ABSTRACT

Title: Model Reference Two-Degree-of-Freedom Adaptive Control for Non-minimum Phase System

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In the research and industrial domain of control system engineering, the solution of tracking problems of dynamic systems is one of the crucial control tasks and the perfect set point tracking is essentially required in the real, practical industrial area. Different feed-forward techniques like model-based feed-forward, enhanced feed-forward, two feed-forward, adaptive feed-forward, feed-forward model inverse control have been applied till date, but among all these techniques, adaptive feed-forward is the most effective control approach. The adaptive feed-forward needs the inverse of the system model, but it is feasible when the system is linear and its inverse model exists.

The NMP system is a system which has at least one RHP zero in its transfer function model and it exhibits non-minimum characteristics, like initial undershoot or overshoots in the system dynamics, which leads to internal instability of the system dynamics and obstructs good tracking of the desired trajectory.

The adaptive inverse model technique is also a very useful tracking control method for dynamic systems, but it is applicable for MP systems only. In the case of an NMP system, it gives an unbounded output response as RHP zero becomes RHP poles. So, an efficient method is essentially needed for achieving the approximate desired trajectory tracking of an unstable inversion-based NMP system. Here, one novel control technique has been proposed, where the direct MRAC and the SFB control, based on an arbitrary pole placement method, are considered for feed-forward and feedback compensation in the 2DOF framework, respectively. The inverse transfer function model of the NMP system is considered as a plant for feed-forward controller, whereas a non-inverse NMP system has been made for feedback compensation, and both the controllers are decoupled with each other.

The proposed control methodology has been verified by applying its technique on 2nd order, 3rd order unstable NMP plant and 4th order practical mechanical system and a realistic

Op-amp based 2nd order NMP system in the MATLAB SIMULINK environment and finally proved its efficacy using real hardware experimental set up.

The proposed control law is not only able to solve the tracking and stability problem of the NMP system theoretically, but it also exhibits the robust performance of this control approach in a real hardware environment.