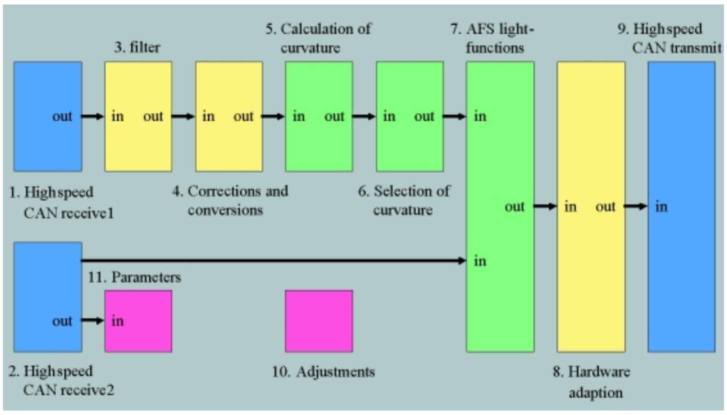
Advanced Frontlighting System at Volkswagen

CUSTOMERS

- **Direct download of Simulink models to MicroAutoBox**
- **Bypassing with built-in ECU interface**
- **ControlDesk for experiment control**

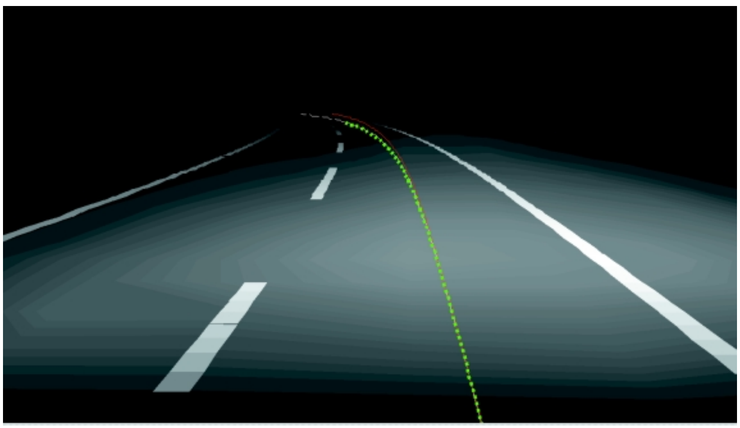
About 90 percent of the information that a driver needs for safe driving is provided visually. Therefore it is obvious that perfect visibility is a crucial factor in reducing the risk of an accident. A major stepping stone towards significant improvements is the Advanced Frontlighting System (AFS): an adaptive headlamp system, which is currently under investigation by automotive OEMs and suppliers. Volkswagen has already implemented this system into prototype vehicles. This state-of-the-art technology was developed and tested using dSPACE Prototyper. VW uses MicroAutoBox for laboratory research as well as for in-vehicle experiments: a unique feature of MicroAutoBox.



Simulink structure containing several subsystems.

Intelligence to Headlamps

Adaptive headlamp control is a key factor for enhancing visibility at night. We are therefore developing the Advanced Frontlighting System (AFS), which contains adaptive control strategies. Sensors continuously capture the parameters of the vehicle's environment such as road geometry, road type and weather conditions [1], [2], [3], [6]. This data, mainly derived from vehicle dynamics sensors [2], [3], is available on the CAN bus. However, there is more involved than simply relating the position of the headlamp to the steering angle. For example, driving through bends requires complex control strategies to achieve the best illumination results [4]. And intelligent headlamps should emit their light distribution in a different way when driving through cities or driving on highways. Accordingly, during city driving the headlamps should illuminate a wide front area, while outside the city long-range illumination is desired. Therefore, the headlamp light distribution is constantly altered according to the implemented control algorithms (predictive, iterative, model based, etc.), which means the driver receives visual information earlier and more focused.

