REACTIVE TEST OF EMBEDDED SYSTEMS USING MODELS

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Partly funded by the German Ministry of Economic Affairs and Energy (BMWi)
CONTENT

• Introduction
• Test environment architecture
• Industrial case study
• Conclusion
Closed-loop vs. open-loop tests

- Open-loop: no reaction to test object’s behaviour during the test run

- Closed-loop: reactive testing

- Closed-loop model-based testing
Two kinds of test specification in MBT

- Open-loop test: specifying a test model, generating test cases (test sequences) from it and executing them

- Closed-loop test: specifying a test model and running it parallel to the test object (co-simulation)
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Using a framework for automating test execution

- ContinoProva: Automated test execution and evaluation across various tools deployed in the test environment, e.g. debugger, relay box, CAN tool, ...

- Defining interfaces for coupling new tools; integrating different kinds of test specification
Automation procedure

- Test model specified in Enterprise Architect

- Generating executable code from the test model and integrating it into ContinoProva

- UML Testing Profile used as architecture guidance
Test environment architecture – ContinoProva

- Test evaluation
- Test control
- Test report
- Test client
- Test server
Test environment architecture – external tools
Test environment architecture – MBT integration

- Test model
- Abstraction layer for different modeling tools
Test environment architecture

- Test model: UTP TestCase
- Abstraction layer for different modeling tools
- Test evaluation
- Test control: UTP Arbiter
- Test report
- Test client: UTP TestLog
- Test server
- Abstraction layer communicating with external tools
- External tools
- Test object: UTP SUT
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Test object and test objective

• Test object:
  • A ventricular assist device (VAD) pumping blood from the heart to the aorta, connected to a control unit and battery

• Test objective:
  • Does the software of the control unit detect a kink or a leak in the hose connecting the pump and the pneumatic drive (by sounding an alarm)?
  • Kink and leak diagnosis: Unusual low resp. high friction within the system
Characterization curves of friction and its hysteresis

Frictions’ characterization curves depending on the pressure

Friction’s hysteresis diagram
The test model (UTP TestCase)

• Characterization curves have to be individually explored for each pump, cannula and patient during testing
• Sampling the characterization curve step by step (by increasing the pressure)
• For each pressure value simulating a kink/leak by increasing/decreasing the friction and running the system into alarm states
• Decreasing/increasing the friction and checking whether the alarm is stopped according to the hysteresis diagram
The State Machine
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Results

• The presented test environment architecture and the MBT approach fit well into the use case:
  • closed-loop test
  • high variability of interaction with the environment
  • Heterogeneous tool environment

• The architecture cannot be used in the cases, where the test environment has to fulfill hard real-time requirements, e.g. when testing car engine ECUs
THANKS FOR YOUR ATTENTION!

ANY QUESTION?