Intelligent Collision Risk Prediction Using Cooperative Sensor Technology

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Agenda

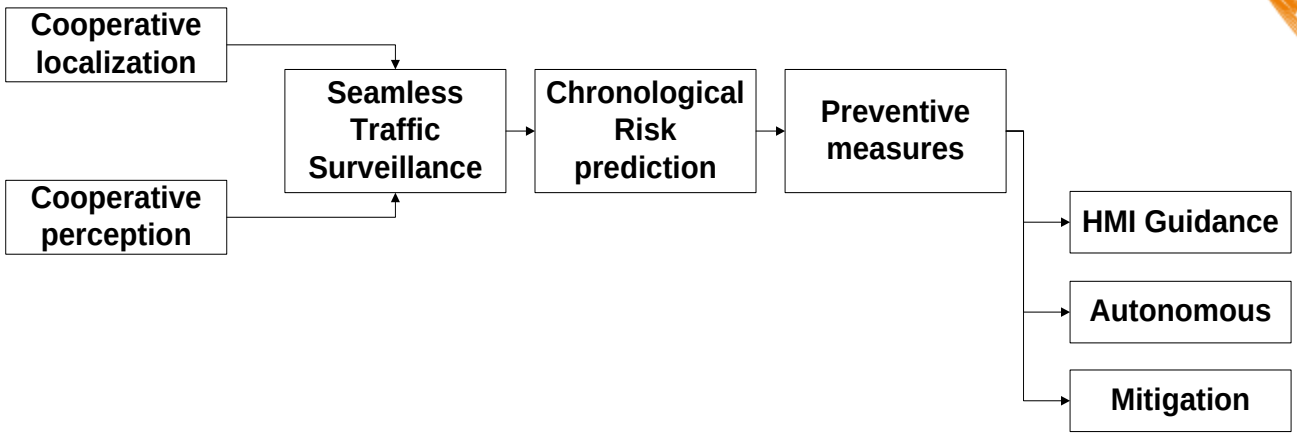
- **Potential of cooperative sensor systems**
- **Working principle**
- **Capability of prototypical cooperative systems using intelligent risk prediction algorithms**
- **Evaluation of cooperative systems and testing options**

Research Initiative Ko-FAS – Goals and Partners

Ko-FAS: Cooperative sensors and cooperative perception for the predictive traffic safety

Goal: Significant reduction of severe accidents and fatalities

Realization:



Partner:

BMW Group Forschung und Technik, Continental, DAIMLER, SICK Sensor Intelligence., DELPHI, MAGNA ELECTRONICS, Fraunhofer IIS, Fraunhofer Heinrich-Hertz-Institut, UNIVERSITÄT PASSAU, IZVW, ITE, hochschule aschaffenburg university of applied sciences, Steinbeis Transferzentrum Embedded Design und Networking, Steinbeis Innovationszentrum Embedded Design und Networking, Duale Hochschule Lörrach

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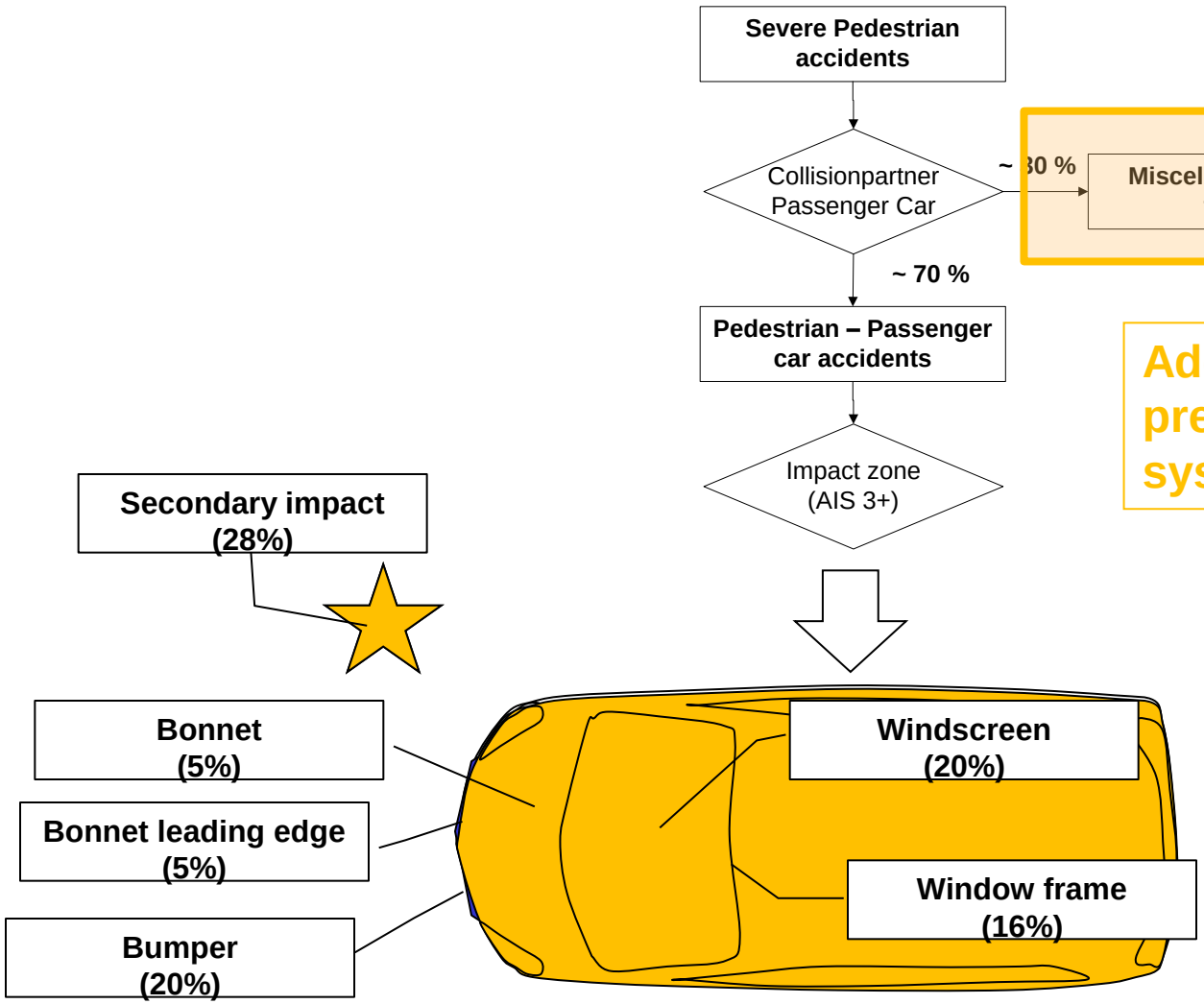
Potential of cooperative sensor systems



