Driver Intent Inference Based on Parametric Models

Fahrerabsichtserkennung auf Basis parametrischer Modelle

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1. **Driving accidents, e.g. veering off the street.**

   - Numbers decreasing, i.e. thanks to ABS und ESP.

2. **Accidents with at least two conflicting traffic participants.**

   - Driver misinformation is the most common cause of accidents!
Driver Intent Inference
Motivation

- Unnecessary warnings need to be avoided.
- Knowledge of the driver's intent is essential to determine the relevance of potential conflicts.
Driver Intent Inference Challenges

Velocity-based right turn prediction

Huge variety of situations:
- Initial conditions
- Driving style
- Intersection geometry
- Surrounding traffic
Driver Intent Inference Challenges

Velocity-based right turn prediction

Huge variety of situations:
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⇒ Necessity to describe the underlying cause-effect relationships

\[
\dot{v} = a \left[ 1 - \left( \frac{v}{u} \right)^\delta - \left( \frac{d^*(v, \Delta v)}{d} \right)^2 \right],
\]

\[
d^*(v, \Delta v) = d_0 + T v + \frac{v \Delta v}{2 \sqrt{a b}}.
\]

Parametric models:
- Natural way to integrate expert knowledge
- Generalize well to arbitrary situations
- Efficient to evaluate
Real World Traffic: Multiple Hypotheses
Self Localization and Hypothesis Tree.

**Digital map**
- Database of distinct lane segments represented by their centerlines.
- For efficient map-matching, lane centerlines are modeled as circular arc splines.

**Hypothesis tree**
- Directed acyclic graph.
- Horizontal neighbours represent lane change maneuvers (one per lane segment only).
- Each leaf node represents a unique path through the intersection.
Path Probabilities

Prior probability:
- Lane assignment based on lateral deviation.
- Lane change probabilities based on remaining segment length.

Investigated features:
- Velocity profile
- Indicator activation
- Gaze direction

Posterior probability:

\[
P(H|O) = \frac{\prod_i P(O_i|H)}{P(O)} \frac{P(H)}{P(H)}
\]

Normalizing Constant
Prior Probability

Feature Likelihoods

Risk Assessment
Driver Assistance
Velocity Feature

Intelligent Driver Model.

\[ \dot{v} = a \left[ 1 - \left( \frac{v}{u} \right)^{\delta} - \left( \frac{d^*(v, \Delta v)}{d} \right)^2 \right], \]

\[ d^*(v, \Delta v) = d_0 + T v + \frac{v \Delta v}{2\sqrt{a b}}. \]

Expected Acceleration

Observed Acceleration

Feature Likelihood

Turn Related Deceleration.
Velocity-Based Right Turn Prediction
Multiple explanations for right turn signal.

Right turn indicator activation distances:

- Indicator activation PDF
- Indicator activation CDF

Lane change indicator activation time:

Exact time of lane changes.
Gaze Direction Feature

Expected gaze points:

Expected vs. observed head direction:

⇒ Model can be used to evaluate arbitrary hypotheses!
Right Turn Prediction: 12 Drivers, 5 Intersections, 400 Crossings

Good classification performance even with implausible observation of the indicator feature!
Major achievements
- Prediction of entire paths rather than single maneuvers.
- Interaction with preceding vehicles taken into account.
- Driver intent inference for other traffic participants.

Ongoing work
- Add mirror glances to the driver gaze direction model.
- Driver situation awareness: Provide warnings only when necessary.
- Evaluation of lane change prediction.
References


