Formalization of Software Architecture for Embedded Systems

Shoji Naitou

School of Information Science,
Japan Advanced Institute of Science and Technology

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Embedded systems are used in a great variety of electrical equipments. Complexity and scale of embedded systems are steadily growing as electronic devices like microprocessors are evolved. Object-oriented software methodologies are going to be adopted in this domain. The OO methodologies so far developed, however, mainly focus on analysis phase of software development and do not pay much attention on design phases where the embedded software is different from the usual information systems. In the embedded systems, hardware restrictions and time constraints are very severe and we need to take these factors into consideration in the earlier stage of the design phase where logical structures extracted in the analysis phase are transformed into software structure.

After I supposed that specified application domain, I proposed a software architecture for building embedded systems using object-oriented methodologies (Synchronized Execution Sequence Based Software Architecture :SES-Based architecture). This architecture is based on the concept of synchronized sequence of method execution which is derived from object interaction diagrams found in most OO methodologies. This architecture represents software as a collection of sequence of method execution which is not blocked due to waiting hardware and resource availability. This architecture will make analysis of timing requirements easier than other architectures based on the direct behavior of objects. So this architecture facilitates to estimate timing requirements of the constructed systems and was successfully adopted in an industrial setting in prototyping a real product.

The Concept of SES has been successfully adopted in developing a telephone system at NEC corporation. We formalized this method and proposed a software architecture as a framework to handle real-time requirements. Then we proposed an approach, which is called SES-Based approach, though this approach has not been applying to embedded system in the development phase. In this paper, the research purpose is to make

useful effectiveness of SES-Based approach clear by applying SES-Based approach to the telephone system.

First, we introduce SES-Based approach, and we apply SES-Based approach to the telephone system. The way to use this approach is to apply analysis phase based on OOSE, then problem domain object model, analysis object model, interaction diagrams are obtained as results. But this telephone system has developed based on implicit knowledge on this specific domain. This characteristic makes it difficult for us to analyze this system to us. So in this paper we analyze this system mainly based on user's manual for using telephone system and other documents which are produced at prototyping stage.

Next, I consider nature of this specific domain with results of analyzing source code from reference document, which specifies a fraction of computation in the telephone system. Then we defined the notation of interaction diagram, so that make it facilitates to transform the interaction diagrams into the SES-Based design model. I represent behavior of source code with extend interaction diagrams. I extract SESs from that source code. These results are transformed into SES-Based design model.

Finally, from the framework of software architectures aspects, we evaluate SES-Based approach from the results of case study.

We do not obtained SES-Based approach from analysis phase to implementation phase so there are some problems left, though we found that SES-Based approach are adaptable for embedded system which has property of time-critical.