Addressable with preventive /cooperative systems

Addressable with active bonnet

Source: Accident analysis Ko-TAG Liers, VUFO, ACEA

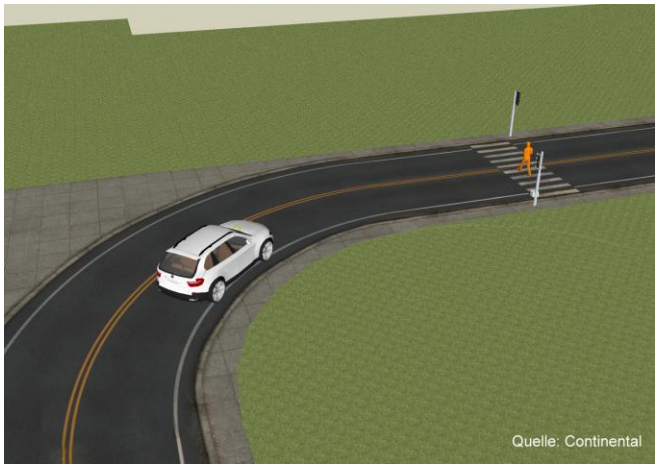
Typical secondary impact:

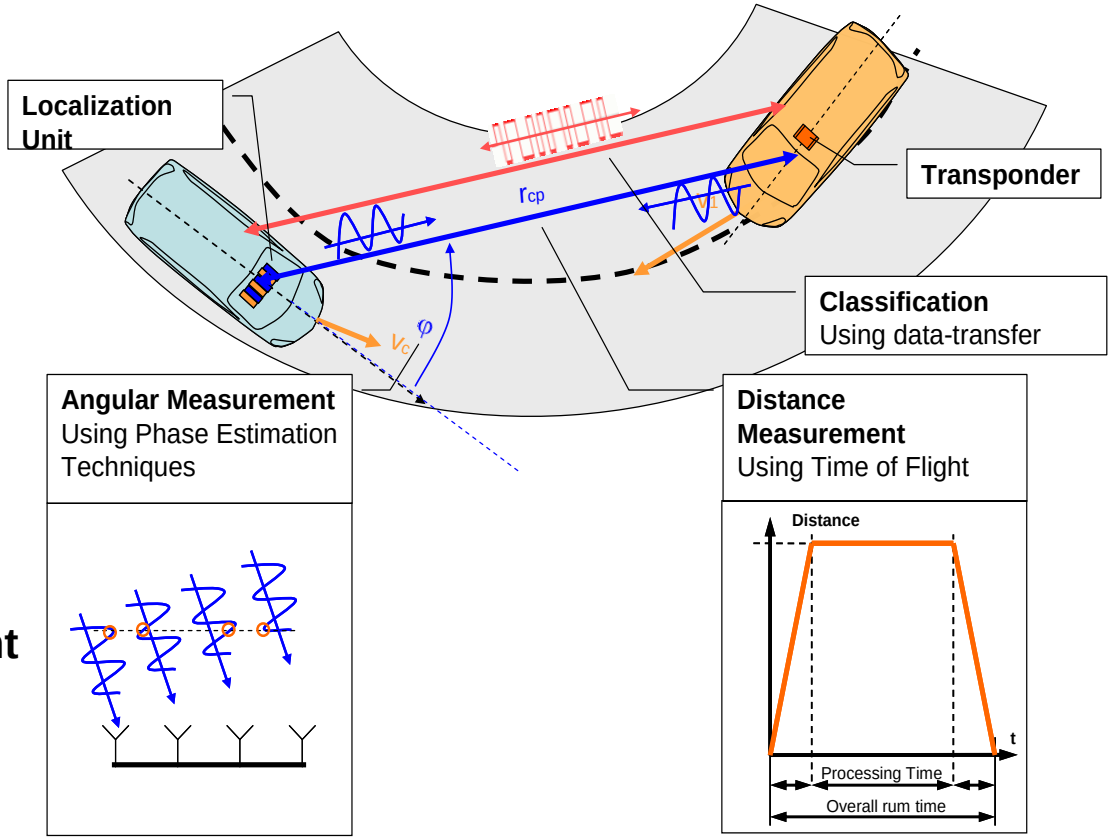
- Secondary impact is not addressable with current passive or contactbased active pedestrian protection systems

