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Powertrain On Board Diagnosis development by model application

- Efficient development process -

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For environment protection problems including global warming, fuel economy and emission regulations become more severe year by year. On the other hand, customer's expectations are also changing, therefore new products like CASE and MaaS need to be produced to satisfy them. To cope with a change of the market needs flexibly and rapidly, high development efficiency and speed are required, and we have created an efficient calibration process for On Board Diagnosis (OBD) requirement, applying a model based technology.

The engine OBD has the function that detects part malfunction and notifies it to the driver to prevent undesirable emission. OBD calibration is mainly classified as "Judgement threshold calibration", "Detection conditions configuration" and "Detection Frequency guarantee in the market". In the past, all OBD monitor items have been calibrated with vehicle evaluation in the latter half of development, which are prone to problems in lead-time and quality. To increase calibration efficiency, we constructed a new process by utilizing a powertrain system coupled model. The model consists of 4 parts, transmission model, vehicle model, powertrain control software, and Mean Value Engine Model (MVEM) which is reduced engine physical model. And with this model, the engine behavior can be reproduced with any arbitrary driving pattern, which cannot be reproduced by conventional single engine SiLS model. This model is premised on building at the early stage of the development, and the control and physical state can be updated by replacing software and hardware model. In this paper, we will introduce how to utilize the model for malfunction detection conditions and frequency calibration.

Regarding the detection condition calibration, it is required to ensure each part malfunction detectability. Therefore, evaluation with a part malfunction is necessary, and it can be simulated by the model. An implementation example of Intake VVT malfunction is shown in Fig.1. By inputting and outputting part malfunction information to MVEM, an arbitrary malfunction state will be inserted into the model. A result comparison of the vehicle and the model is shown in Fig.2. Intake VVT advance malfunction will be detected with the deviation from the target. In fact, the model can detect the malfunction at the same time of the detection with a vehicle evaluation. Regarding the monitoring frequency in the market, it is necessary to meet the requirements by the regulation. Therefore, the real road driving evaluation has been modeled. Considering the variation effects of vehicle weight, engine power, driver behavior and so on, these were expressed by controlling the acceleration and deceleration strength to each vehicle characteristics. In fact, the model reproduces the detection frequency as the same level as the vehicle evaluation.

Thus, detection conditions and frequency can be simulated and calibrated with using our powertrain system coupled model. By reducing the vehicle evaluation, the prototype cost and the burden of vehicle re-evaluation can be reduced, which led to the high efficiency of the entire powertrain calibration development. This method has already been adopted in the field of vehicle development.

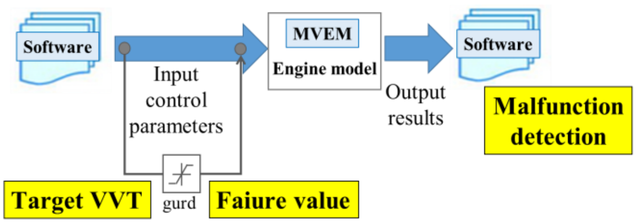

Fig.1 SiLS implementation methods for Intake VVT

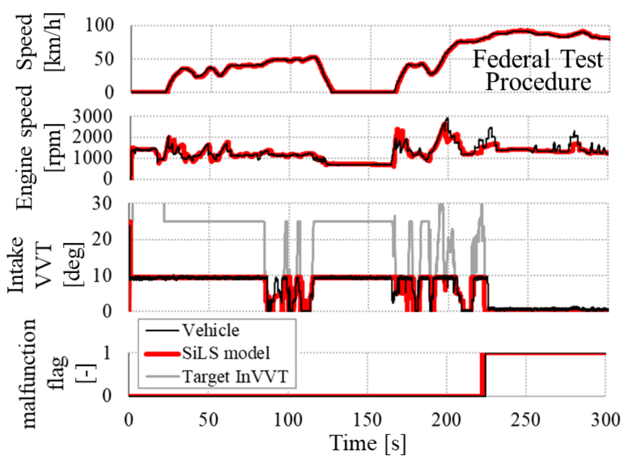

Fig.2 Intake VVT malfunction detection with SiLS