International Co-operation on Theories and Concepts in Traffic Safety

Intelligent traffic detection for pedestrian-sensitive traffic light control and other safety applications

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Improving road safety and optimizing the traffic flow for all road users are major challenges for the future transportation system. In this context DLR and VITRONIC have entered into a cooperation. The starting point were VITRONICs enforcement systems, which have been contributing to safety for many years, e.g. by detecting speed and red-light violations at traffic lights [1]. The basic idea is that this technology can be expanded and used in parallel for additional functions. With the Local Traffic Safety Analyzer (LTSA), an initial safety-focused traffic control and information system was jointly developed and prototypically implemented at a test intersection in the city of Potsdam [2]. The system is based on a sensor platform that detects traffic objects. The data are processed in real time using AI approaches to interpret the traffic situation. The traffic objects are classified and their trajectories determined. With these data, the LTSA serves two use cases: It detects safety-critical situations and broadcasts warning messages via V2X communication. Furthermore, it enables adaptive signal control by providing the data to the local traffic light system (TLS). The approach is designed to be modular and can be expanded to include additional use cases, particularly those relevant to safety (e.g. long-term tracking of dangerous spots, providing data for traffic data platforms and traffic models, supporting automated and connected vehicles to determine operational designs (OD) or to accomplish operational design domains (ODD)).

This abstract focuses on the optimization of DLR’s signal control modules for considering pedestrians automatically and adaptively at traffic lights (compared to the initial LTSA prototype). TLS are essentially safety and efficiency systems for intersections. They separate the traffic flows from each other to ensure safe crossing. Thus, a rule-compliant behavior already offers a very high safety level. However, especially pedestrians do not always observe the "safe" signals, which can lead to a significant number of pedestrian accidents [3]. In this context, it is assumed that the inefficiency of traffic lights for pedestrians particularly triggers the incorrect behavior, as the signal controls are usually geared towards motor vehicle traffic. A pedestrian-sensitive signal control that adaptively integrates vehicles and pedestrians should improve efficiency for all road users. The aim is to achieve a more rule-compliant and less aggressive traffic behaviour, which indirectly increases safety. For this, DLR's modules determine relevant pedestrian parameters in real time from the recorded object data:

- whether and by how many pedestrians a signal group is requested
- the actual pedestrian waiting times
- whether a pedestrian crossing is currently being crossed and by how many pedestrians
- how long pedestrians are likely to need to reach or cross the pedestrian crossing

This opens up new functional possibilities in signal control with regard to pedestrians:

- automated and demand-based request (no manual actuation of request buttons needed)
- consideration of actually measured pedestrian waiting times instead of assumed values
- dynamic control of the green time depending on the actual approach or crossing time

In combination with a differentiated phase design, in order to be able to react more flexibly to the respective situation, various control strategies can be implemented. The DLR is striving for a multimodal optimum, where the traffic light controls the overall traffic flow in an aligned and safe manner. Therefore, different approaches were identified with regard to the new possibilities for pedestrian-sensitive signal control. For example:

- Switching to a phase without pedestrian signals, if all pedestrians have crossed or no pedestrian wants to cross the intersection.
- Pedestrians are given green directly after an automatically detected request or at the latest when they actually reach a maximum waiting time value.
- The tracked waiting time is used to decide the order of phases.
- Green times are extended as required for "latecomers", a large number of and especially slower pedestrians.
- Switching to special pedestrian phases, especially if no other road users require green, e.g. pedestrian-all/diagonal-green.
- Conditionally compatible flows are divided into different phases, each is only switched when required (direct safety aspect).

Methodologically, a conceptual phase was carried out. On the basis of the initial LTSA prototype, objectives and expectations were refined and the system design was revised. The modules for data processing have already been developed and coupled with a SUMO simulation. Several control strategies are currently tested in this simulation. Afterwards the components will integrated into the LTSA system at the test intersection and tested in real traffic. Regarding the mentioned assumption "safety by efficiency", the analyses focus on efficiency parameters of traffic light control, e.g. waiting times and the number of stops. Depending on the availability, further traffic behavior and safety related data should also be evaluated (e.g. number of jaywalkers).

It is expected that particularly skipping the pedestrian signals when no pedestrians (or no longer) request them, although this sounds contradictory to the actual aim of promoting pedestrian traffic, has a positive effect on overall and also on pedestrian traffic. This generally allows other road users to cross more quickly and/or shortens the phase transitions. The remaining time can be used for other road users and pedestrians that annouce a need at this time or subsequently. At the conference, the optimized traffic light functions, the testbed implementation and initial test results will be presented in more detail.

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