557a Model Predictive Control of Weight-on-Bit near Its Optimum in Hydrocarbon Well Drilling: the Value of Constraints

Ankur Awasthi and M. Nikolaou

In our previous work we demonstrated that controlling weight on bit (WOB) near its optimum when drilling through a rock formation to reach a hydrocarbon reservoir is challenging because of the nonlinear relationship between the rate of penetration (ROP) into the drilled formation and the weight on bit (WOB). The nature of this nonlinearity is such that the system experiences transition from open-loop stability to open-loop instability at a steady state very close to the optimal WOB. Given the significant economic benefits of controlling WOB near its optimum (to maximize ROP) it is sensible to consider advanced control strategies. In this presentation we demonstrate how constrained MPC can be used to improve control performance. In particular, we demonstrate how the presence of output constraints can affect the closed loop stability of the system as compared to their unconstrained counterparts using an infinite horizon approach. The effects of uncertainty (e.g., value of optimal WOB) and the need for adaptation as drilling progresses through layers of varying resistance are also discussed. Suggestions for future development of nonlinear MPC algorithms for this problem are made.