UNIKASSEL VERSITÄT

Chair for Communication Technology

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Traffic Safety in Future Cities by Using a Safety Approach Based on AI and Wireless Communications

Immanuel König

Situation / Problem

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- VRU: vulnerable road users
  - Pedestrians
  - Bicyclists (also e-Bike)
  - Scooter drivers (also e-Scooter)

- Problem: they are vulnerable

Situation / Problem

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- Germany
  - About 1 000 VRUs (vulnerable road users) are killed in road accidents
  - Over 100 000 are injured per year (2019)
- Worldwide
  - 350 000 are killed per year (2016)
- Number of VRUs will increase
  - Political will
  - Increasing environmental awareness motivates VRU mobility

How to solve this?

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BYCLYLITS!

disturb traffic since 1900

Bildquellen: Hintergrundbild: Unfall mit Fahrradfahrerin in Weißenburg, https://www.region-schwabach.de/wordpress/unfall-mit-fahrradfahrerin-in-weissenburg/

training programs

VRU are trained in critical situations

traffic planning

Planning tries to avoid critical situations

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Bustellenplanung: B.A.S., https://www.bas.de/dienstleistungen-baustellen-absperr-service-planung.php

active warnings

An active warning is given to the driver

active warnings

An active warning is given to the VRU

training programs

VRU are trained in critical situations

traffic planning

Planning tries to avoid critical situations

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eye tracking of VRU

Detection of traffic events from the point of view of the VRU's **viewing directions** by means of eye tracking

cameras in vehicles

Detection of traffic events from the point of view of the vehicle using camera data from vehicles

wearables of VRU

Detection of traffic events from the point of view of the VRU's body movements using the sensors of wearables

Bildquellen: Hintergrundbild: Unfall mit Fahrradfahrerin in Weißenburg, https://www.region-schwabach.de/wordpress/unfall-mit-fahrradfahrerin-in-weissenburg/
Kamera: CleanPNG, https://de.cleanpng.com/png-qbbh4v/
EyeTraker Brille:tobiipro, https://www.tobiipro.com/de/produkte/tobii-pro-glasses-2/

hotspot detection

hotspots

Bildquellen: Heatmap: spektrum.de, https://scilogs.spektrum.de/datentyp/digitalisierung-der-stadt-smart-city-fangt-doch-einfach-mal-an/
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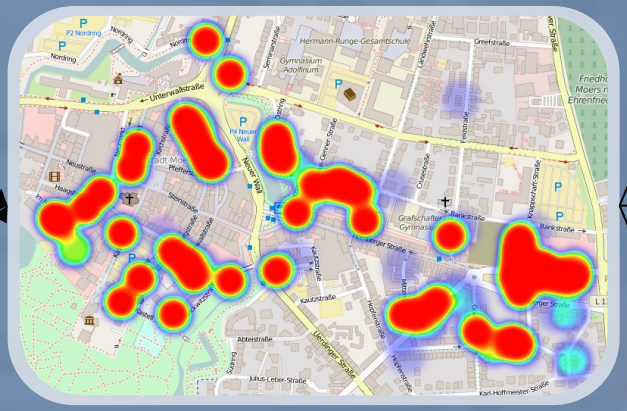
hotspot detection



hotspots

measures

active warnings

traffic planning

training programs

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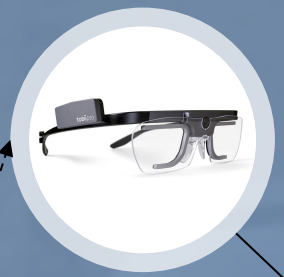
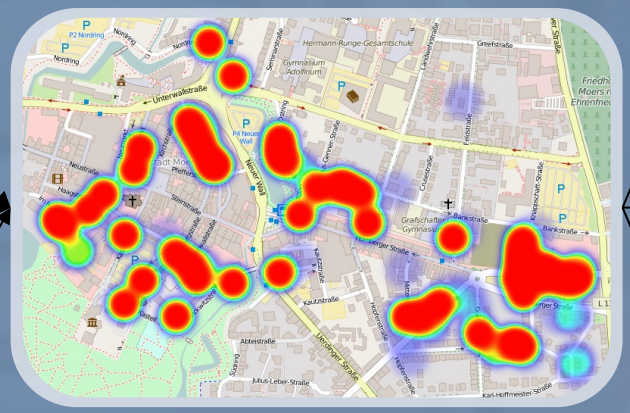
hotspot detection





hotspots

measures

active warnings

traffic planning

training programs

evaluation

simulator

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Fahrradsimulator: Bundesanstalt für Straßenwesen, https://www.bast.de/BASt_2017/DE/Verkehrssicherheit/Technik/Radsimulator.html

