Requirements Engineering for Control Systems

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In automobiles control systems play an important role. The task of a controller is to continuously compare and adapt the current value(s) of some system to some possibly changing desired value(s) [6]. Control system functionality is nowadays implemented in software on electronic control units (ECUs). Requirements engineering for control systems is challenging since two disciplines meet that have evolved rather independently from each other: software engineering and control systems engineering. Within the ZAMOMO project (http://www.zamomo.de, "Integrating Model-Based Software and Control Systems Engineering") we aim to integrate both development threads and to address the peculiarities in this domain.

In [2, 3, 8], several special requirements have been identified that need to be addressed when developing software for embedded systems (including controllers). Additionally, a survey within the MOOSE project [4] has investigated the de facto situation in real enterprises. Finally resulting from our own project experience, special requirements of small and medium sized enterprises (SMEs) have been identified [10]. In the presentation, the above mentioned issues concerning control system development (see [9] for a more extensive discussion) have been related to the four key requirements principles that have been identified during the previous workshop [5].

Intertwine Requirements and Contexts Embedded systems are per se much more constrained by design parameters of the given hardware, other environmental issues such as installation spaces, or the available platforms for electronic control units etc. In particular, SMEs need to capture and consider requirements as well as a first system design fast and reliably quite early, namely during the offer development phase, in order to provide a reliable and competitive cost calculation.

Evolve Designs and Ecologies Regarding evolution it is worth to mention that there is a high frequency of innovations in the control systems domain, especially on the hardware level. Consequently, domain knowledge and thus requirements must explicitly and adaptably be represented and evolved.

Manage through Architectures The automobile industry has already identified the need for some stable platform. The AUTOSAR initiative (http://www.autosar.de) establishes a generic, vendor independent platform to enable the interaction of control system components with varying or overlapping functionality within one or between several electronic control units.

Recognize Complexity The inter-disciplinarity of control problems, especially when a solution is realized in software, is an important indicator for the complexity in this domain and requires a joined, tailored development methodology. Awareness has been raised that textual approaches towards requirements capture should be substituted by model-based approaches that have clear formal semantics, enable

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automatic analyses and traceability (despite of shortcomings of the currently existing graphical representations, especially in regard to scalability). Furthermore, SMEs in the automotive and control systems domain need more project-oriented approaches (instead of pre-planned product lines) to tackle variability and reuse.

In addition to the relation to the four key principles raised earlier, a characteristic of control system development that could possibly serve as a means to cope with requirements complexity and evolution in general has also been identified: *simulations*. Control system engineers use non-real-time and real-time simulations to reduce expensive hardware tests and simply to test early. Despite early approaches to include simulations in the software development process (see [1]), a similar emphasis is currently missing in the software and especially requirements engineering field. Considering the evolution of stakeholder needs and simulating their effect on the system/software to be developed in advance [7] might be a potential solution to reduce complexity by identifying and afterwards focussing the most relevant aspects/artefacts.

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