Context-Dependent Scene Interpretation and Collision Risk Prediction

Kontextabhängige Situation Interpretation und Bewertung von Kollisionsrisiko

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Objectives for Context-Dependent Situation Interpretation

Objectives

• Recognition of Driver Intention
  • stop, turn L/R, straight

• Risk Assessment

Appropriate Strategy

• Warn the driver 2 seconds* before the last instant to avoid the collision by braking

* HMI-Efficency & Acceptability: Frederik Naujoks et al., IZVW – Uni Würzburg
Challenges for Context-Dependent Situation Interpretation

• Many road users on the intersection → Combinatorial and interpretation issues

• Context dependency
  • Localization, Intention prediction, Traffic rules
  • Occlusions → Communication to complete the field of view

• Handling of data
  • Heterogeneous input
    → Measured, computed, communicated
  • Uncertainties in data
Intention Recognition and derived Situation Features

• Assumptions:
  • Vehicles behavior is conform with traffic rules

• Digital Map*:
  • allowed maneuvers, priority rules

• Forward predicted paths**

• Extraction of Situation Features

* Digital Map: Roland Krzikalla, SICK
** Paths Prediction: Dominik Petrich, Daimler
Situation Features

• SL – Significance level of a predicted path*  

• $TTx = \{TTE, TTL\}$ – Time to Enter/Leave the conflict area

• $TTB^{**}$ - Time to brake to avoid the collision

* SL: Dominik Petrich, Daimler  
** TTB: Computation based on Forward Simulation, Daimler
Method to Resolve the Challenges

Data uncertainties ➔ Method for probabilistic reasoning

Object-oriented Bayesian Networks (OOBN)

- Appropriate knowledge representation
- Reduction of complexity by model library of fragments
  ➔ Reuse or modify in similar situation context
  ➔ Easily extendable

- Mimic human reasoning
The System Approach on Situation Analysis

- Cooperative environment*
- Fuse data (collected from sensors)**
- Select relevant vehicles
- Assign road-lanes to vehicles
- Predict forward paths of vehicles***: SL
- Intersect paths to detect conflict area
- Extract the situation features: TTx
- Use OOBN for risk assessment
- Generate the warning

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* Ko-PER
** Data Fusion: Florian Seeliger, MRM/driveU – Uni Ulm
*** Paths Prediction: Dominik Petrich, Daimler
Object-oriented Bayesian Networks for Recognition of Potential Collisions and for Risk Assessment of Real Collisions

Warning Condition: ISSUE WARNING when Collision Probability > 0.80 and TTB ≤ 2sec

Bayesian variable

Time values based on continuous Gaussian distributions
Real Traffic Situation and Risk Analysis

- Integration of FMP & OOBN
- Situation Analysis for all plausible hypotheses of relevant objects

→ Collision Risk Analysis by Bayesian networks under uncertainties

FMP = Forward Motion Prediction
Test Result: Evaluation of Risk in a Collision Situation with Warning

Context-dependent Situation Interpretation and Collision Detection

Last moment to apply brakes to avoid collision

Entrance of conflict area

Time to react (0.8s)
Video of Demonstration Scenario 1 on the Aschaffenburg Intersection

Crossing
Video of Demonstration Scenario 2 on the Aschaffenburg Intersection

Left Turn Across Path

Fahrдemonstration Ko-PER Assistenz

Szenario Linksabbiegen

Daimler, Delphi, driveu
Summary

- Scalable system approach
- A novel combination of forward path prediction with object-object relations for risk assessment, allowing reliable risk assessment
- Hierarchical object-oriented modeling
  - Creation of model libraries with generic OOBN-fragments

Successfully deployed and tested in the experimental vehicle
Questions?

Thank you!