MSCar: Enhancing Message Sequence Charts with Interactivity for Analyzing (Automotive) Communication Sequences

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Motivation.
Complexity of In-Car Communication Networks.

• Automobiles contain lots of electronic
• Distributed Functions
  → ACC, Auto-Start-Stop
• In-Car Networks
  → up to 80 ECUs, 4000 FBs)
• Enormously increased complexity

• Automotive engineers:
  → Need for more insight
• Our Approach:
  → Support the engineer with proper visualizations
• Our Contribution:
  → Take a well-known visualization form, extend it, make it interactive and fine-tune it to the underlying problem
Motivation.
Current Practice.

• Most engineers work with textual information…
  – Traces in list form (special tools)
  – Textual descriptions in databases
  – Printed and pdf catalogs (of functions, messages, etc.)
  – With Hexadecimals!

• …and with (mostly static) visualizations

• A lot of time and experience is needed to get insight!
In-Car Communication.
Schematic Overview.
In-Car Communication. Design Goal - Dependency Chains.

Importance of dependency chains:
- Sources of errors not always clear
- Consequences of errors
MSCar.
Basic Idea and Requirements.

• Idea: An interactive Message Sequence Chart to visualize the dependency chains

• Why MSC?
  – Preliminary Interviews and User Studies
  – Common in engineering
  – Time-dependent visualization

• Requirements
  – Representation of all (automotive specific) forms of communication
  – Support preattentive processing
  – Usability

• Goal: Support exploring dependency chains
MSCar.
Schematic View.

(a) Inner-ECU communication
(b) Across-ECU communication
(c) Multiple receivers
(d) Parallel communication
MSCar.
The Visualization.

- Color coding supports preattentive processing
- Causal Ordering of the elements
- High Interactivity to support exploration tasks
- Implementation: Java Piccolo
MSCar.
Interaction.

- Semantic Zoom

- Dynamic Path Highlighting

- Details on Demand

- More:
  - Scrolling (with adjusted labeling), Changing the Trigger-FB, Free Scalability, History, …
MSCar.

Live Demo.

Outline
Motivation.
In-Car Com.
MSCar.
Evaluation.
Future Work.
Evaluation.
Design of the User Study.

- Qualitative user study

- MSCar included in a Dual View System – Part of the study exclusively for MSCar

- Goal: Get feedback about design, usefulness and usability

- Six Participants
  - Three domain experts (rare)
  - Three graduated students with a strong usability background

- Design of the study
  - Think-aloud protocols
  - Audio recording
  - 1. Phase: Tasks
  - 2. Phase: Interview and feedback
Evaluation.
Results from User Study.

- Very positive feedback from domain experts
- Task solving without problems

“The task I now solved in a few minutes, would have taken at least 15-20 minutes with the traditional methods”

“The opening and closing of the ECUs is enormously helpful and understandable”

- Good usability, small usability problem: Details on Demand hovers sometimes overloaded
Future Work.

New Concepts.

• Readjusting hover size and details position

• Multiple Hovers

• Direct Manipulation to readjust the ECU column position

• Toggle between causal and time realistic presentation

• Further Investigation of Usage in MCV Systems
Future Work.

Further Evaluation.

- Up to now: Qualitative user feedback
- Reviewing new features
- Comparison to other visualization forms
  - E. g., graph visualization
- More inside in HCI and perceptual aspects
  - E. g., Heuristic Evaluation, Cognitive Walkthrough, …
  - E. g., Evidence of preattentive processing, …
- Get a clear understanding of the benefits
  - Long term studies
  - Wider audience
  - Potentials for time saving
Thanks.
Questions and Discussion.

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PS: Evaluation.
Detection of an error.