Extracting threads from concurrent objects

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February 16, 2001

Keywords: Object-oriented development methodology, Embedded system, Concurrent object .

The computer system which is embedded in electrical equipments are called 'embedded-system'. The complexity and the scale of embedded systems become lager and lager. However, current development methodologies for embedded systems are not suitable for large systems because they mainly focus on small software.

To solve this problem, object-oriented software development methodologies are going to be adopted in this domain. OO methodologies have been successfully adopted to large software systems and widely used in many domain. Their development cycle consists of three phases: analysis, design and implementation phase. In the analysis phase, we construct the analysis model to describe the logical structure of the system. In the design phase, we decide how to realize the system and construct the design model.

In embedded systems, there are severe constraints of resources and timing constraints to be considered. It is important for development methodologies to facilitate these constraints. These constraints should be considered in the design phase. The analysis model consists of concurrent objects. On the other hand, in the design phase, synchronized processes are realized as a thread and asyncronized processes are realized as concurrent threads respectively. The problem of timing and resource are not occured only in an object but in threads. So timing and resource constraints are discussed on the design model.

Unfortunately, present OO methodologies are not specific for embedded systems. They are not enough to handle constraints of embedded systems. Actually some new OO methodologies that are specialized for embedded systems are proposed. They support the thread-based design model and give the solution of timing and resource constraints

on the model. But the way of extracting threads from the analysis model hasn't been established yet.

Our objective is to establish how to extract threads from analysis model. In this paper, we propose the method how to get thread-based model from object-based model.

In this paper, first, the behavior of the analysis model is defined. The Analysis model consists of a set of objects. The behavior of the object is described with the regular-expression. The communication method between objects is a synchronized-communication. The synchronized-communication means that both the sender and receiver object wait until the end of the communication. The whole behavior of the analysis model is described with the regular-expression and *synchronized composition operators*.

Next, we proposed the thread model. The thread model consists of threads and the concurrency between threads. The behavior of the thread is described with the regular-expression and the behavior of the thread model is described with regular-expression and *concurrent operators*.

Finally, we proposed the method to transform from the analysis model to the thread model by the axiomatic system of the equivalent transformation.

Using our method, the object-based model can be transformed into the thread-based model by formal approach. This work gives the logical base to create the design model from the analysis model.