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Abstract

Title: Benefits of Model Predictive Control in Multilevel Inverter-Based Power Electronics and Drives

The field of power electronics and drives is undergoing a profound transformation, driven by the demand for higher efficiency, enhanced dynamic performance, and seamless integration with renewable energy sources. In this context, Model Predictive Control (MPC) has emerged as a promising solution and has been deeply investigated in the scientific literature, giving rise to numerous variants and applications. In particular, Finite Control Set MPC (FCS-MPC) has demonstrated remarkable potential in multilevel inverter-fed systems, offering fast dynamics, intuitive formulation, and the ability to naturally handle system constraints.

Despite this extensive academic attention, MPC has not yet become the de facto standard in commercial industrial applications, where conventional modulation and control techniques still dominate. The reason lies in several open challenges that continue to limit its wider adoption, such as the pursuit of lower current distortion, the reduction of losses in both converters and machines, improved robustness to parameter variations, full compliance with evolving grid codes, and the economic implications of variable apparent switching frequency.

This tutorial aims to critically investigate these challenges while showcasing the practical benefits that FCS-MPC can already deliver in both AC drives and grid-connected applications. By bridging the gap between research achievements and industrial needs, the presentation will provide participants with a comprehensive understanding of the state of the art, the barriers that remain, and the pathways toward establishing predictive control as a key enabling technology for the next generation of power electronic systems.