Smartphone / wearables-based collision detection and Active Warnings

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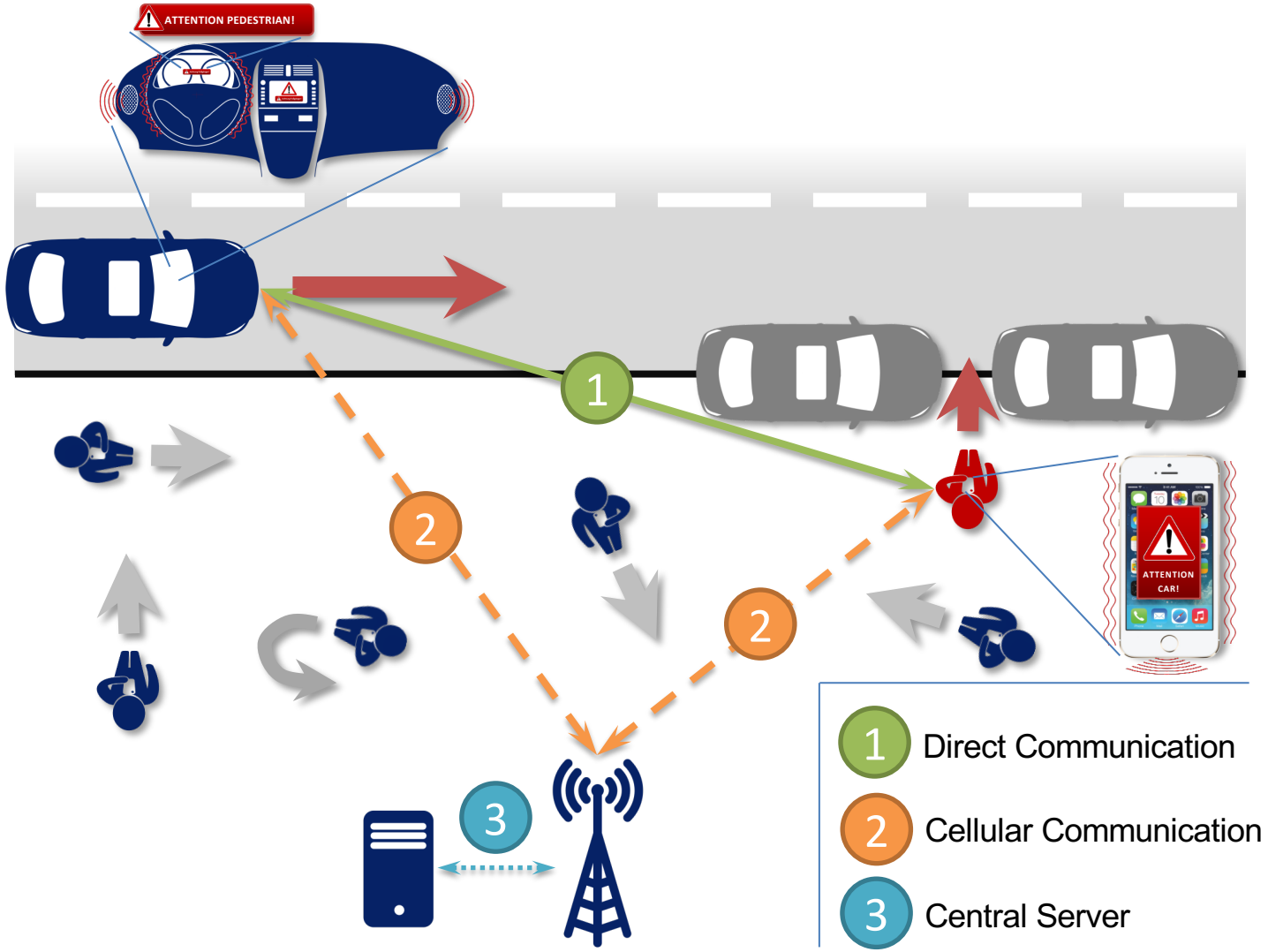
1. Detect / predict movement trajectories of VRU
   - AI + Smartphone / Smartwatch inertial sensors
2. Detect / predict movement trajectories of vehicle
   - AI + Smartphone / Smartwatch inertial sensors
   - Car onboard sensors
3. Calculate collision probability
4. Give active Warning
   - To both, the VRU and the driver of the vehicle

