Model predictive torque control based on virtual vectors for six-phase induction machines

Osvaldo González, Jesús Doval Gandoy, Magno Ayala, Paola Maidana, Christian Medina, Jorge Rodas, Carlos Romero, Larizza Delorme, Ricardo Maciel, and Raúl Gregor

Abstract

Model Predictive Control (MPC) has become an effective control strategy, particularly in Multiphase Induction Machines (MIMs). Unlike their three-phase counterparts, MIMs have additional degrees of freedom, known as $(x-y)$ voltages or currents. MPC can integrate diverse constraints through a predefined cost function to regulate $(x-y)$ components, but this can come at the cost of disturbing the flux and torque production. To address this challenge, a new approach has been introduced in this paper: Model Predictive Torque Control using Virtual Vectors (PTC-VV) for a six-phase IM. This approach aims to regulate copper losses in the $(x-y)$ plane, which classic PTC cannot achieve using a single switching state during the sampling period. This work demonstrates the effectiveness of using virtual vectors in torque control for six-phase IMs through comprehensive simulation studies. The PTC-VV approach provides robust reference tracking for torque, flux, and stator $(\alpha-\beta)$ and $(x-y)$ current regulations. This results in enhanced efficiency and adaptability of the control system, marking a notable advancement in PTC techniques. Additionally, this approach reduces the $(x-y)$ currents in six-phase IMs.