Control of a liquid rocket system based on global linearization and state feedback

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A mathematical model has been constructed for the liquid rocket engine (LRE) which consists of the main combustion chamber, the turbopump, the gas generator, the valves, the propellant pipelines, the cooling jacket and the injector head. Simulation study exhibits a significant mismatch between the dynamics of rocket engine system and rocket motion. Very slow dynamics and severe nonlinearities are obtained by analyzing the governing equations and the dynamic simulation. Thus the liquid rocket system cannot be properly controlled by a linear controller. Using the cascade control algorithm it is enabled to overcome the control difficulty caused by the difference of time constants. It is demonstrated that no tuning procedure can find a single parameter set that gives a satisfactory PI control result for the set-point tracking problem of rocket velocity. That necessitates systematic tuning procedure that is a part of the GLC synthesis. Also, GLC provides a model for treating control problems arising in severely nonlinear liquid rocket system.