Summary

Title : Automation of testing for automotive embedded systems

Author: Antonia Gyurova Lavrova

Scientific supervisor: Sylvia Ilieva, Ph.D.
Advisor: Ilina Manova

Date: 2006, 18th October

Keywords: testing, test types, test methods, classification tree, classification tree method, embedded system, automotive software

In the last 15 years software is used in more and more products, which are traditionally subject of mechanical and electrical engineering. This especially applies to automotive industry, where the biggest part of innovations are based on software and electronics. The automotive industry is faced with finding the optimal balance between time and production costs as well as assurance of the required quality, reliability and safety. The tight deadlines for developing software products limits their testing time too. Embedded automotive systems have to meet safety-critical requirements and that's why they have to be tested in real conditions, for a long period of time and tests must cover as much as possible of clients demands.

This master thesis researches the applicability of a certain black-box testing method – classification tree method (CTM) – in the automotive industry. A classification of test types is made according to three criteria:

- ✓ software readiness
- ✓ functional and technical demands to the system
- ✓ if there is execution of test object.

A survey of the most popular and used classical techniques for test scenarios optimization is made – structure testing, mutation testing, boundary-value testing, random testing, decision table, category-partition method etc. Two modern methods, borrowed from Artificial intelligence, are also presented – evolutionary testing and classification tree method. Special attention is paid to an extension of CTM for embedded systems (CTM/ES), which is developed by the leading automotive company Daimler Chrysler AG. The four stages of defining test scenarios with CTM/ES are described in the thesis and its main advantages are underlined. The advantages are:

- ✓ graphical description of test scenarios, which makes test design easy to apprehend, maintain and reuse;
- ✓ deep analysis of specification, which allows comprehensive verification for omissions, inaccuracies and inconsistencies;
- ✓ ability for calculating minimum and maximum number of test steps, required to fully cover the classification tree. This allows estimation of test execution time at early development stage;

- ✓ CTM enables unified representation of test scenarios which result from other test design techniques used for embedded automotive software;
- ✓ CTM provides means for description of time-variable test scenarios;
- ✓ CTM can be easily combined with evolutionary algorithms for testing temporal behaviour of automotive systems.

The current approach, used in a company from the automotive industry, is the research basis of CTM applicability for testing embedded systems. In this approach the subjective judgement of the tester is leading and the quality of defined scenarios depends on his knowledge and experience in the test object domain (error guessing / intuitively testing), as well as using random testing. In order to compare the two approaches, four evaluation criteria are defined:

- ✓ effectiveness – the ability of defined scenarios to cover the described clients requirements;
- ✓ efficiency – defined test scenarios cover a great number of real situations, which increases the possibility of finding errors;
- ✓ complexity – the effort, required for defining the necessary test scenarios;
- ✓ documentation.

Test scenarios for a module from existing project in the company are implemented with CTM and the results are compared with the results received from using the current approach. The comparison shows that CTM requires much more effort for defining the test scenarios than the current approach, but CTM provides more confidence in the coverage of clients requirements, greater possibility of finding defects and facilitates tests modification.

As a corollary of this comparison, the following recommendations for improvement of the current test process are defined:

- ✓ when tests creation and modifications are planned, time for test scenarios design have to be planned too;
- ✓ a systematic approach have to be used for test case selection, which can be combined with other test techniques;
- ✓ test case design have to be documented and stored in configuration management tool;
- ✓ review of tests scenarios and time for their optimization have to be planned;
- ✓ a tool, which on the basis of test design generates the basic part of the code, needed for tests execution, have to be used. Thereby more time will be spent on the selection of accurate test steps, not on their concrete implementation.