电力电子与电力传动

PWM整流器的欠驱动特性与非线性控制

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摘要：

针对三相电压型脉宽调制(pulse width modulation，PWM)整流器级联式双闭环控制系统结构的选择成因尚缺乏理论阐释的问题，基于欠驱动系统理论对此结构进行理论研究。建立PWM整流器在dq同步旋转坐标系下的数学模型，并对其欠驱动特性进行分析。给出PWM整流器驱动变量与欠驱动变量的选择方法，利用零动态分析理论与部分反馈线性化控制策略，设计电流内环控制器。为增强PWM整流器抵抗电网电压和负载扰动的能力，提出自抗扰比例积分电压外环非线性控制方案。所设计的PWM整流器控制系统具有较好的稳态和动态性能，特别是对电网电压/负载扰动具有很强的鲁棒性。仿真与实物实验结果证明了所提理论的正确性和控制策略的有效性。

关键词： 脉宽调制整流器　欠驱动特性　双闭环控制系统　自抗扰比例积分控制

Underactuated Property and Nonlinear Control for PWM Rectifier

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Abstract:

Based on the underactuated system theory, the cascaded double-closed-loop control system structure of the three-phase voltage-type pulse width modulation (PWM) rectifier was studied theoretically for lack of effective interpretation for choosing this specific structure. The underactuated property of PWM rectifier was analyzed with its model in the dq synchronous reference frame. The choosing method for actuated and underactuated variables was given. Consequently, the current inner-loop controller was designed, based on the zero dynamics theory and partial feedback linearization control method. Moreover, auto-disturbance- rejection proportional integral (ADR-PI) voltage outer-loop controller was presented to reinforce the rejection ability for the AC voltage and DC load disturbances. The proposed PWM rectifier control system has better steady and dynamic performances, as well as strong robustness for the disturbances especially. Simulation and practical experiment results validate the correctness of the proposed theory and the effectiveness of the control strategy.

Keywords: pulse width modulation (PWM) rectifier　underactuated property　double-closed-loop control system　auto-disturbance-rejection proportional integral (ADR-PI) control

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