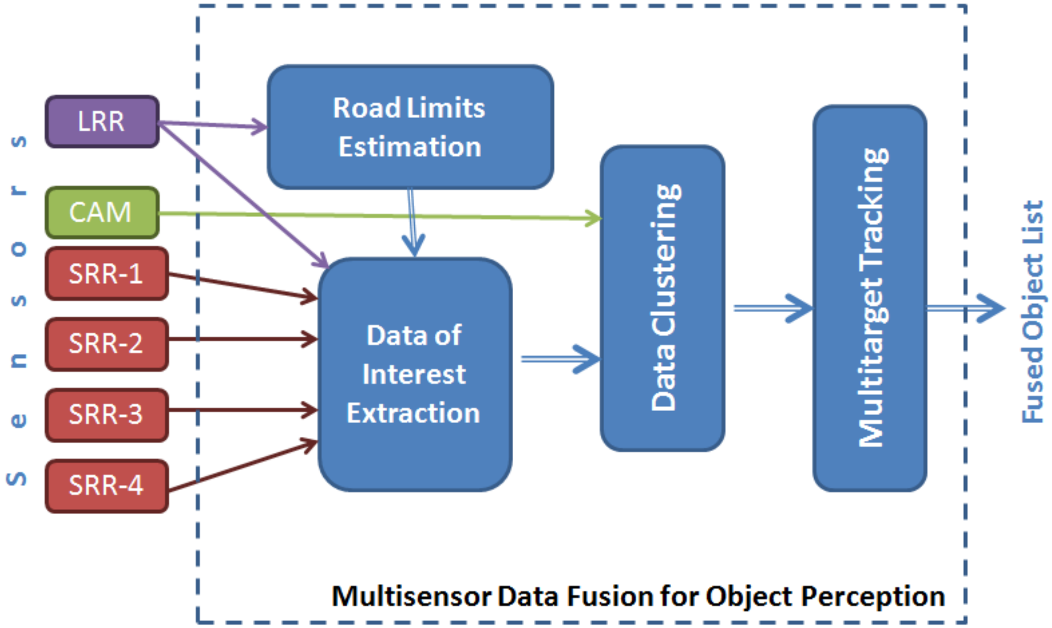
Delivered Modules

- Objective (1) covered ➔ data of interest extraction & data clustering => treating set of homogeneous sensor data as a single sensor.
- Objective (2) partially covered ➔ common ID for FOP and SROP sensor sets separately.

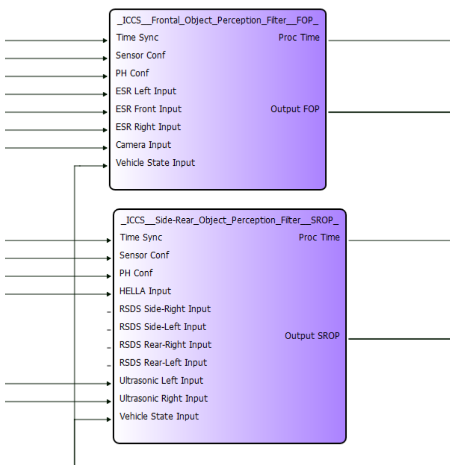
Research Module (Extra)

- Current architecture does not allow a Global Track ID ➔ Creation of a new offline research platform that hosts a global tracking module OP (=FOP+SROP) and produces a single object list.

