Glucose-insulin regulatory system based on High-Order Integral Sliding Mode technique

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Diabetes is a condition in which the body either does not produce enough, or does not properly respond to, insulin, a hormone produced in the pancreas. This causes glucose to accumulate in the blood, often leading to various complications. Keeping normal level of blood glucose minimizes the risk of potentially serious or even life threatening aggravation of the decease.

Our approach to the glucose level regulation is represented by the fully closed-loop control system, we call "artificial pancreas". The system consists of three parts: *the "real-time" subcutaneous glucose sensor; the control system that calculates the necessary insulin dosage based on real time glucose levels; and the pump that releases the desired amount of insulin.*

The controller is based on the High-Order Integral Sliding Mode technique and preserves the main advantages of the traditional High-Order Sliding Mode (HOSM) approach – robustness and high accuracy in presence of parameter variations and external disturbances. Hovewer, compared to the traditional HOSM methods, our algorithm enables choosing transient dynamics and assigning the transient time function of the initial conditions. The transient dynamics is developed using the optimal control technique to minimize the amount of insulin delivered to the blood (which significantly reduces the risk of hypoglycemia).