- Necessity of a forward-looking sensor system
  - with intelligent collision risk assessment
  - with autonomous measures

Approach: Cooperative Sensor System

Working principle:

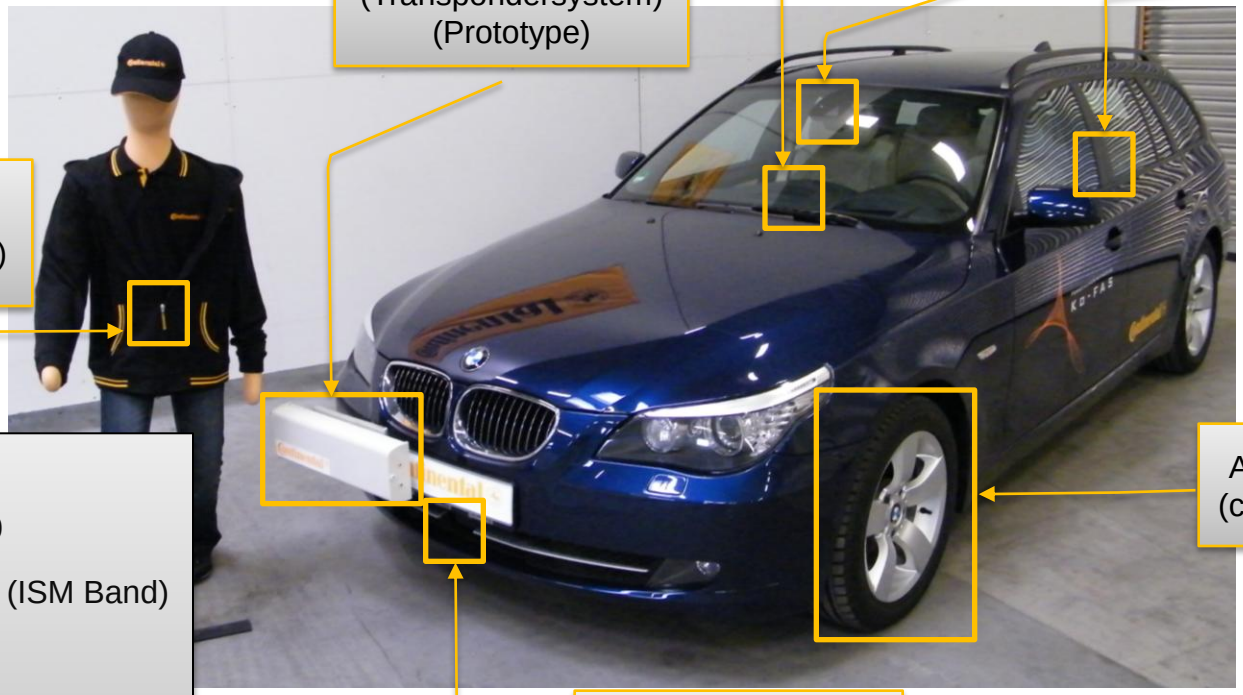




- **Reliable object classification**
- **Localization without line-of-sight**
- **Chronological tracking**
- **Resolution of individual pedestrians in groups**

System architecture prototype

Concept Vehicle Integration:



Performance Data:

