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A VELOCITY-BASED LPV MODELING AND CONTROL FRAMEWORK FOR AN AIRBREATHING HYPERSONIC VEHICLE

Guangbin Cai[1,2], Guangren Duan[1] and Changhua Hu[2]

[1]Center for Control Theory and Guidance Technology
Harbin Institute of Technology
No. 92, West Dazhi Street, Harbin 150001, P. R. China
cgb0712@163.com; g.r.duan@hit.edu.cn

[2]Unit 302, Department of Automation
Xi'an Research Institute of High-Tech
Xi'an 710025, P. R. China
hch6603@263.net

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Abstract. *This paper focuses on developing a linear parameter varying (LPV) controller for an airbreathing hypersonic vehicle using a velocity-based approach. The design of flight control systems for airbreathing hypersonic vehicles is a highly challenging task due to the unique characteristics of the vehicle dynamics. Motivated by recent results on a velocity-based linearization approach and LPV control theory, a velocity-based LPV modeling and control framework combined with a novel implementation method of nonlinear gain-scheduling controller has been developed, which provides a nonlinear tracking control structure. Within this framework, an accurate LPV modeling of nonlinear systems and advanced design of self-scheduled controllers are implemented, which relaxes the restriction to near equilibrium operation in traditional gain scheduling approaches. The framework is applied to a nonlinear longitudinal dynamic model of the airbreathing hypersonic vehicle. Simulation results demonstrate the effectiveness of the proposed method.*
Keywords: Airbreathing hypersonic vehicle, Linear parameter varying (LPV) systems, Velocity-based approach, Nonlinear control, Gain scheduling control, Controller implementation

1. **Introduction.** Since there is a worldwide flurry of research and development activities toward building test vehicles and experimental facilities to fill the void of flight test data that characterizes the current state of the airbreathing hypersonic flight, the age of airbreathing hypersonic flight is upon us [1]. The researches on airbreathing hypersonic vehicles have become much more attractive in recent years mainly due to their promising prospects for reliable affordable access to space routine and global reach capabilities [2]. A key issue in making airbreathing hypersonic flight feasible and efficient is the control design, which is a highly challenging task due to the strong interactions among the elastic airframe, the propulsion system and the structural dynamics [3]. The requirements of flight stability and maneuvering performance for hypersonic flight control systems are higher than other aircrafts because of more significant dynamic characteristics due to facts such as various coupling effects, strong nonlinearities, high flight altitudes, large flight envelopes, extreme ranges of operating conditions and rapid changes of mass distribution. Therefore, seeking better control-oriented model and designing more appropriate controller of hypersonic vehicles are one of the major tasks in developing hypersonic vehicle technologies.