Dealing with linear and non-linear time delays under Model Predictive Control of Power Electronic Inverters

Model Predictive Control (MPC) has attracted significant attention in the area of inverter control. Some advantages of the MPC approach include the ability to handle complex and non-linear situations and to seamlessly deal with multiple design objectives. While its early implementations were primarily focused on current and torque control of two-level inverters, more recently MPC applications included a variety of converter topologies and power electronic devices, e.g. multiphase and matrix converters, multilevel inverters, AC/DC converters, etc. Also, early MPC applications in power electronics were mostly based on Finite Control Set, while more recent applications are targeting more PWM-like modulation schemes.

Performance of any digital control scheme applied to inverters, or any other power electronic structures, can significantly suffer due to time delays. These time delays can be linear (or state-independent) and non-linear (state-dependent). An example of a linear delay is the delay due to sampling, control calculation and application of the new voltage state, which results in the same delay in each control cycle. An example of a non-linear delay is the invertir dead-time, which is different depending on the direction of the load current. Both types of the delays are well-known and are addressed in literature. At the same time, the known solutions result in significantly more complicated hardware and/or softwareimplementations.
Introduction of MPC to power electronics gives a new and unique opportunity to fully compensate for both types of the delays in a clear and easy way. This can be done by including the delays, both linear and non-linear, in the model predictions. As an illustration, in this talk the MPC-based design of closed-loop current control for voltage source inverters (VSI) will be discussed. Then it will be shown how to include compensation for linear delays and for the invertir dead-time related delays in the current control scheme. Extensive simulation and experimenal results will be presented to illustrate the main points of the presentation.

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