The ROADSAFE Toolkit: Rapid Prototyping for Road-Testing Novel Automotive User Interfaces

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ABSTRACT

The design and evaluation of efficient feature-rich, yet non-distracting automotive user interfaces for driver assistance is an increasingly challenging task. To reduce efforts as well as to complement and validate lab studies under real-world conditions, we developed the latest version of our ROADSAFE toolkit, a highly flexible framework for prototyping and evaluating novel automotive user interfaces on the road. The toolkit is especially targeted at HCI researchers with a focus on easy creation and adaption of interfaces considering short design iterations and off-the-shelf hardware. Further, the ROADSAFE toolkit offers a series of features which enable the investigation of user aspects of current and future in-car applications including real-time multimedia supplements on different quality levels, interactive scenarios requiring user input and deployment on arbitrary end devices.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces—*Prototyping, Evaluation/methodology*

General Terms

Design, Human Factors

Keywords

User interface, widgets, multimedia, interactive, road test

1. INTRODUCTION

Due to the rapidly growing complexity of both a car's functionality and accessible contextual information, the design of efficient in-car Human Machine Interfaces (HMIs) is one of the key challenges in Automotive Software Engineering [1]. Thereby, advanced driver assistance is an especially important trend [5]. With technological advances such as Vehicle-to-Infrastructure (V2I) environments collecting and exchanging relevant traffic data in real-time, vast amounts of new information is and will be available. However, corresponding warnings and instructions need to be communicated to the driver in a safe manner, informing about relevant details in an efficient, non-distracting way. We argue that HCI researchers need a rapid prototyping toolkit in order to test novel interfaces under real-world conditions on the road to complement respective in-car HMI lab studies. A suitable toolkit must be highly flexible and extensible, allow for short design iterations without writing code and offer built-in support for validating future in-car use cases involving multimedia applications and interactive elements.

One related approach focussing on a flexible UI model for in-car HMIs is proposed by de Melo et al. [2]. The authors suggest the creation of suitable automotive UIs from abstract representations for integrating external applications. Another approach is *FLUID* (Flexible User Interface Development) [6] developed by *BMW Car IT* offering a layered architecture and modular UI components. However, *FLUID* is executed on the vehicle's embedded processor and therefore its application is limited to automobile manufacturers. Also targeted at the automotive industry is *Windows Embedded Automotive* with its *Automotive UI toolkit* [3] featuring sophisticated design tools but offering no special support for the conduct of road-tests and the evaluation of future in-car use cases.

The ROADSAFE toolkit presented in this paper is detached from the car's electronics and runs on a modern laptop computer operated by a test manager on the back seat. Extending an earlier version [4], our present toolkit not only allows for rapid UI design adaptations but has been substantially updated, e.g., it now allows for the easy device-independent creation of multimedia and interactive test scenarios.

2. THE ROADSAFE TOOLKIT

The presented toolkit is implemented in *Python* enabling the easy extension in future utilizing concepts of a modern dynamic programming language. The latest version of the ROADSAFE toolkit offers the following features:

Reusable widgets. In our prototyping toolkit, user interface elements are encapsulated as *widgets* which define the element's appearance and behavior. Each widget is a separate Python class derived from a widget super class. In addition to general attributes, such as position and size, each widget has access to one central *data repository* object, where current values of relevant contextual variables can be retrieved. For example, a traditional bird's eye map widget (shown in Figure 1) makes use of the current location of the car and a info widget accesses the list of currently relevant safety messages.

Flexible UI configuration. The overall layout of the UI is defined by *skins* which place widgets at certain screen locations

Figure 1: Real-time safety message with a live preview image.

Figure 2: Interactive "Park and Ride" scenario with an AR view.

Figure 3: Traffic camera view with a smartphone as end device.

and set some of their visual and behavioral properties. For each test person, we prepare a *scenario* which defines different sections of the respective test drive and specifies which skin to use for each section. The skins may be changed at defined trigger locations or manually by the test manager during the test drive, e.g., to switch between a traditional bird's eye view and an Augmented Reality (AR) view (depicted in Figure 2). Both skins and scenarios are defined in easily interchangeable XML files. Hence, the toolkit allows for the quick and easy adaption of visual apperance and behavior.

Multimedia integration. In addition to a high-quality text-to-speech engine for auditive feedback, our toolkit allows for the integration of custom multimedia content. This allows us to investigate end user requirements for future V2I multimedia services which may include live videos from traffic cameras. Again easily definable in XML, we are able to prepare distinct configurations for test drivers and confront them with different quality settings from still images up to high-quality videos for exploring the required quality levels from a user perspective (see Figures 1 and 3).

Interactive scenarios. Besides driver assistance in form of traditional turn-by-turn navigation and real-time safety messages, new interactive in-car use cases are emerging. One example is the consideration of alternative transport possibilities and the recommendation of multimodal routes in real-time (Figure 2). The ROADSAFE toolkit supports the investigation of such scenarios: again, without programming know-how, interactive elements such as buttons can be integrated and defined in skins using XML. Triggered actions include the change to another skin (e.g., to switch between different views) and playing of sounds and speech messages (e.g., to provide an auditive route description).

Arbitrary end devices. Competing with dedicated navigation devices, feature-packed smartphones and even tablets are increasingly used for driver assistance. Since optimal communication strategies for driver information may vary for different target devices (primarly due to different display sizes), a prototyping toolkit must support arbitrary end devices. In addition to the obvious solution of attaching an external display for the driver via a video connector, the ROADSAFE toolkit integrates a custom video streaming module. Thus, we are able to provide a smartphone or tablet PC with visualizations by the same rendering engine, conveying the impression of a fully functional smartphone application for the test driver (Figure 3). Of course, interactive scenarios are also supported in this setup: touches on the end device are forwarded to the laptop computer where respective mouse actions are triggered.

Demo mode. The creation and validation of road-test scenarios can be expensive in terms of both time and money. To reduce efforts, our toolkit offers a demo mode for reviewing the defined route and occuring events: GPS traces (e.g., recorded by a GPS mouse or created by a route planner) can be easily integrated in our toolkit to simulate test drives apriori in the lab and prepare testing scenarios, e.g., to finetune trigger locations of messages for the road test.

The ROADSAFE toolkit and its concepts proved to be highly useful for several user studies investigating in-car HMI research questions under real-world conditions.

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4. REFERENCES

[1] M. Broy. Challenges in automotive software engineering. In *Proc. ICSE*, pages 33–42, 2006.

[2] G. de Melo, F. Honold, M. Weber, M. Poguntke, and A. Berton. Towards a flexible UI model for automotive human-machine interaction. In *Proc. AutomotiveUI*, pages 47–50, 2009.

[3] Microsoft. Windows Embedded Automotive. http://bit.ly/g2c9p8, 2010.

[4] D. Schabus, M. Baldauf, and P. Fröhlich. Prototyping for road-based user testing of safety-related traffic telematics services. In *Adj. Proc. AutomotiveUI*, 2010.

[5] A. Schmidt, W. Spiessl, and D. Kern. Driving automotive user interface research. *IEEE Pervasive Computing*, 9(1):85–88, 2010.

[6] R. Stolle, C. Salzmann, and T. Schumm. Mastering complexity through modeling and early prototyping. In *Proc. Euroforum Conference on 'Software im Automobil'*, 2006.