

Artificial pancreas under stable pulsatile MPC: Improving the closed-loop performance

Abstract

This work presents a pulsatile Zone Model Predictive Control (pZMPC) for the control of blood glucose concentration (BGC) in patients with Type 1 Diabetes Mellitus (T1DM). The main novelties of the algorithm – in contrast to other existing strategies – are: (i) it controls the patient glycemia by injecting short duration insulin boluses for both, the basal and bolus infusions, in an unified manner, (ii) it performs the predictions and estimations (critical to anticipate both, hypo and hyperglycemia) based on a physiological individualized long-term model, (iii) it employs disturbance observers to compensate plant-model mismatches, (iv) it ensures, under standard assumptions, closed-loop stability, and (v) it can be used – under minor modifications – as an optimal basal–bolus calculator to emulate conventional therapies. Because of the latter characteristic, a significantly better performance is achieved, not only in terms of classical indexes (time in the normoglycemia zone, avoidance of hypoglycemia in the short term, avoidance of hyperglycemia in the long term) but also in terms of its applicability (use of the pump or injections). Such a performance is tested in a cohort of in-silico patients from the FDA-accepted UVA/Padova simulation platform, considering the most challenging scenarios.