Version: Ko-TAG 1.0

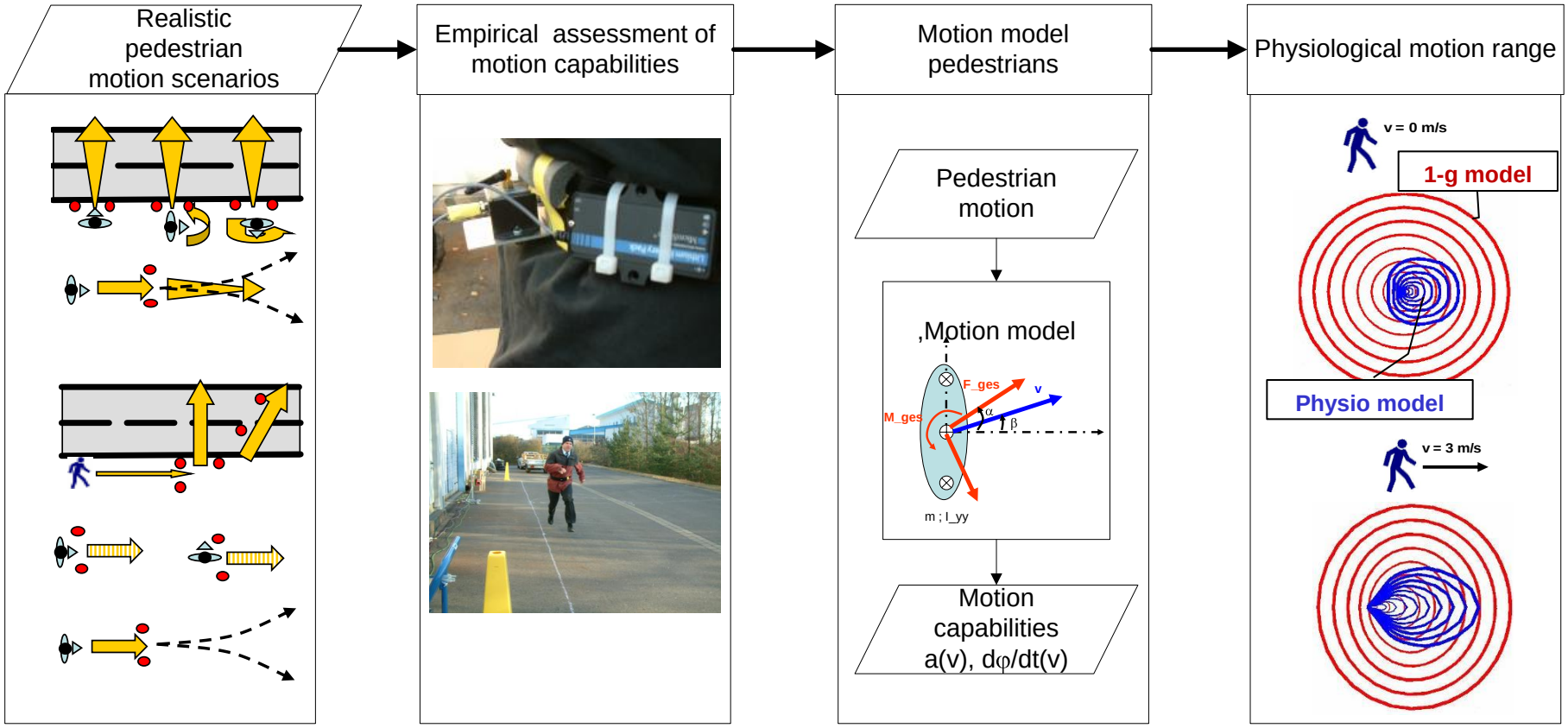
Frequency: 2.4 GHz (ISM Band)

Range: > 200 m

Accuracy: +/- 10 cm

Multi-User-Capability

Pedestrian model – Physiological motion range

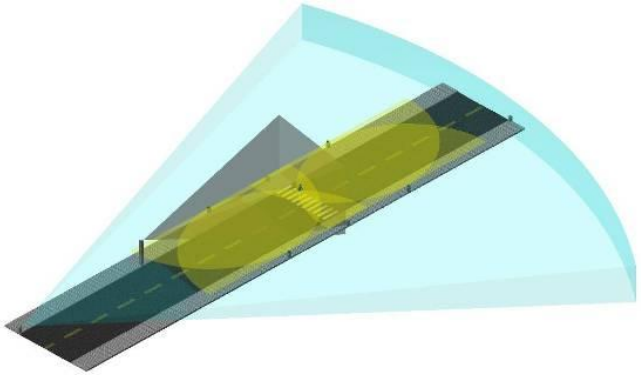


- Motion model for Bicyclists also available

Pedestrian model – Behaviour model

Target: Motion behaviour of Pedestrians in road traffic scenarios

Concept:



- Analysis of contrived scenarios with 1-2 persons
- Preliminary Tests under “enhanced laboratory conditions“
- Contrived scenes
- Little pedestrian appearance
- No vehicle traffic

Recordings in real road traffic

- „Unscripted“ pedestrian movement
- Massive pedestrian appearance
- Vehicle traffic

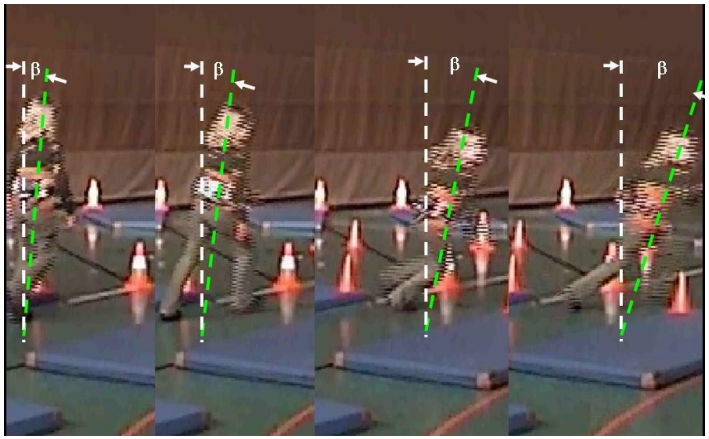
Spessart Gymnasium in Alzenau

Target:

