Classifying and Modeling Exceptions through Object Process Methodology

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Abstract

Exception handling is a fundamental issue that needs to be addressed by complex systems such as embedded systems, real time systems and medical information systems. Modern systems are becoming ever more complex, increasing the number of exceptional situations they have to cope with. Modeling exceptions appropriately is a crucial step in a system design process, since correcting errors detected after the design phase can be very costly. There is a tremendous potential to save such costs and time through improving the requirements and modeling practice, especially via exceptions managing. This can be achieved by developing and adopting methods that model a wide range of exceptions during the design phase of a system's lifecycle.

There is a shortage of methodologies for supporting system architects and designers to model and handle exception correctly. Exception handling mechanisms that are specific to various application domains and design paradigms are also scarce. The design of exceptions and their handling mechanisms requires understanding the nature of the wide range of potential exceptions as well as the ability to represent them by using explicit modeling constructs in a solid methodology.

Our work focuses on supporting system designers with a methodology for modeling abnormal behaviors and exceptions that can be predicted in advance and developing mechanisms for handling them during the design phase. Our research has investigated the nature and characteristics of exceptions that can be envisioned during system design. The result is an exceptions ontology that comprises an extensive, domain-independent classification of exception types and their characteristics, as well as their phases (i.e. detection, diagnosis and handling). We model the exceptions ontology with Object-Process Methodology (OPM), which we extended for this purpose.

OPM is a graphical modeling methodology that includes the behavioral and structural aspects of a system in a single model and is supported by the OPCAT (Object-Process Case Tool) modeling environment. OPM has proven experimentally to be effective in producing system specifications of high quality, compared to OMT – the main ancestor of the Unified Modeling Language (UML). OPM is suitable for modeling dynamic systems as it can directly express events, Event-Condition-Action rules, guarding conditions (pre-conditions that guard the execution of a process) and timing exceptions.
The OPM exception handling extensions include support of measurable exceptions, and general asynchronous exceptions. The utilization of objects and processes in OPM, along with its built-in complexity-management mechanisms, enabled us to develop simplifying shortcuts for describing complex guarding conditions with their possible uncertainties, using encapsulation and abstraction methods. The expressiveness of OPM with its exception handling extensions has been evaluated with favorable results through several real industrial case studies from the domains of real time systems and medical care flow systems that were enriched with almost all the possible exception types included in the exceptions ontology.