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Traffic Light Assistant App for cooperative multimodal signal control

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This work addresses the following topic(s) from the Call for Contributions:
(Please check at least one box)

☐ Placemaking to integrate urban spaces and mobility
☒ Promoting sustainable mobility choices in metropolitan regions
☐ Governing responsible mobility innovations
☐ Shaping the transition towards mobility justice
☐ System analysis, design, and evaluation
☐ other: _____

Extended Abstract

Problem statement

To create livable cities, one of the key challenges of our time is to transform our urban transportation system. In the future, traffic areas, infrastructure and mobility services must be designed to be people-centered and environmentally friendly. At the same time, we want to increase mobility for everyone. To achieve this, it is necessary to promote sustainable transport modes (public transport, walking, cycling etc.) to realize a significant change in the modal split and to manage the overall traffic as efficiently as possible. Adaptive traffic control systems can contribute to both. So far, however, the focus of those systems has generally been on motorized private transport. Therefore, it is crucial that in the future all road users will be considered actively in traffic control. That way the traffic can be managed with regard to a multimodal system optimum or a specific prioritization strategy for one or more road user groups depending on local objectives.

Research objectives

Particularly in urban areas, the adaptive control of traffic lights at intersections is the main measure for optimizing traffic flow. Therefore, the research question is how a multimodal signal control system can be created, which can respond to all road users as needed and thus enable various control strategies. To achieve this, the idea is to use today's technological possibilities of mobile devices and (road) user-to-infrastructure (U2X) communication. Therefore, the DLR has created an innovative Traffic Light Assistant App (TLA-App) with new features that will be presented in this paper.

The TLA-App can be applied to any mobile device (e.g., smartphone or on-board computers), so that a widespread usage among all kind of road users is possible. The basic function of the app is to continuously locate the user and transfer its individual traffic data to the traffic light control. The traffic flow can already be

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improved by this information, as shown by DLR's VITAL approaches (Oertel et al., 2016; Oertel et al., 2017). However, compared to other systems, for example via OBUs or other traffic apps (Yunex Traffic, 2023), it is crucial that our TLA-App brings additional intelligence and especially individuality into the traffic light system: The users can directly enter and modify their specific traffic parameters. Furthermore, the app can receive data from the infrastructure and run modules to generate, analyze, process and store the available data. Moreover, it can output information to the user.

To be more specific (see **Figure 1**), individual road user data (esp. transport mode, speed and acceleration range), which vary widely, for example, among cyclists, are stored in a user profile and are thus available for further utilization. Furthermore, it uses a routing function to determine the user's direction at the intersection. By combining all individual live and profile data, the app identifies the next traffic light, the relevant signal group and the distance to the related stop line, as well as predicts individual arrival times (e.g. earliest, latest and probable). All this information can be sent to the traffic light as a modular input for signal control.

By outputting information, the app can influence the traffic flow on an additional level. Provided that a traffic light supplies signal state information, the app gives recommendations for an optimized intersection crossing (GLOSA[1] function).

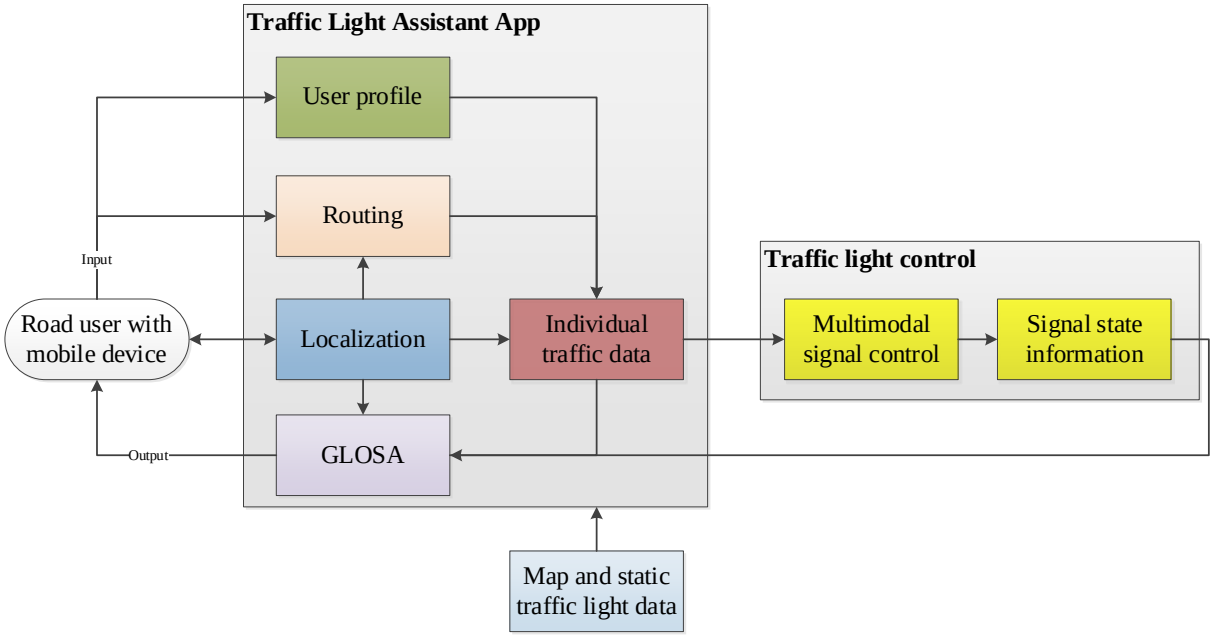

Figure 1: The underlying architecture of the multimodal signal control system

All functions of the app consider the individual characteristics of the user. Therefore, the traffic signal control benefits from additional, multimodal and more individualized information and can thus optimally control the traffic across all road users.

