

Recently, attention has been directed to model-based control as a method for designing an engine control system and other vehicle control systems. This method makes it possible to formulate a logic development based on the detailed model of a plant and a robust controller design by taking the non-linearity and characteristic variation of the plant into consideration. However, there is the problem of requiring extensive time to perform the procedure from the modeling to the designing of the control system because of the need for a strict analysis of the phenomena to obtain a practicable model.

In our study, we have developed an on-line design method¹⁾ that shortens the design time by representing the plant model by interpolation of the vertex characteristics and then construct the control system on an onboard ECU when it is possible to determine the plant characteristics from the data and knowledge accumulated in the past. In practice, an LPV (Linear Parameter Varying) type model is introduced for interpolation, and the plant model determined according to the operating conditions is interpolated using one parameter (θ). The controller of the same LPV type as the plant model is employed, and the interpolating is done using the parameter (θ_c) having duality with the LPV model parameter (Fig. 1).

The design based on the method consists of the following two steps :

Step 1: Off-line preparation (Fig. 2 upper)

The LPV model and the LPV controller are initially prepared by an off-line process. The controller is computed by applying an LMI (Linear Matrix Inequalities) technique.

Step 2: On-line tuning (Fig. 2 lower)

Dual parameters (θ and θ_c) are identified by the recursive least-squares method. Since the number of parameters is significantly reduced when compared with the conventional method, the real time identification can be executed on the ECU. Modeling and determination of the controller are performed

while taking data during the on-line process. The controllability can also be evaluated.

The design method is applied as a practical example to an AT lock-up clutch slip control system useful for fuel economy improvement (Fig. 3). The conventional method required a long time for its design because the control system was designed by making model identification under every driving condition in order to precisely control the slip speed. Our design method has made it possible to shorten the time required for the model identification as shown in Fig. 3. As a result, the design time has been shortened by 50% or more when compared with the conventional method.

Reference

- 1) Hibino, R., et al. : "On-Line Design Method of Feedback Controller for Automatic Transmission System", 3rd IFAC-Workshop on Advances in Automotive Control, (2001), 299, IFAC

(Report received on October 30, 2001)

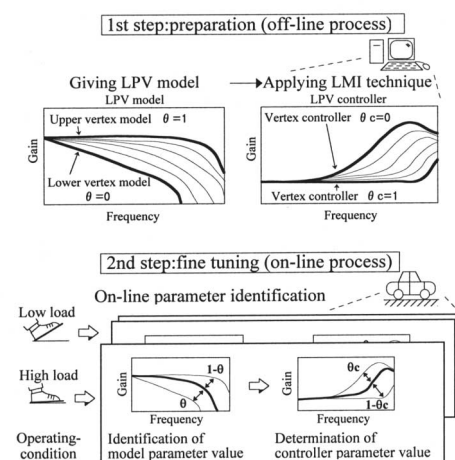


Fig. 2 Design procedure.

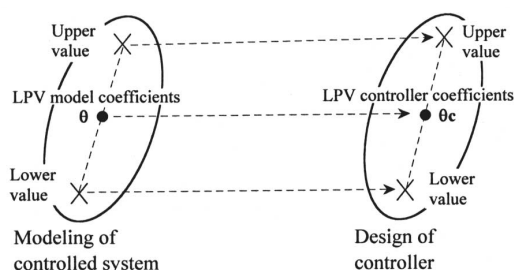


Fig. 1 Concept of interpolation for modeling and design.

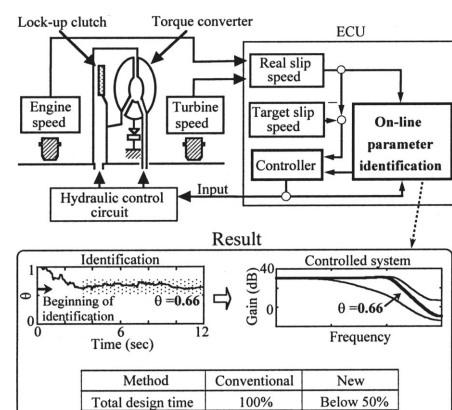


Fig. 3 Application to slip control system.