Model Checking-Based Software Testing for Function Block Diagrams

- Tool-supported automatic test generation enables more efficient industrial control software testing

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Eduard Paul Enoiu is a PhD student in the Software Testing Laboratory at the Department of Embedded Systems at Mälardalen University. Eduard is working on the TOTEM project in collaboration with Bombardier Transportation AB where he is responsible for developing an automated test generation platform for train control software. Eduard received his MSc in Computer Science from Mälardalen University in 2011 for the thesis titled “A Design Framework for Service-oriented Systems”. Also, he graduated from Politehnica University of Bucharest in 2009 with a degree in computer engineering. Eduard has developed several testing and verification tools: CompleteTest, ViTAL Tool and RESE IDE.

Research interests include: software modelling; model based testing; model checking; analysis and simulation; formal verification; integrating formal verification into semi-formal techniques; software engineering.

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Abstract
Software testing becomes more complex, more time-consuming, and more expensive. The risk that software errors remain undetected and cause critical failures increases. Consequently, in safety-critical software development, testing control software is standardized and it requires a tester to show that tests fully exercise, or cover, the logic of the software. This method often requires a trained tester to perform manual test generation, is prone to human error, and is expensive or impractical to use frequently in production.

To overcome these issues, software testing needs to be performed earlier in the development process, more frequently, and aided by automated tools.

Eduard Enoiu, a Phd Student at Mälardalen University, has devised an automated test generation tool called CompleteTest that avoids many of those problems. The method implemented in the tool and described in a licentiate thesis, works with Function Block Diagram software, and can provide tests in just a few seconds. In addition, it does not rely on the expertise of a researcher specialized in automated test generation and model checking. Although CompleteTest itself uses a model checker, a complex technique requiring a high level of expertise, to generate tests, it provides a straightforward tabular interface to the intended users. In this way, its users do not need to learn the intricacies of using this approach such as how coverage criteria can be formalized and used by a model checker to automatically generate tests. If the technique can be demonstrated to work in production, it could detect and aid in the detection of software errors in train control software, where conventional testing is not always applicable and efficient.

Eduard conducted studies based on industrial use-case scenarios from Bombardier Transportation AB, showing how the approach can be applied to generate tests in software systems used in the safety-critical domain. To evaluate the approach, it was applied on real-world programs. The results indicate that it is efficient in terms of time required to generate tests and scales well for most of the software.

There are still issues to resolve before the technique can be applied to more complex software, but Eduard and his collaborators are already working on ways to overcome them. In particular, they need to understand how its usage in practice can vary depending on human and software process factors.
List of Publications

Publications Included in the Licentiate Thesis


Other Relevant Publications


Software Testing Laboratory

The software testing laboratory (STL) at Mälardalen University is led by Paul Pettersson and Daniel Sundmark. STL focuses on industry-relevant research in software testing. In our research, we develop, refine, and evaluate methods, theories and tools for testing of complex software-intensive systems.

With an emphasis on method and tool development, as well as industrial and practical real life case studies, our research focus includes (but is not limited to) test design, model-based testing, search-based software testing, decision-support for software testing, and test automation.

The objectives of STL are to improve the current state-of-the-art in software testing, to share our results with the broader research community, to actively seek academic and industrial collaboration, and to transfer results and knowledge for industrial adoption.
ITS-EASY is an industrial research school in Embedded Software and Systems, affiliated with the School of Innovation, Design and Engineering (IDT) at Mälardalen University (MDH) as an integrated part of the MDH strategic research area Embedded Systems (ES).

ITS-EASY is funded by the Knowledge Foundation (KKS), and the eleven participating companies. ITS-EASY started October 1st 2011, and will continue until September 30th 2020. During that period the PhD students will complete their studies and obtain the doctoral degree in Computer Science.

ITS-EASY is a large organization: it counts 22 PhD students, 14 main advisors from IDT, 18 co-advisors from IDT and the partner companies, and more than 25 associated members; senior researchers and industrial specialists. The board, led by Helena Malmqvist, ABB, has six members, and the industrial committee where all participating companies are represented, has 11 members. The management team of the research school consists of four members. All in all, about 85 persons are directly engaged in ITS-EASY.

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