Methodological approach

The first step in the development process was to analyze existing and novel control approaches and their optimization potentials. The driving forces were vulnerable road users (VRU), in particular cyclists, who have hardly been considered in signal controls so far. To assess the impact of the app idea, a first approach for cyclists was tested in different SUMO[2] simulations. The results predominantly showed positive effects for cyclists. At the same time, the quality of the remaining traffic flow deteriorated only minimally or even improved slightly (Halbach and Eggers, 2021). Due to the promising simulation results, the initial idea was extended to an overall concept for the new cooperative multimodal signal control system. Subsequently, a first prototype of the app was set up and tested at a research intersection in Braunschweig.

[1] Green Light Optimal Speed Advisory
[2] Simulation of Urban MObility

(Expected) results and perspectives of implementation

Figure 2 shows screenshots from the current version of the app. So far, the user can choose between the transport modes “car” and “bicycle”. The communication between the app and the signal control takes place via an MQTT broker. The app sends the individual traffic flow data to the controller as a customized CAM (Cooperative Awareness Message). The standard CAM already covers several of the required information. The additional data are integrated via a special vehicle container. The GLOSA function of the app utilizes standardized SPATs (Signal Phase and Timing Message) supplied by any signal control. The displayed arrow indicates whether the relevant signal group is reached at green or red at the current speed. The speedometer below recommends an appropriate speed adjustment if needed. If the user has to stop at the traffic light, the waiting time until the next green phase is displayed. The visualizations on the display are supported by acoustic outputs.

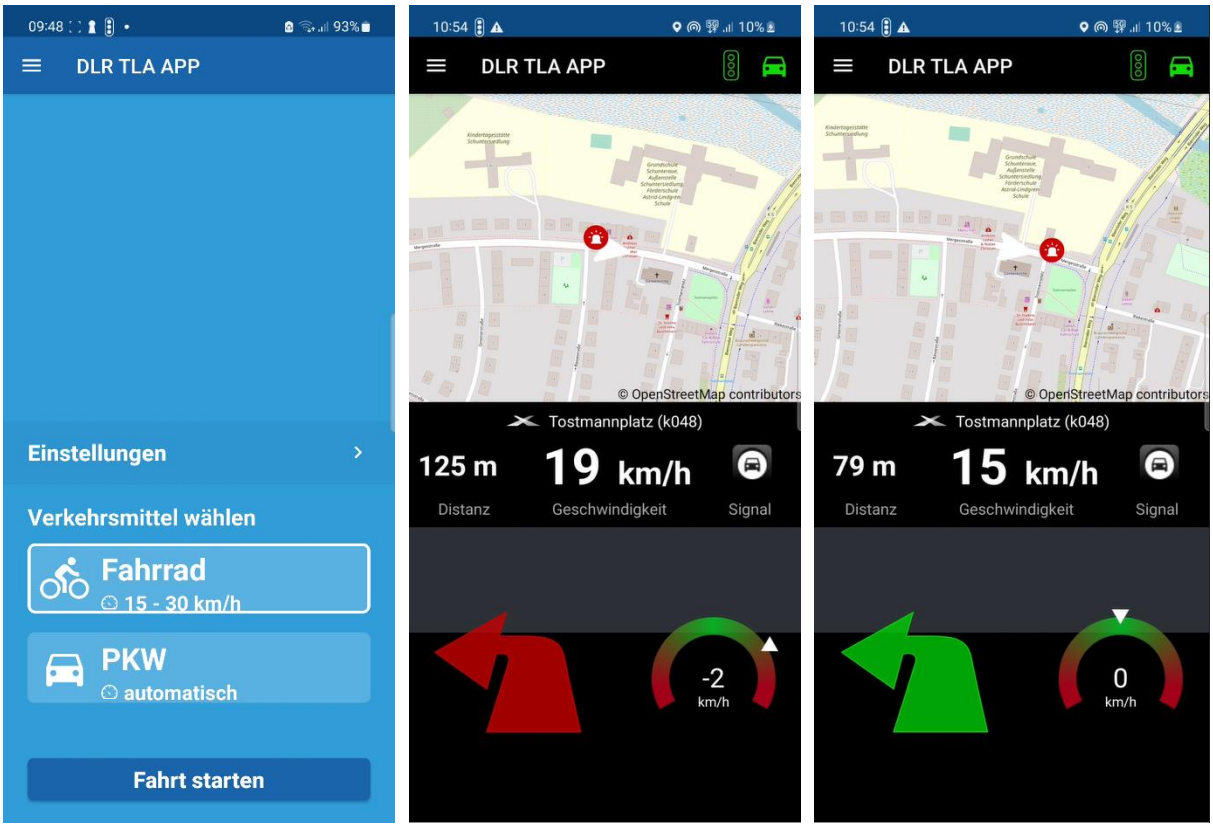

Figure 2: Screenshots of the current Traffic Light Assistant App

A number of further steps have already been planned. The next step is to integrate the app with DLR's VITAL approaches and to conduct scientific studies in real traffic. In addition, enhancements to the app itself are planned, such as the further development of the routing function, the selection of additional transport modes, or the extension of the user profile by further datasets and an automated update function. The Traffic Light Assistant App should also be extended in perspective to a general Traffic Assistant App, which will then also integrate functions of path and network control.

References

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