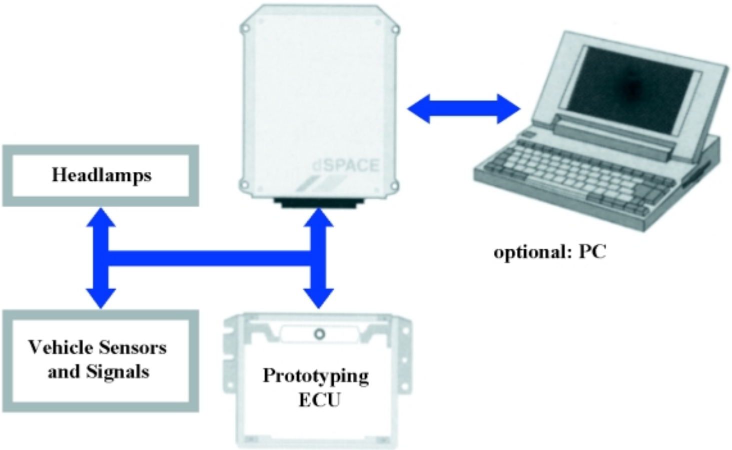


Light distribution and road geometry [3], [5].

Complex Design, Easy Implementation

The development process of the control algorithms begins in the MATLAB/Simulink environment. The MATLAB/Simulink design tool is widely used by Volkswagen and its associated subsidiaries and suppliers. This allows us the shared use of existing Simulink blocks and significantly speeds up the system engineering process. At this stage, the control design is entirely PC-based. Lane geometry as well as light distribution are visualized and analyzed during simulation runs with GEOSim [3] and AFSim [5] (Simulink-based tools developed by Volkswagen). The featured Simulink model is hierarchically organized, with each main block representing up to 31 subsystems. To achieve valid results, the offline simulation has to be as realistic as possible. We therefore use the same CAN data for the stimuli of the offline experiment as occurs on a real CAN bus.

To see how the algorithms work in real life, powerful real-time hardware is essential. As a result, the Simulink model is downloaded to MicroAutoBox to conduct further development steps. The code running on MicroAutoBox is generated automatically and is a 1:1 representation of the controller model. At this stage, we are still validating the



Overview of MicroAutoBox system integration.

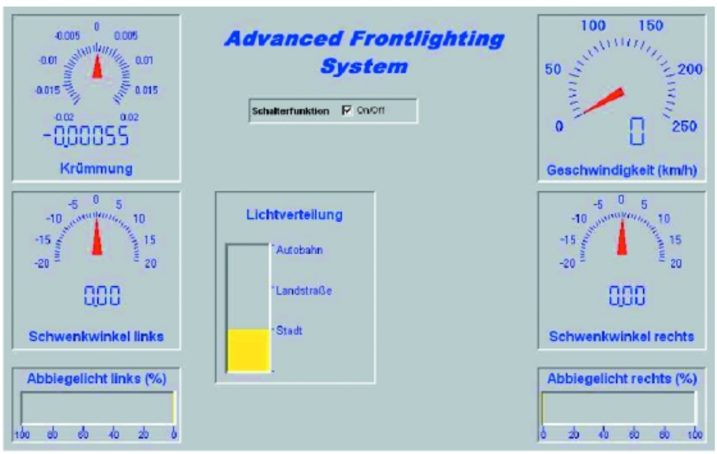
control design within the laboratory. MicroAutoBox is fed with plausible sensor signals, and with ControlDesk running on the connected PC, we control, monitor and record the experiment parameters.

Integrating MicroAutoBox into a prototype vehicle requires some additional effort: the CAN connection and the link to the headlamp hardware have to be set up. The dedicated RTI CAN Blockset to access the CAN bus within MATLAB/Simulink was an enormous help here. The AFS put into the prototype vehicle is based on a supplier system, which comes with a prototype electronic control unit (ECU) and prototype headlamp hardware. Since these elements contain only very basic features, our appreciation of MicroAutoBox's built-in bypass interface via CAN bus is understandable. The control algorithms run on MicroAutoBox and are seamlessly integrated into the hardware setup. At this point in the development stage, we focus on fine tuning the parameters and validating the entire functionality. Modifications can be implemented on-the-spot, even during obligatory test drives at night. Since MicroAutoBox boots up automatically, expert know-how is not necessary to get the system up and running. Additional time-consuming and error-prone coding on the supplier prototype ECU is therefore avoided.

Time is Money

MicroAutoBox represents a real-time hardware concept which ideally suits our development environment. Since we consider it absolutely essential to have a seamless design chain, our decision to use MATLAB/Simulink along with dSPACE solutions was a matter of course. The most important benefit is a substantial reduction in design time: Engineers can evaluate their ideas at any stage of the development process.

Gabriel Schwab
Volkswagen AG
Germany



Key parameters featured by ControlDesk.

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