Wearables and communication



Computer vision / vehicle-based collision detection and Active Warnings

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1. Detect VRUs
   - Faster R-CNN
   - CenterNet

2. Track VRUs
   - Kalman tacking

3. Anticipation / Predict VRUs
   - Probabilistic approach

Computer vision from vehicle

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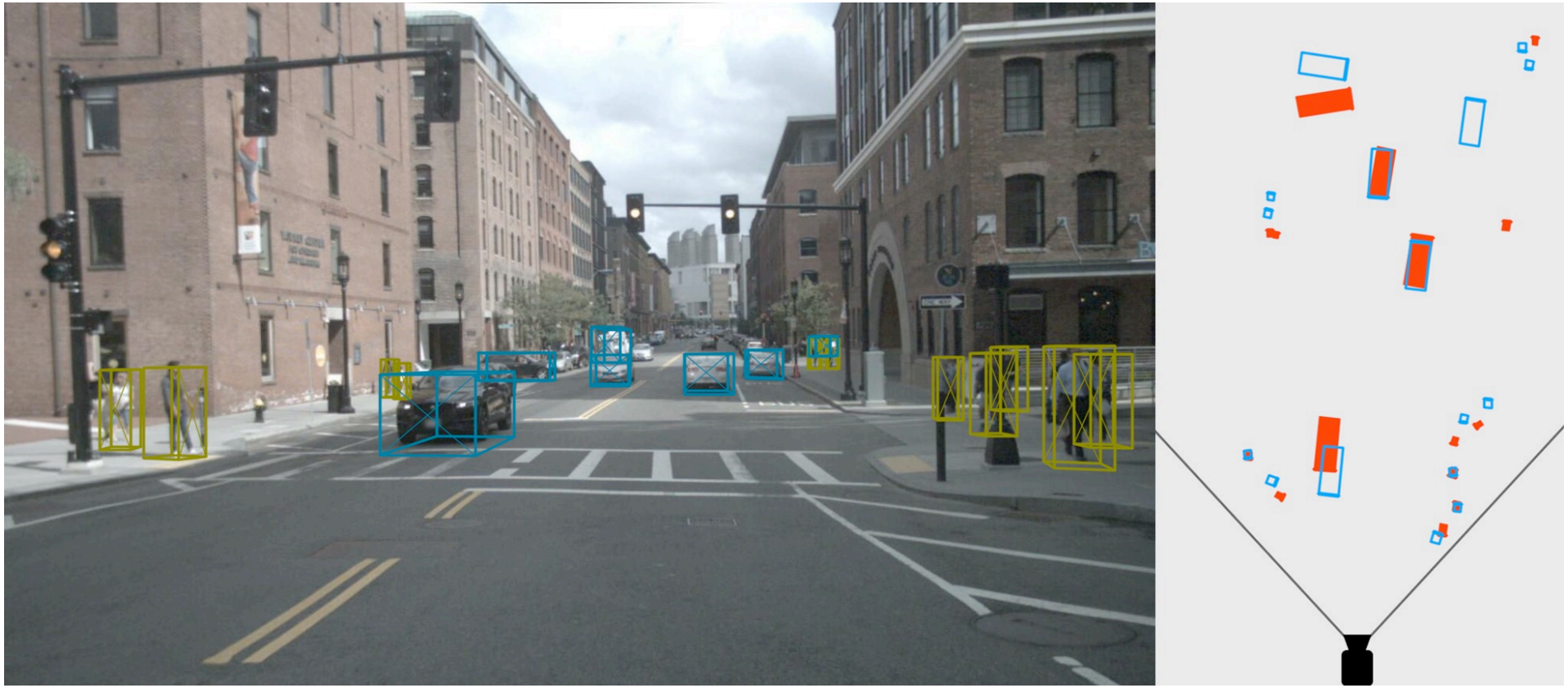