- Early detection of changes of movement of a pedestrian by specific conditions before/while starting a running motion

Example 1:

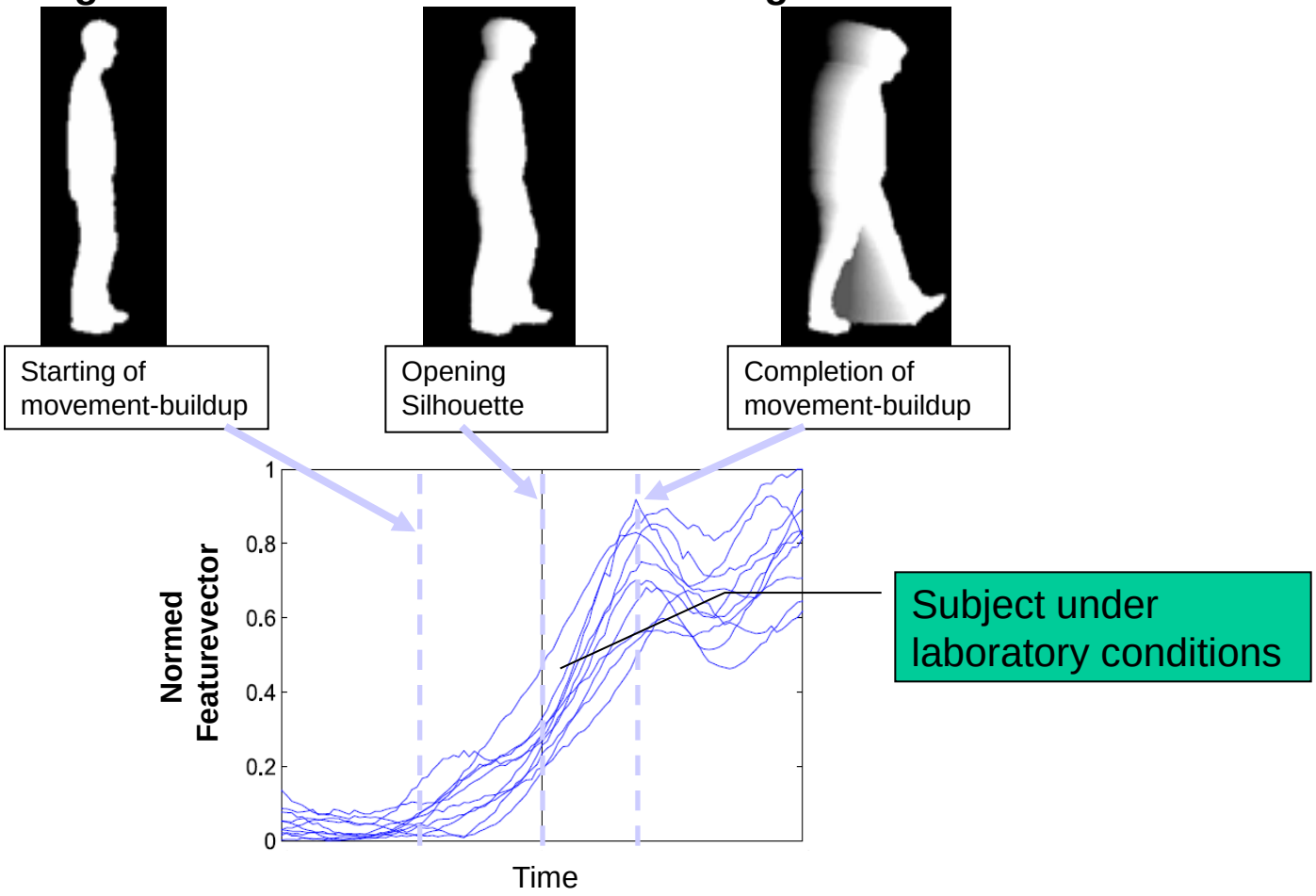
Change in body inclination



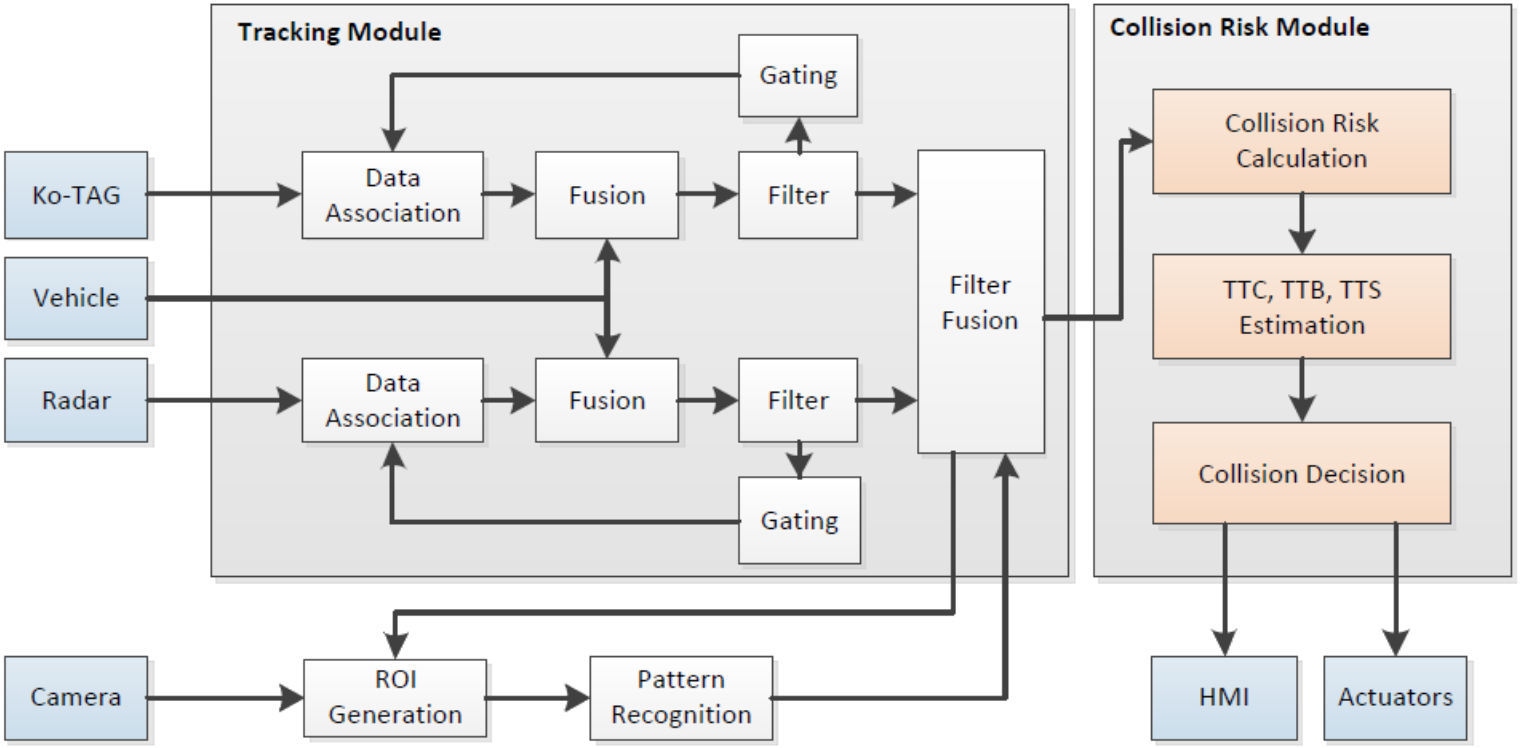
Example 2:

Change of center of gravity

Quantitative changes of chosen features in the starting movement



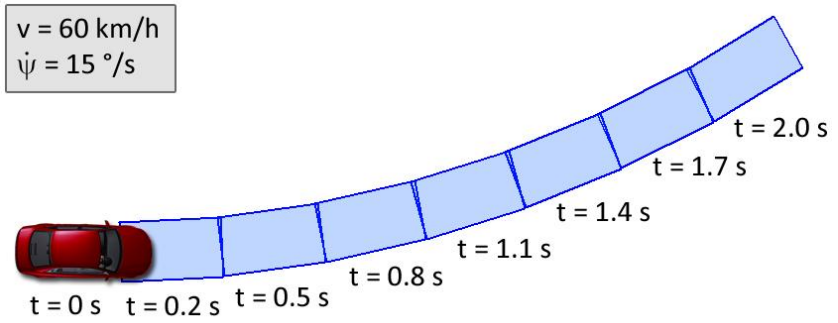
System architecture



- **Tracking based on different motion models**
- **Estimation of additional object parameters**
- **Robust operation via sensor fusion**
- **Camera matching to prevent misuse**

