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ORIGINAL ARTICLE

Improving the Computational Effort of Set-Inversion-Based Prandial Insulin Delivery for Its Integration in Insulin Pumps

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Abstract

Objective:

Set-inversion-based prandial insulin delivery is a new model-based bolus advisor for postprandial glucose control in type 1 diabetes mellitus (T1DM). It automatically coordinates the values of basal–bolus insulin to be infused during the postprandial period so as to achieve some predefined control objectives. However, the method requires an excessive computation time to compute the solution set of feasible insulin profiles, which impedes its integration into an insulin pump. In this work, a new algorithm is presented, which reduces computation time significantly and enables the integration of this new bolus advisor into current processing features of smart insulin pumps.

Methods:

A new strategy was implemented that focused on finding the combined basal–bolus solution of interest rather than an extensive search of the feasible set of solutions. Analysis of interval simulations, inclusion of physiological assumptions, and search domain contractions were used. Data from six real patients with T1DM were used to compare the performance between the optimized and the conventional computations.

Results:

In all cases, the optimized version yielded the basal–bolus combination recommended by the conventional method and in only 0.032% of the computation time. Simulations show that the mean number of iterations for the optimized computation requires approximately 3.59 s at 20 MHz processing power, in line with current features of smart pumps.

Conclusions:

A computationally efficient method for basal–bolus coordination in postprandial glucose control has been presented and tested. The results indicate that an embedded algorithm within smart insulin pumps is now feasible. Nonetheless, we acknowledge that a clinical trial will be needed in order to justify this claim.

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Abbreviations: (PPBD) postprandial basal duration, (SIB) set inversion based, (T1DM) type 1 diabetes mellitus

Keywords: bolus advisor, embedded algorithm, optimized computation, smart insulin pump

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