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# Vehicle maneuver-based long-term trajectory prediction at intersection crossings

**Identifying the trajectory of a vehicle during 4-leg intersection approaching, given its kinematics, map position & short-term maneuvering intention.**

## Highlights of the approach

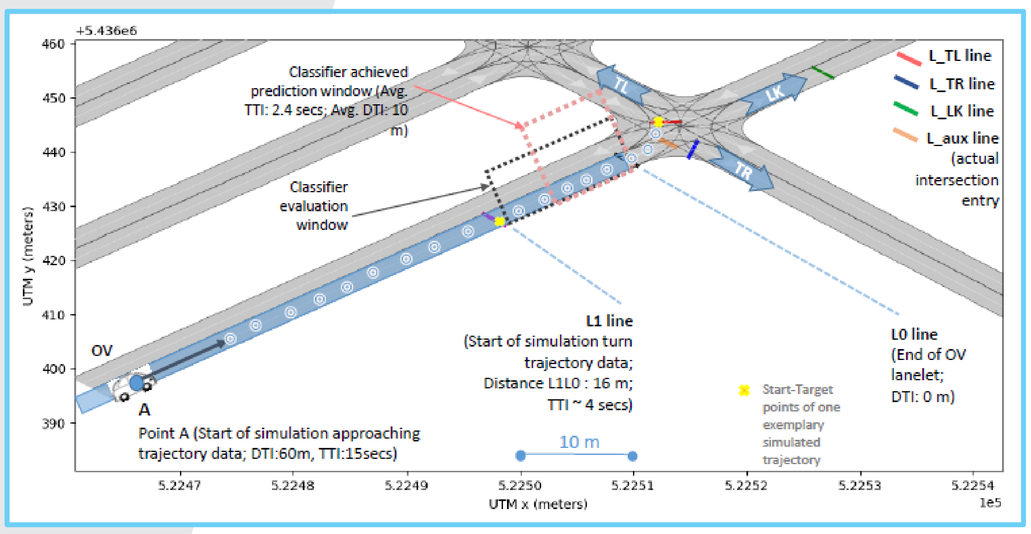


*Fig. 1. Simulation experiment's points of interest for an observed vehicle (OV) crossing a 4-leg intersection by either driving straight ahead (LK), turning right (TR) or left (TL).*

- **Trajectory fusion for long-term trajectory generation:** A classical kinematic-based vehicle trajectory, accurate only in short-term and map-agnostic, is fused with a long-term map-aware trajectory derived based on the vehicle's maneuver classification and the associated target lane.
- **Experimental setup and results:** Quantitative experiments on simulation datasets of crossing tracks on a 4-leg intersection. Effective and robust extension of the trajectory prediction horizon:
  - Turn prediction horizon longer than 3 secs (average classification time at 3.67 for turning left and 3.07 seconds for turning right )
  - Trajectory prediction horizon considerably extended (over 5 secs ahead) based on the associated target lane information.

## Methodology

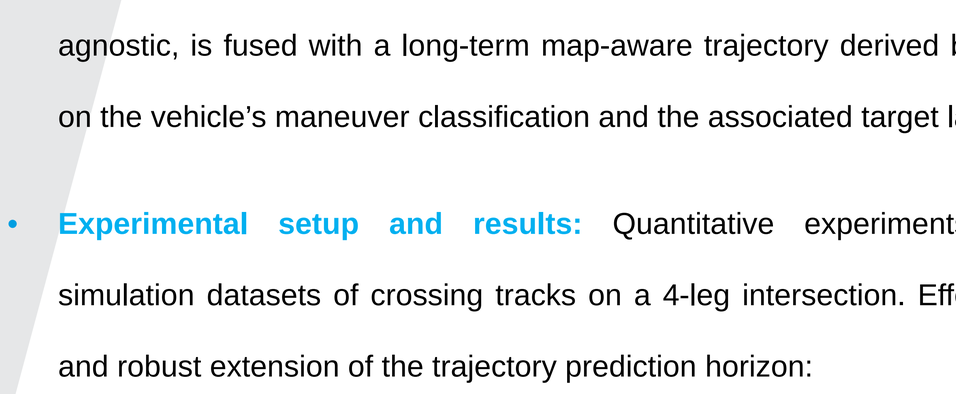


*Fig. 2. Proposed System Architecture*

- The system is divided into two main parts: the maneuver classification and the trajectory prediction (Fig. 2).
- HMM classifier that incorporates lane-level map information with past position and kinematics of the vehicle (Fig. 3).
- Derivation of smooth long-term trajectory, given the targeted map lanelet. Final predicted trajectory as a combination of the motion-based and long-term trajectories.

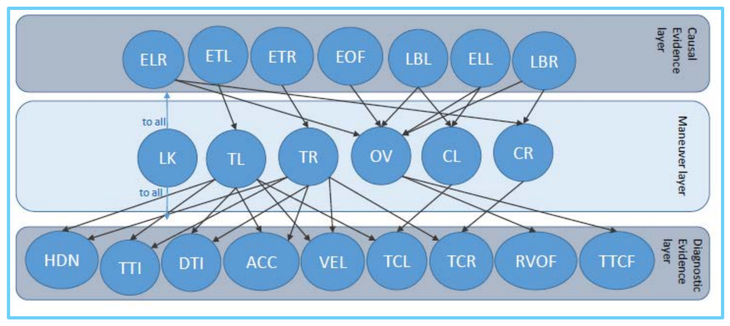


*Fig. 3. HMM layers*

## Results

- Maneuver classification evaluation window (Fig. 1) consists of the road area between lines L1 and L0.
- Evaluation of HMM classifier's performance by the prediction horizon length and the classifier's precision/recall rates.
- Turning detection consistency & qualitative performance against TTI (Fig. 4).

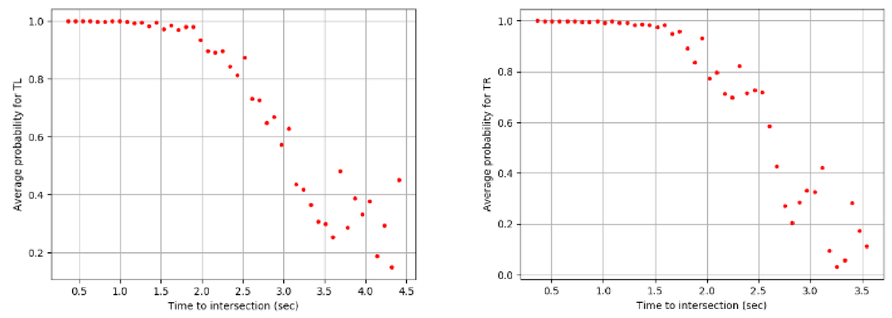


*Fig. 4. Average probability of left-turn (on the left) and of right-turn (on the right) intention as the OV crosses the HMM evaluation window (L1-L0 area depicted in Fig. 1)*

- Trajectory prediction quantitative comparison using RMSE between the baseline and the CTRA/Fused trajectories.
- Short and a long-term evaluation (Fig. 5).

| Type of Trajectory and prediction evaluation window | *TL* | *LK* | *TR* |
|---|---|---|---|
| Short-range CTRA (3 points) | 1.10 | 0.54 | 1.01 |
| Short-range Fused (3 points) | 0.51 | 0.32 | 0.53 |
| Long-range CTRA (8 points) | 1.86 | 1.18 | 2.54 |
| Long-range Fused (8 points) | 0.38 | 0.39 | 0.38 |

*Fig. 5. Trajectory RMSE comparison*



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