An Ensemble Nonlinear Model Predictive Control Algorithm in an Artificial Pancreas for People with Type 1 Diabetes

This paper presents a novel ensemble nonlinear model predictive control (NMPC) algorithm for glucose regulation in type 1 diabetes. In this approach, we consider a number of scenarios describing different uncertainties, for instance meals or metabolic variations. We simulate a population of 9 patients with different physiological parameters and a time-varying insulin sensitivity using the Medtronic Virtual Patient (MVP) model. We augment the MVP model with stochastic diffusion terms, time-varying insulin sensitivity and noise-corrupted CGM measurements. We consider meal challenges where the uncertainty in meal size is ±50%. Numerical results show that the ensemble NMPC reduces the risk of hypoglycemia compared to standard NMPC in the case where the meal size is overestimated or correctly estimated at the expense of a slightly increased number of hyperglycemia. Therefore, ensemble MPC-based algorithms can improve the safety of the AP compared to the classical MPC-based algorithms.

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Contributors: Boiroux, D., Hagdrup, M., Mahmoudi, Z., Poulsen, N. K., Madsen, H., Jørgensen, J. B.
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