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Cardiogram: Visual Analytics for Automotive Engineers

SedImair, Isenberg, Baur, Mauerer, Pigorsch, Butz

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Today's Design Study

Application Area: Automotive Engineering

Study Environment: With BMW Group





Problem and Requirement Analysis

8.6R

Design of Cardiogram

Evaluation of Cardiogram

Problem & Requirements

General Motivation: More and more electronics...



7

... Enabled by In-car Communication Networks



General Problem: It got complex...



General Challenge: Understand Network Data





Target Users: In-car Network Analysts

Task: Find errors in in-car communication networks

Procedure: Test drives and data analysis

⊠ 75836... F... 55

Rx 16 5a 77 f8 27 00 20 00 20 20 0f 00 0...

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Data: Recorded Traces (List of network messages)

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Current Practices



(Some) Problems

Distributed errors?

Car Behaviour vs. Trace?

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Deriving Requirements

Handling the masses of data

- Data abstraction and automated filtering
- Support for automated error detection
- Avoid repetitive work and unnecessary iterations

New Perspectives on Complex Errors

- Beyond raw data and signal plots
- Visual Overview Techniques
- Multiple, modular and coordinated solutions

Engineer-centered solutions

- Fast access to raw data
- Familiarity
- Support collaboration

Requirements: Today's Focus

Handling the masses of data

- Data abstraction and automated filtering
- Support for automated error detection

New Perspectives on Complex Errors

- Beyond raw data and signal plots
- Visual Overview Techniques
- Multiple, modular and coordinated solutions
- Engineer-centered solutions
 - Fast access to raw data
 - Familiarity
 - Support collaboration

Our Solution: Cardiogram

Our idea: Using State Machines

Handling the masses of data

- Data abstraction and automated filtering
- Support for automated error detection
- New Perspectives on Complex Errors
 - Bevond raw data and signal plots





Abstraction: SMs to Interpret Vehicle Behavior (simplified)



Aut. Error Detection: SMs to Interpret Errors (simplified)





Data Reduction

1 Verification Tag per SM

10M messages --> 10K transitions



Visualization

... only when necessary

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Evaluation

Field Studies during and after deployment



(Some) Results: State Machine Approach

Externalization of Expert Knowledge

SMW Power

Additional Benefit: Supports Collaboration

Database

BHN Westerry

(Some) Results: State Machine Approach

Complete Coverage vs. Sparse Samples

Thousands vs. Tens of Traces / Day



(Some) Results: Visualization

Understand Behavioral Cross-Correlations

Example: Overpressure Sensor Problem



(Some) Results: Visualization

Understand Behavioral Cross-Correlations

Example: Overpressure Sensor Problem





Summary

Cardiogram / Contributions

Based on in-depth domain analysis

A: State Machine Approach

B: Visualization Component

Cardiogram adopted by engineers

Michael SedImair msedl@cs.ubc.ca

10-05-2011

Cardiogram: Visual Analytics for Automotive Engineers

SedImair, Isenberg, Baur, Mauerer, Pigorsch, Butz



Slides: www.cs.ubc.ca/~msedl/talks/sedlmair2011chi.pdf



Back Up



Cardiogram: 4 Steps





