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ORIGINAL ARTICLE

Applicability Results of a Nonlinear Model-Based Robust Blood Glucose Control Algorithm

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Abstract

Introduction:

Generating optimal control algorithms for an artificial pancreas is an intensively researched problem. The available models are all nonlinear and rather complex. Model predictive control or run-to-run-based methodologies have proven to be efficient solutions for individualized treatment of type 1 diabetes mellitus (T1DM). However, the controller has to ensure safety and stability under all circumstances. Robust control methods seek to provide this safety and guarantee to handle even the worst-case situations and, hence, to generalize and complement results obtained by individualized control algorithms.

Methods:

Modern robust (e.g., H_{inf}) control is a linear model-based methodology that we have combined with the nonlinear model-based linear parameter varying technique. The control algorithm was designed on the high-complexity modified nonlinear glucose–insulin model of Sorensen, and it was compared step-by-step with linear model-based H_{inf} control results published in the literature. The applicability of the developed algorithm was tested first on a control cohort of 10 healthy persons' oral glucose tolerance test results and then on a large meal absorption profile adapted from the literature. In the latter case, two preliminary virtual patients were generated based on 1–1 week real continuous glucose monitor measurements.

Results:

We have found that the algorithm avoids hypoglycemia (not caused by physical activity or stress) independently from the considered absorption profiles.

Conclusion:

Use of hard constraints proved their efficiency in fitting blood glucose level within a defined interval. However, in the future, more data of different T1DM patients will be collected and tested, including dynamic absorption model and *in silico* tests on validated simulators.

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Abbreviations: (AP) artificial pancreas, (CGM) continuous glucose monitor, (CHO) carbohydrate, (LPV) linear parameter varying, (LTI) linear time invariant, (MPC) model predictive control, (OGTT) oral glucose tolerance test, (RDS) rapidly digestible starch, (RS) resistant starch, (SDS) slowly digestible starch, (T1DM) type 1 diabetes mellitus

Keywords: artificial pancreas, linear parameter varying, polytopic set, robust control, type 1 diabetes mellitus

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