Adaptive Null Steering Using Model Predictive Control Scheme

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With the exponential growth of commercial wireless communications over the last years it has become imperative to adapt novel advanced technologies both in the user terminal and the base station. Next generation base stations should employ both sophisticated antenna arrays and smart antenna array capabilities. Adaptive beamforming should be employed to minimize co-channel interference and maximize the capacity of the base station using spatial multiplexing on top of the other multiplexing schemes. Maximizing the performance of the beamformer we need to simultaneous steer the main lobe of the array at the direction of interest and place nulls in the interferers. The focus of this abstract is to apply model predictive control (MPC) to an adaptive nulling algorithm.

Model predictive control is a very powerful method that has the ability to compute either a priori (offline) the entire control law using a look up table or online and solve at each time step a quadratic problem (QP). The choice depends on the size of the problem. Fast algorithms can also be employed like warm-start, active set method etc. to speed up the process on the online case. The algorithm presented here is based on a minimum variance algorithm with null widening and has been reworked as a multi-parametric quadratic programming (mp-QP)

$$\begin{aligned} &\min \frac{1}{2} z^T H z \\ &s.t\ Gz \leq W + Sx(t) \end{aligned} \tag{1}$$

where z is the optimization variable with the weights w of the array, H contains the covariance matrix information and G,W,S contain the information for the constrains $w^H s(\theta_0) = 1$ and $|w^H s(\theta_n)|^2 \leq Null\ Level$ ($s(\theta_0)$ is the direction of interest and $s(\theta_n)$ is the desired null direction).

Using the MPC scheme for adaptive null beamforming in the general form of (1) gives versatile applications that depend mainly on the size of the base station as stated. Both online and offline solutions have been developed and optimized for this beam former. The choice of the method depends on the complexity of the base station and the available hardware.