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Practical Use of 1D Engine Model to Improve Powertrain Development Efficiency (Second Report)

- Concurrent Development Using Real-Time Engine Model -

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To achieve a carbon-neutral society, electrification of automobiles is required. Diversification of the powertrain is necessary to satisfy the energy source situation and users requirement of various countries and regions. Hybrid powertrain is one of the solutions. Its development scale is easily enlarged due to the wide range of subsystems related to vehicle performance. To address this issue, it is effective to operate V-process as a development process, and the development efficiency can be improved by executing the process of specification clarification, prototyping, and performance verification to satisfy the target performance. However, there is a risk of siloed development if information and models are not shared among the subsystems as they are developed concurrently. In case of the siloed development, each subsystem is optimized individually.

In order to solve the above problem, this study focused on 1D real-time engine model (RT model) that can be utilized from the specification clarification phase (MILS, SILS) to the performance verification phase (HILS). The purpose of this paper is to develop a modeling method that can easily create a highly accurate RT model.

In this paper, authors examined the RT modeling method and verified the accuracy of the RT model by a comparison between the reduction method and QPM method. Figure 1 summarizes performance of the RT model and method selection. The accuracy of the RT model created by QPM is superior to that of the reduction method under steady-state, transient, and crank-based conditions. In addition, since the QPM method was possible to make the RT model only by changing the solver, authors judged that the QPM method was an effective method that reduces the modeling worktime compared to the reduction method.

By applying the selected RT model made by the QPM method, harmonized concurrent engineering was demonstarated. In the V-process, the powertrain performance is designed based on the vehicle performance requirements. In the early stage of development, MILS is mainly used, and the calculation speed of the MILS study can be improved by applying the RT model. Next, when the stage of development shifted to the hardware/software performance study based on the powertrain performance requirements, authors were able to improve the calculation speed of the study of MILS and SILS performed in the engine and engine control area by modeling and deploying the RT model. Furthermore, by deploying the RT model to the MILS when examining the transmission specifications, it became possible to examine the specifications of the engine and transmission mutually. In the later stage (verification) of development, the RT model was implemented in HILS, and the control verification in ECU-HILS and the performance verification in cooperation with the transmission test dyno were carried out. In summary, authors have demonstrated that the application of the RT model to the development process can improve the calculation speed of MILS and SILS study, expand the scope of HILS verification, and contribute to harmonized and concurrent development.

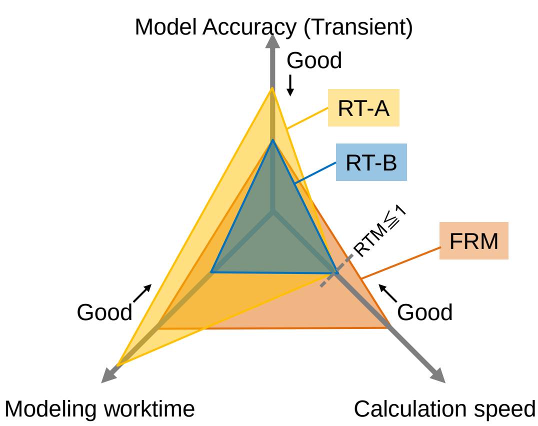

Fig.1 Comparison results of RT models

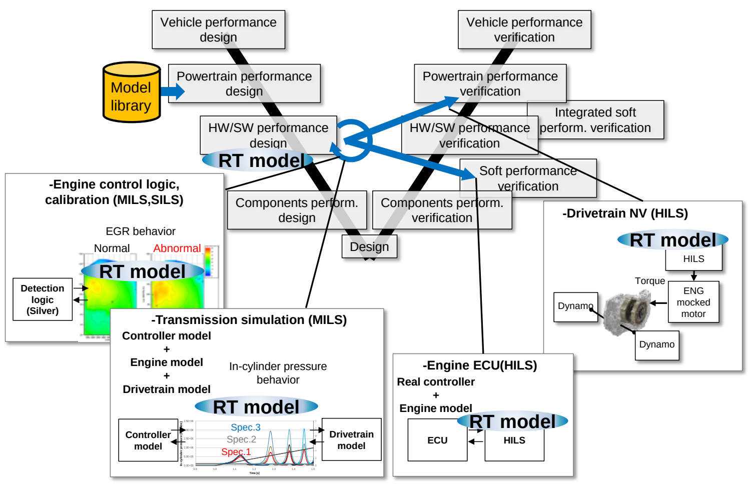

Fig.2 Application areas of RT model in concurrent development

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