EXCESS PASSIVITY BASED CONTROL OF NONLINEAR BUCK-BOOST CONVERTER

Sree Likhita Gavini (Afshin Izadian)
Purdue School of Engineering and Technology, IUPUI
Indianapolis, IN 46202

Buck-boost converters are nonlinear systems and can either step-up or step-down the output voltage. A number of effective non-linear controllers such as sliding mode control, passivity based control, feedback linearization are in use for regulating the voltage of power converters. Direct regulation of voltage in non-minimum phase power converters such as buck-boost converter is challenging, as the zero dynamics of the output voltage are unstable. Consequently, these controllers make use of one-to-one correspondence between the voltage and current equilibriums and exploit the property that when the average output of the buck-boost converter is the inductor current, the system dynamics are stable. So the existing control strategies indirectly regulate the voltage, but their performance is susceptible to circuit parameter variations like load variation. As a result, adaptive versions of the controllers are incorporated to achieve a satisfactory performance, which in turn increases the system complexity. This problem of regulating the non-minimum phase voltage of the power converters continues to challenge and some solutions to this problem are presented based on different energy shaping approaches. The principal investigation in these approaches focuses on characterizing the energy of the system based on the physical structure of the system and uses this energy function description to draw conclusions about the degree of passivity i.e. damping in the system.

This work approaches the problem by characterizing the degree of passivity in the system from passivity indices rather than from the system's energy function, and thus views the problem from a system level rather from a circuit level description. We claim and support our claim from simulation and experimental results that this approach is complementary to existing approaches and uses a linear control to achieve the same objective as direct regulation of voltage and robustness against load variations.