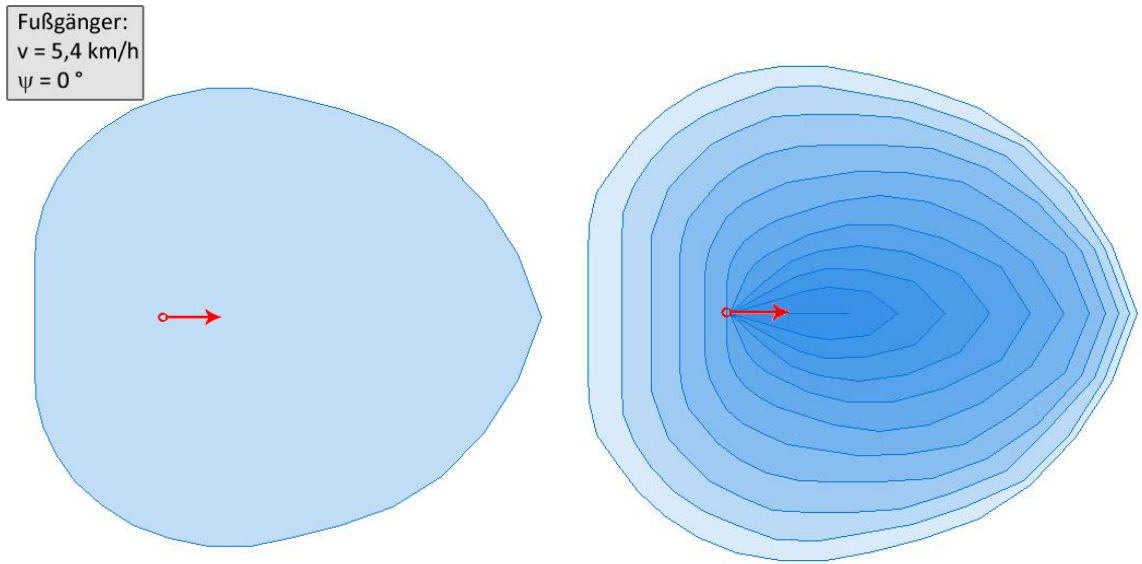
Collision Risk Calculation:

- Vehicle movement prediction based on linear bicycle model
- Pedestrian movement predicition based on physiological model
- Relevant time period: 2 s prior collision



Pedestrian-Model:

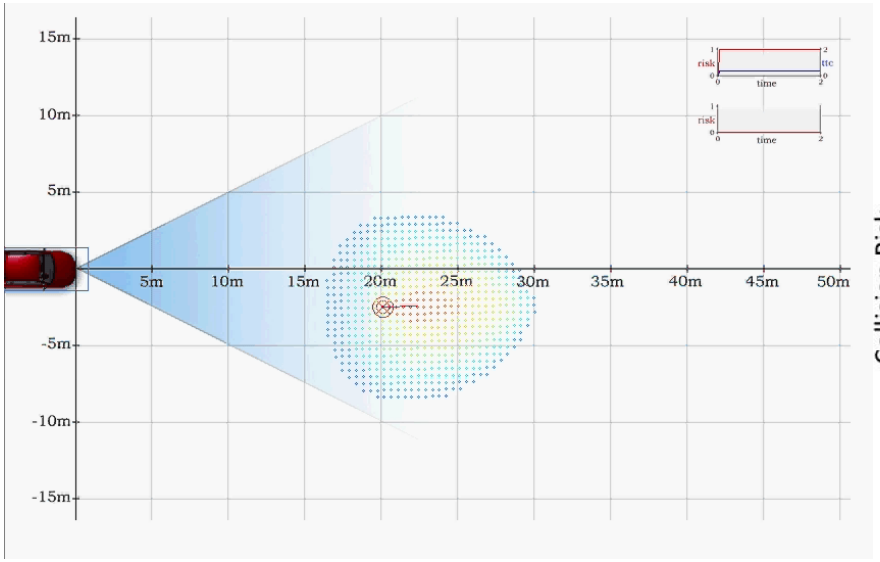
- First approach: Utilisation of the maximum physiological potential
- Second approach: Weighting of the movement area based on statistics