Simulation study example cyclist and car

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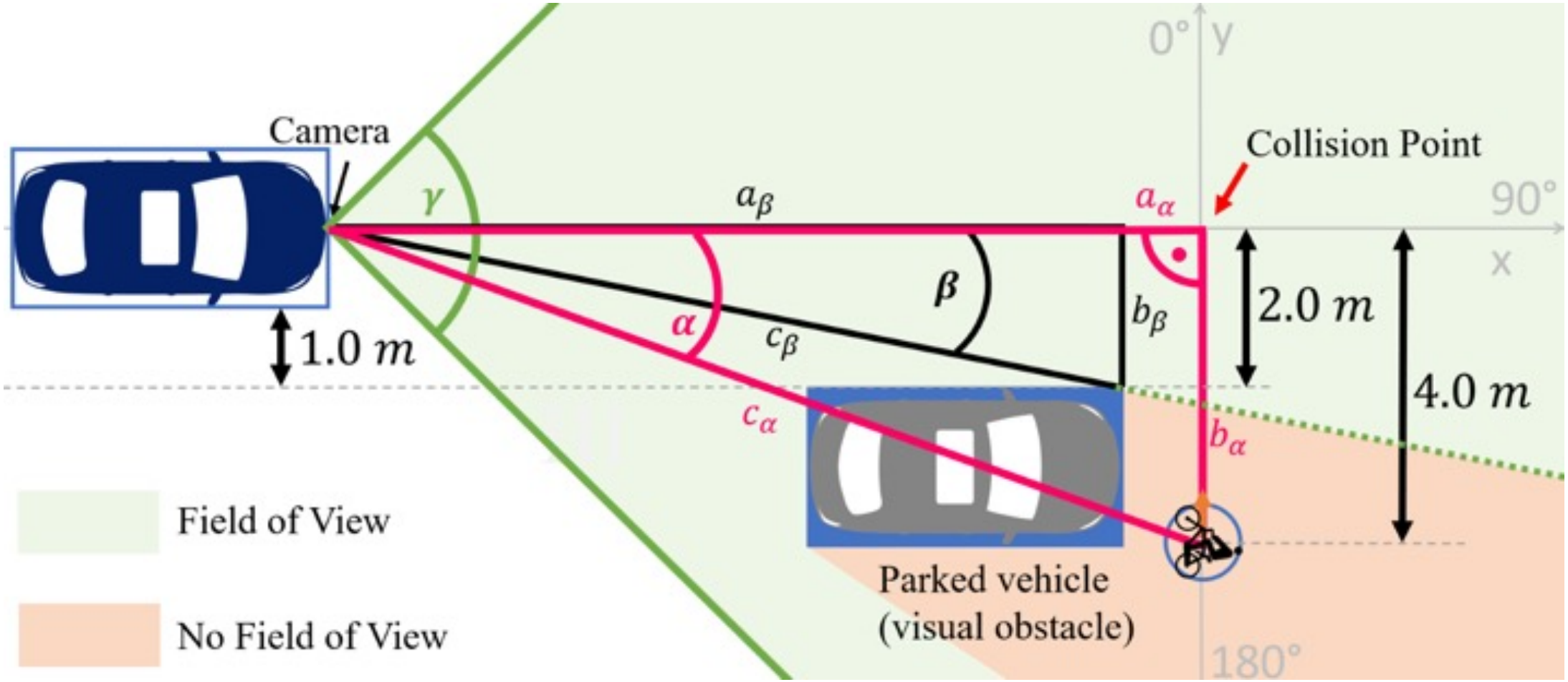
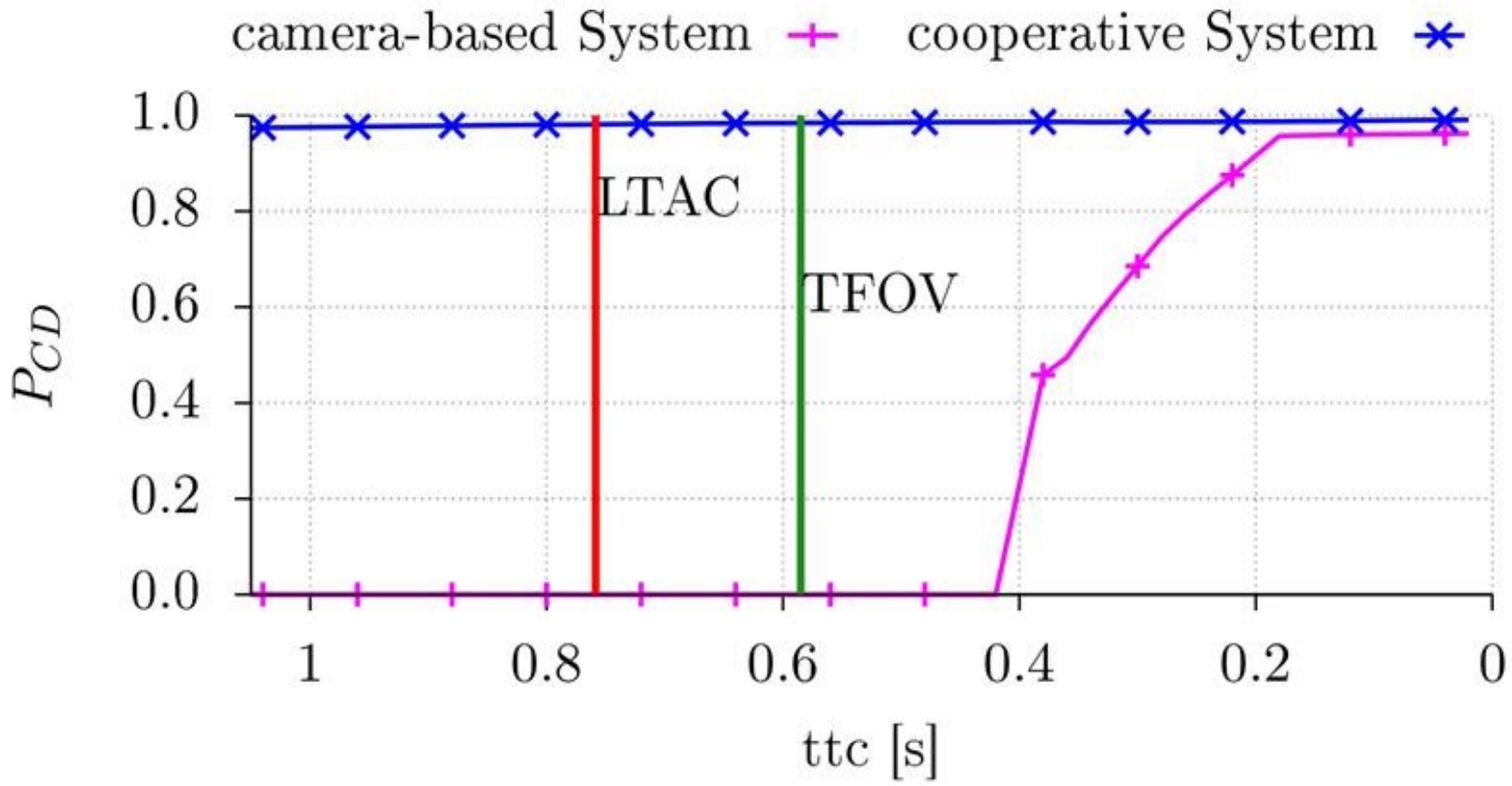


