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Multivariable Robust Control of a Proton Exchange Membrane Fuel Cell System

Fu-Cheng Wang, Hsuan-Tsung Chen, Yee-Pien Yang and Jia-Yush Yen

Abstract

This paper applies multivariable robust control strategies to a proton exchange membrane fuel cell (PEMFC) system. From the system point of view, a PEMFC can be modeled as a two-input-two-output system, where the inputs are air and hydrogen flow rates and the outputs are cell voltage and current. By fixing the output resistance, we aimed to control the cell voltage output by regulating the air and hydrogen flow rates. Due to the nonlinear characteristics of this system, multivariable robust controllers were designed to provide robust performance and to reduce the hydrogen consumption of this system. The study was carried out in three parts. Firstly, the PEMFC system was modeled as multivariable transfer function matrices using identification techniques, with the un-modeled dynamics treated as system uncertainties and disturbances. Secondly, robust control algorithms were utilized to design multivariable $H\infty$ controllers to deal with system uncertainty and performance requirements. Finally, the designed robust controllers were implemented to control the air and hydrogen flow rates. From the experimental results, multivariable robust control is shown to provide steady output responses and significantly reduce hydrogen consumption.