ABSTRACT

Power systems of various domains have observed significant advancements driven by power electronics enabled systems. With domination of power electronic converter (PEC) enabled power systems, stability of the system becomes heavily coupled to the control methodology. Classically, linear controls are obvious solutions to PEC systems due to linearization of the topology. However, in presence of non-ideal elements, parametric variations and uncertainties, load and input disturbances, and nonlinear components interfaced to the converter, linear controls are limited in performance and often face stability concerns. Therefore, advanced controls utilizing forecasting, nonlinear techniques, robust methods, adaptive control laws, and pseudo-intelligent framework have been studied in PEC application.

While advanced control methods exist to resolve the problem of parameter uncertainty, nonlinear load dispatch, and feedback perturbations, many such approaches are either too computationally costly for real-time use at high frequency or dependent on a priori knowledge unavailable to the system integrator. Based on these disadvantages, a new area of research of utilizing memristor-based controls is proposed. Memristor is a passive device relating flux and charge, leading it to exhibit memory-like behaviors. Exploiting this property, a memristor-based adaptive control method is considered.

This work discusses the state-of-the-art of dc/dc PEC control methods, followed by exploration in memristor circuit analysis and memristor application in controls. Analytical and numerical analysis is shown supplementing the performance and stability of the memristor-based control. Simulated case studies show increased robustness compared to existing control schemes against parametric variation and time delay, while providing sufficient damping for nonlinear load-induced oscillations without sacrificing dynamic response performance. These results highlight the potential of memristor-based control solution and its appeal in digital control applications due to a relatively low computational cost and complexity in implementation.