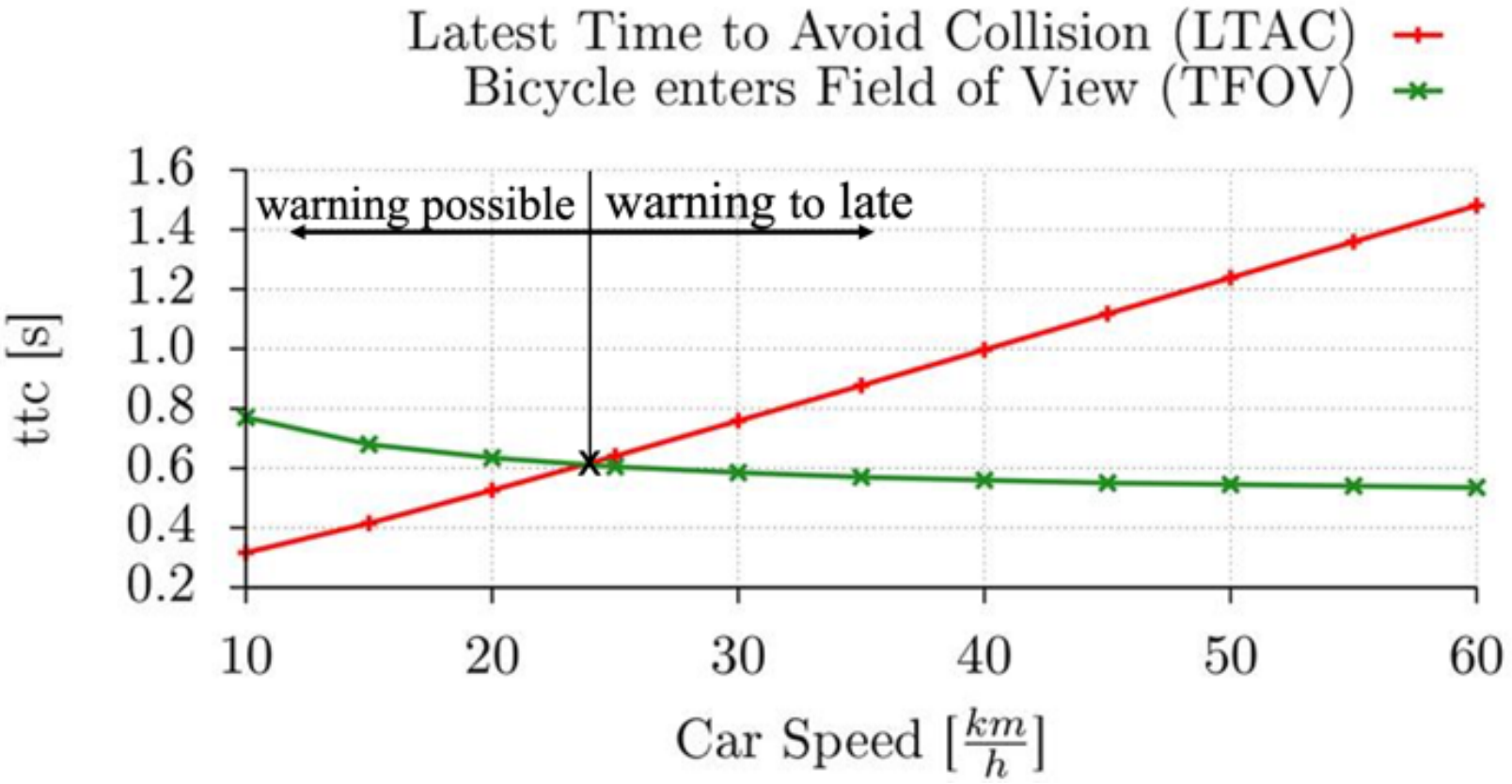
Sketch of the Euro NCAP NLOS scenario (CPNC-50) for a bicyclist.