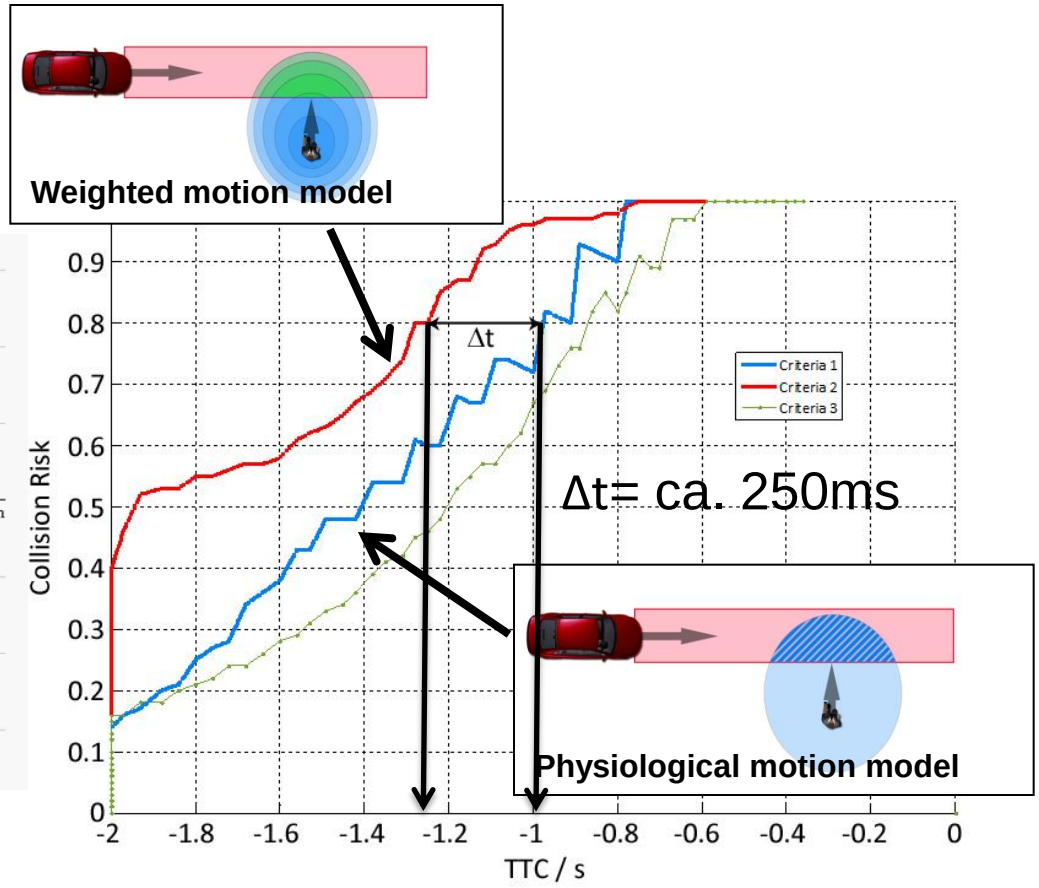


Physiological motion model **Weighted motion model**

Collision Risk Calculation – Model comparison

Typical collision scenario:
Crossing pedestrian

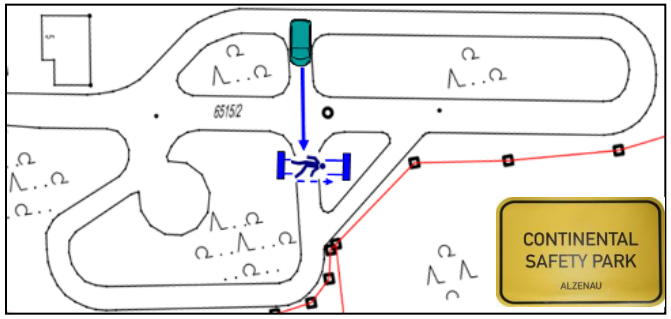




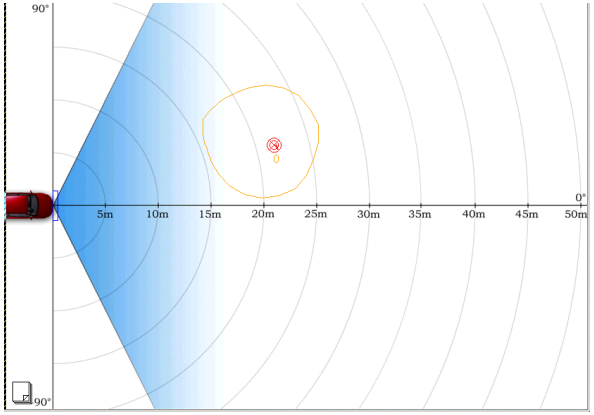
Comparison of two collision risk models

Current system performance

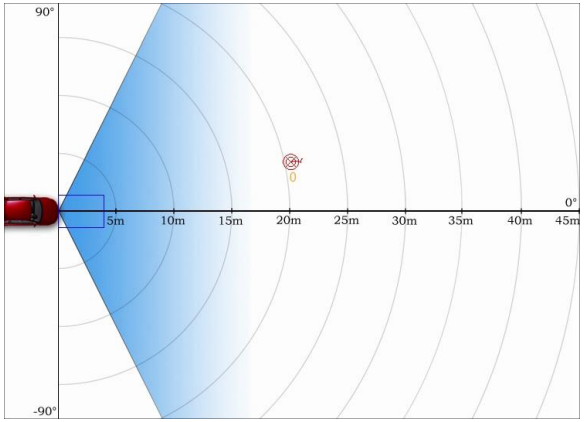
Pedestrian crossing scenario



Collision situation



Near-miss situation



Testing possibilities

- **Evaluation:**
  - Test cases derived from accident analysis
  - Referenced by DGPS and/or position information by Test device

- **Testing possibilities:**
  - Pedestrian Target Simulator (Cable-Car principle)
  - Kinetic 2-D Dummy
  - 3D Dummy
  - IR – 3D-Dummy
  - Testing up to contact without damage

Testing possibilities

- New rail-guided pedestrian target simulator
- Various pedestrian trajectories testable (e.g. Moving along -> Crossing the street)
- Target occlusion and modelling of urban environment possible
- Bicycle Target is planned
- Also applicable for common forward-looking sensorics

Conclusions and Recommendations

- Protection potential of preventive pedestrian protection systems exceeds the contact-based systems by far
- Broad introduction of preventive pedestrian protection systems is highly recommended initially based on ADAS-sensors
- Introduction has to be rewarded by legislation and by consumer groups
- Due to the unique protection capabilities for Vulnerable Road Users (Pedestrians/Cyclists/Bikers) the introduction of cooperative systems is reasonable
- Besides of technical development the opportunities of market introduction of cooperative safety systems have to be investigated emphatically

Thank you for your attention !

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