Evaluating Quality of Automotive Architectural and Design Models

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1 Introduction

As the number and complexity of software systems increase in automobiles, it has become crucial to specify, measure, and evaluate automotive software quality. Automotive design models are commonly being developed using model-based design tools like Simulink and Stateflow. Current quality assessment techniques such as the Mathworks Automotive Advisory Board (MAAB) guidelines and Model Advisor from Mathworks focus mainly on configuration settings and guideline conformance rather than model quality. Furthermore, in the evaluation of automotive Architecture Description Languages (ADLs) [Dajsuren et al. 2012], we identified that the automotive ADLs lack the capability of ensuring the architectural quality. Therefore, there is a strong need for the development of methods for assessing quality of automotive architecture and design models.

Figure 1: Automotive architectural and design models.

Figure 1 illustrates an example representation of automotive architectural and design models. Our objective is to develop novel quality specification, measurement, and evaluation methods targeting both automotive architectural and design models. We combine the methods proposed with recent insights in software quality modeling and create an integrated quality assessment framework for architectural and design models of automotive software. Therefore, we developed a framework, which is based on the internal quality attributes for design models i.e., Simulink models and aggregate them to the automotive architectural models.

Current approaches for improving quality of automotive systems mainly focus on the external quality attributes e.g., correctness, efficiency, and maintenance cost. Hence, our quality framework for automotive architecture enables the improvement of automotive software quality in general.

2 Approach and Results

Similar to our earlier study of modularity in automotive control software [Dajsuren et al. 2013], we followed the Goal-Question-Metric (GQM) approach. By conducting a series of interviews with automotive architects and reviewing relevant standards, we have identified several core quality aspects serving as goals in GQM. Then based on the academic and industrial publications, we have identified a series of questions that need to be answered to achieve the aforementioned goals. These questions have been again reviewed by automotive architects. Finally, we have defined metrics required to answer the questions, and identified/implemented tools capable of measuring and presenting these metrics.

We defined an automotive quality model based on the ISO/IEC SQuaRe quality standard as shown in Figure 2. It comprises six quality characteristics, 16 sub-characteristics, and 71 metrics. We developed a quality assessment framework comprising an automotive quality model and three independent tools (parser, measurer, and quality visualization). The integrated framework has been applied to industrial automotive architectural and design models. By applying the framework to three subsequent releases of an architectural model and the corresponding design models, we have observed, for example, that addition of new functionality or bug fixing in design models often come at a price of increased complexity at the design level, and sometimes compromise modularity of the architectural model.

References


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