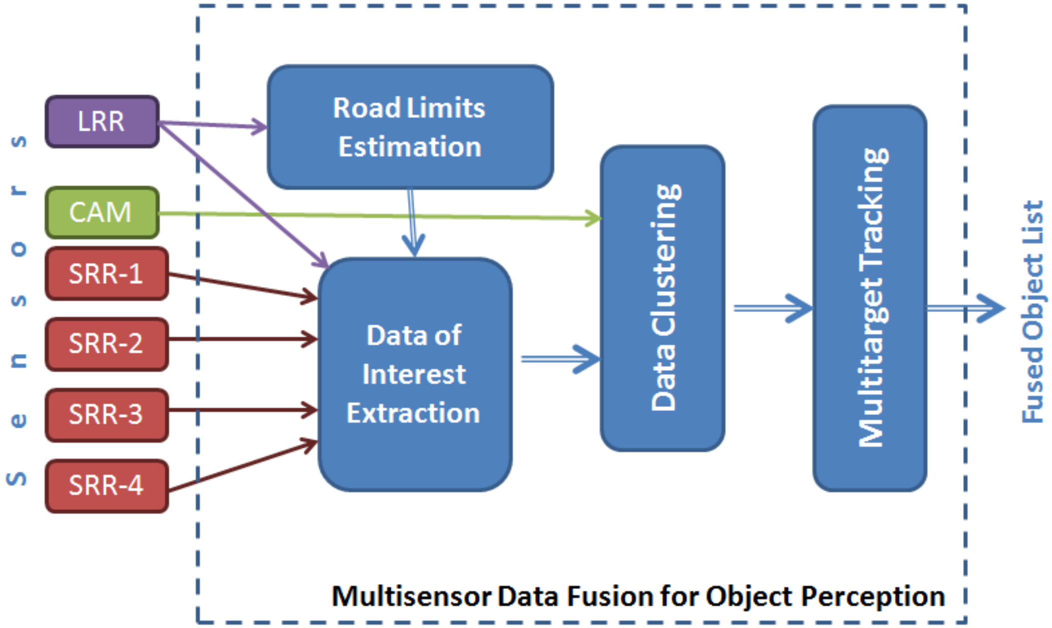
Research module



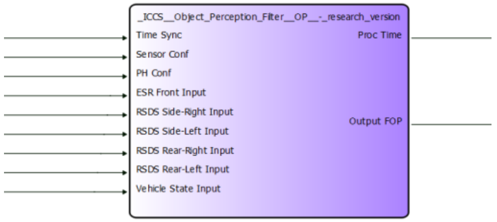
Version in interactIVe demonstrators



Research module



Research module
(All-around tracking OP)



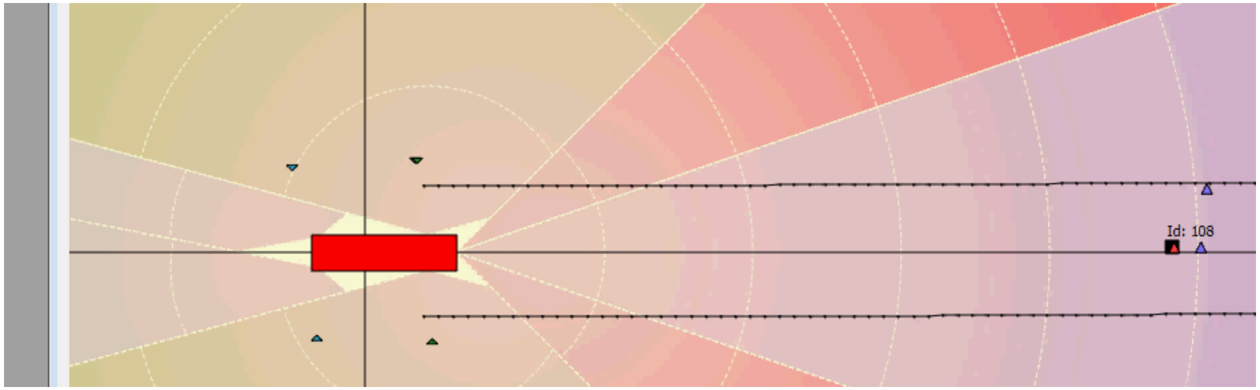
Track ID Evaluation (OP)

Less tracks by	42%
More stable tracks by	29%
More tracks (>100) by	41%

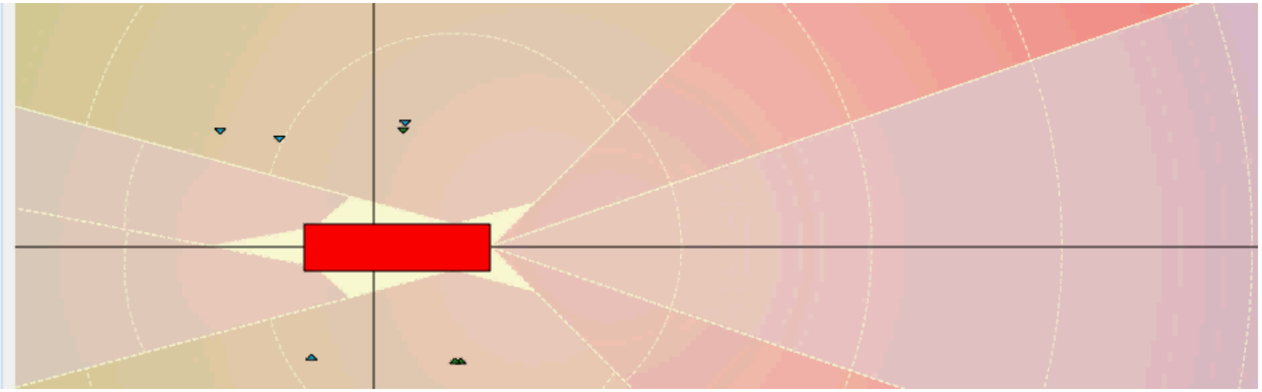
In the expense of bigger time delay and algorithm complexity.

ID Maintenance (example)

FOP & SROP ID's:



Research module OP ID's:



Conclusions & Future Work

Achievements

1. FOP & SROP online modules run in VTEC and FFA demonstrators
2. Intense offline testing and evaluation using recorded data sets from SP4/5
3. OP offline common module was tested

Lessons learned

1. All around ID maintenance could be achieved by one common sensor set.
2. In a multi-sensor set high level fusion can be proved very time consuming, homogeneous sensors could be better low level fused.
3. Proposed fusion architecture in multi-sensor all around sensor deployments
   - Homogeneous sensor inputs (sort and long range radars) are low level fused
   - Heterogeneous sensor inputs (radar/fused and camera) are high level fused

Future Work

1. Elaborate Global Track ID research module in terms of real-time tracking and performance of object perception.
2. Evaluate Hybrid Fusion Architecture on other sensor topologies

Acknowledgements

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interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

Thank you.

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SEVENTH FRAMEWORK
PROGRAMME

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