Information visualization for in-car communication processes

Michael Sedlmair, BMW Group Research and Technology, Germany, Michael.Sedlmair@bmw.de
Supervisor: Andreas Butz, University of Munich, Germany, Andreas.Butz@ifi.lmu.de

Abstract

Modern cars provide a large spectrum of electronic functionality which is realized by a great number of interconnected and communicating electronic control units. The constantly increasing complexity of these in-car communication networks challenges developers in terms of understandability. The goal of my PhD research is to find novel and suitable methods of information visualization to support gaining insight into this specific and complex domain. With a set of prototypes we want to show the feasibility of our approach and to generally understand the practice of information visualization in the field of in-car communication processes.

1. Problem Statement

During the last few years the functionality in automobiles has increased enormously. A huge amount of enhanced functions like ABS, central locking systems or electrically operated window regulators were integrated with the car. They enabled step-by-step safer and more enjoyable driving. Thereby the functions became more and more distributed and so several communication networks had to be integrated with the car. The entire in-car communication network currently consists of several bus systems and interconnects a great number of electronic control units. However, this architecture means increasing complexity to developers of automobiles. Nowadays the description of the communication processes is based on textual information. The trouble is that a lot of time and experience is needed to understand processes, correlations or problems regarding the in-car communication and to derive adequate activities.

2. Approach and Preliminary Results

Our approach to cope this problem is to *visualize it*. Based on the body of research in information visualization (IV), we see several challenges, which we want to address, explore and understand, including:

- Find novel, domain specific visualization methods
- Investigate suitable interaction techniques to manage complexity
- Understand specific requirements of applying IV to an industrial/ automotive environment
- Examine potentials for improvements in the automotive development process

As a start we conducted interviews and workshops with domain specific developers to understand their needs and to address occurring problems. In doing so we discovered three main application areas for the visualization of in-car communication processes: *diagnostics*, *simulation* and *configuration and change management*.

Based on these results and on the findings of my literature review we started generating ideas and designing novel and highly interactive visualization systems. By the application of qualitative and quantitative user studies we investigate their practical usefulness and usability. In the first step we designed and implemented a dual-view visualization for diagnostics [2]. Our tool provides an opportunity to import erroneous data traces and to interactively explore correlations and dependencies of the in-car network. An expert evaluation revealed very positive feedback about our design and emphasized the potential of the approach for saving time in diagnostic processes.

3. Future Steps

In the next step we start to investigate time dependent visualization forms (for simulation) and interactive graph visualizations (for configuration and change management). Regarding the time dependent forms our goal is to find ways how to balance the appearing data flood and the perceivable amount of information by the human cognitive system. Graphs are interesting for exploring dependencies and to monitor changes in the in-car network. Especially the visual comparison of two divergent graphs can be used to analyze target/actual situations. In both areas we search for domain specific and highly interactive solutions. We believe that enhancing the visualization with rich interactivity will help us to manage the enormous complexity of the underlying facts.

The use of coordinated and multiple view (CMV) systems [1] for mastering the complexity is very promising. In this context we want to investigate the potential to combine IV methods with virtual 3D-modells of the car. To support the co-located and collaborative working habits of developers we also will have a close look at CMV systems on multi-touch tabletop displays. In doing so, we hope to directly assist the developers working process and to integrate visualization in the entire workflow.

Based on these research aspects we will try to derive generalizable principles and guidelines for applying IV to the underlying problem field and to complex engineering problems in general.

References

[1] Jonathan C. Roberts. State of the Art: Coordinated & Multiple Views in Exploratory Visualization. In *Proc. CMV'07.* IEEE Computer Society, Washington, 61-71. 2007

[2] Michael Sedlmair, Wolfgang Hintermaier, Konrad Stocker, Thorsten Büring, Andreas Butz. A Dual-View Visualization of In-Car Communication Processes. To appear in *IV '08: Proceedings of the 12th International Conference on Information Visualization,* London, 2008.