Gaussian Process-Based Model Predictive Control of Blood Glucose for Patients with Type 1 Diabetes Mellitus

The insulin sensitivity (IS) of the human body changes with a circadian rhythm. This adds to the time-varying feature of the glucose metabolism process and places challenges on the blood glucose (BG) control of patients with Type 1 Diabetes Mellitus. This paper presents a Model Predictive Controller that takes the periodic IS into account, in order to enhance BG control. The future effect of the IS is predicted using a machine learning technique, namely, a customized Gaussian Process (GP), based on historical training data. The training data for the GP is continuously updated during closed-loop control, which enables the control scheme to learn and adapt to intra-individual and inter-individual changes of the circadian IS rhythm. The necessary state information is provided by an Unscented Kalman Filter. The closed-loop performance of the proposed control scheme is evaluated for different scenarios (including fasting, announced meals and skipped meals) through in silico studies on simulation models of Göttingen Minipigs.