Model Predictive Control for Smooth Distributed Power Adaptation

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Abstract:

This paper addresses the distributed power adaptation (DPA) problem on the downlink for wireless cellular networks.
As a consequence of uncoordinated local scheduling decisions in classical networks, the base stations produce mutual uncontrolled interference on their co-channel users.
This interference is of a variable nature, and is hardly predictable, which leads to suboptimal scheduling and power control decisions.
While some works propose to introduce cooperation between BS, in this work we propose instead to introduce a model of power variations, called trajectories in the powers space, to help each BS to predict the variations of other BS powers. The traje ctories are then updated using a Model Predictive Control (MPC) to adapt transmit powers according to a trade-off between inertia (to being predictable) and adaptation to fit with capacity needs. A Kalman filter (KF) is used for the interference prediction. In addition, the channel gains are also predicted, in order to anticipate channel fading states.
This scheme can be seen as a dynamic distributed uncoordinated power control for multichannel transmission that fits the concept of self-optimised and self-organised wireless networks (SON).
By using the finite horizon MPC, the transmit powers are smoothly adapted to progressively leave the current trajectory toward the optimal trajectory.
We formulate the optimisation problem as the minimisation of the utility function of the difference between the target powers and MPC predicted power values.
The presented simulation results show that in dynamic channel conditions, the benefit of our approach is the reduction of t he interference fluctuations, and as a consequence a more accurate interference prediction, which can further lead to a more efficient distributed scheduling, as well as the reduction of the overall power consumption.