Simulation example cyclist and car



Probability of collision detection (P_{CD}) of a smartphone / wearable-based and a camera-based collision avoidance system in the Euro NCAP NLOS scenario. LTAC is the Latest Time to Avoid the Collision and TFOV the Time the bicycle enters the Field Of View of the camera-based system.

Simulation example cyclist and car



Latest time to avoid the Collision (LTAC) and the time the bicycle enters the field of view of the camera system in the Euro NCAP NLOS scenario (CPNC-50)

Legal Issues

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- Data processing to protect VRUs
  - If cameras are used the persons usually have not permitted to film them
  - If wearables are used agreements on the use of the trajectories must be made
- Processing of test and training data
  - The AI algorithm must be trained
  - Training data also underlies legal conditions

Approaches of traffic planning: roadside changes

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- Detection of accident hotspots
  - Newly built traffic infrastructure → design deficits can be identified
    - Through a sensor data-based conflict investigation
    - Before an accident hotspots develops

- Measures can be for example:
  - Separation of lanes
  - Speed limits
  - Fences

Approaches of traffic planning: training programs

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- For example, traffic education for children and young people
  - Data is used to identify
    - Particularly conspicuous dangerous behavior
    - Traffic violations
    - To prioritize them accordingly in training courses
  - Effects of training can be measured by a before-after evaluation with an experimental and a control group

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Thanks for your attention.