Model-based Closed-Loop Control for Type 2 Diabetes

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ABSTRACT: Diabetes Mellitus (DM) is a chronic disease, whose alarming continuous growth has been estimated by the International Diabetes Federation (IDF) to involve currently 415 million patients worldwide, with a total health expenditure due to diabetes estimated at 673 billion US dollars. Type 2 Diabetes Mellitus (T2DM) involves an inadequate compensatory insulin secretory response, possibly combined to a resistance to insulin action, and it accounts for 85% to 95% of all cases of diabetes, thus having a relevant impact in worldwide National Health Systems, since an untimely control of hyperglycemia facilitates the emergence of many and diverse diabetic complications like retinopathy, neuropathy, nefropathy, etc. In this talk the problem of tracking a desired glycemia is considered, for T2DM patients. A time-delay model is used to describe the glucose–insulin regulatory system, aiming to detail the endogenous pancreatic insulin release, which is not negligible in T2DM. Insulin is assumed to be administered intra-venously. Only measurements of glycemia are considered: to this aim a nonlinear observer for time-delay systems is used to estimate the plasma insulin concentration. In the spirit of the separation theorem, a nonlinear control law is exploited, based on the exact input/output feedback linearization, which makes use of the observer estimates instead of the full state measurements. Theoretical results are validated through a virtual environment broadly accepted as a substitute to animal trials for the pre-clinical testing of control strategies in plasma glucose regulation. Numerical results are encouraging and pave the way to further clinical verifications