Controlling Artificial Pancreas Systems through Machine Learning

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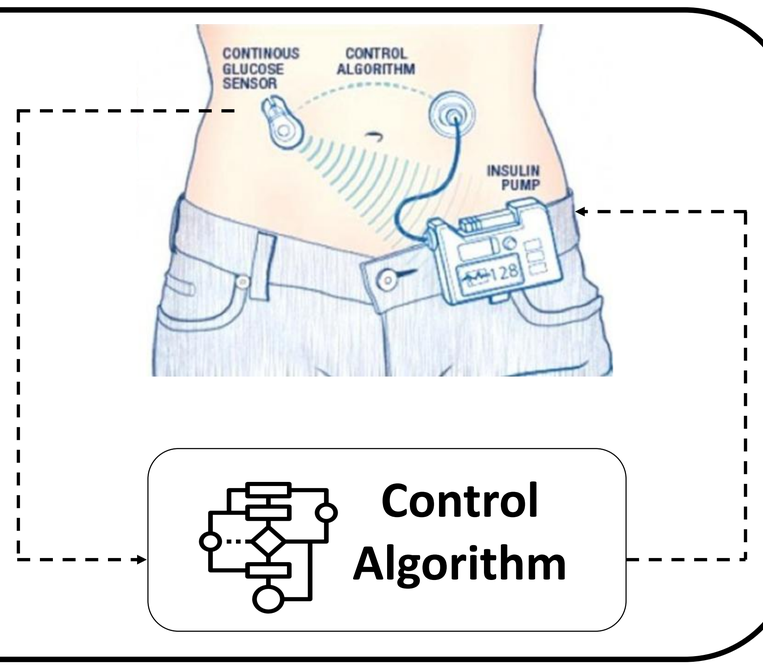
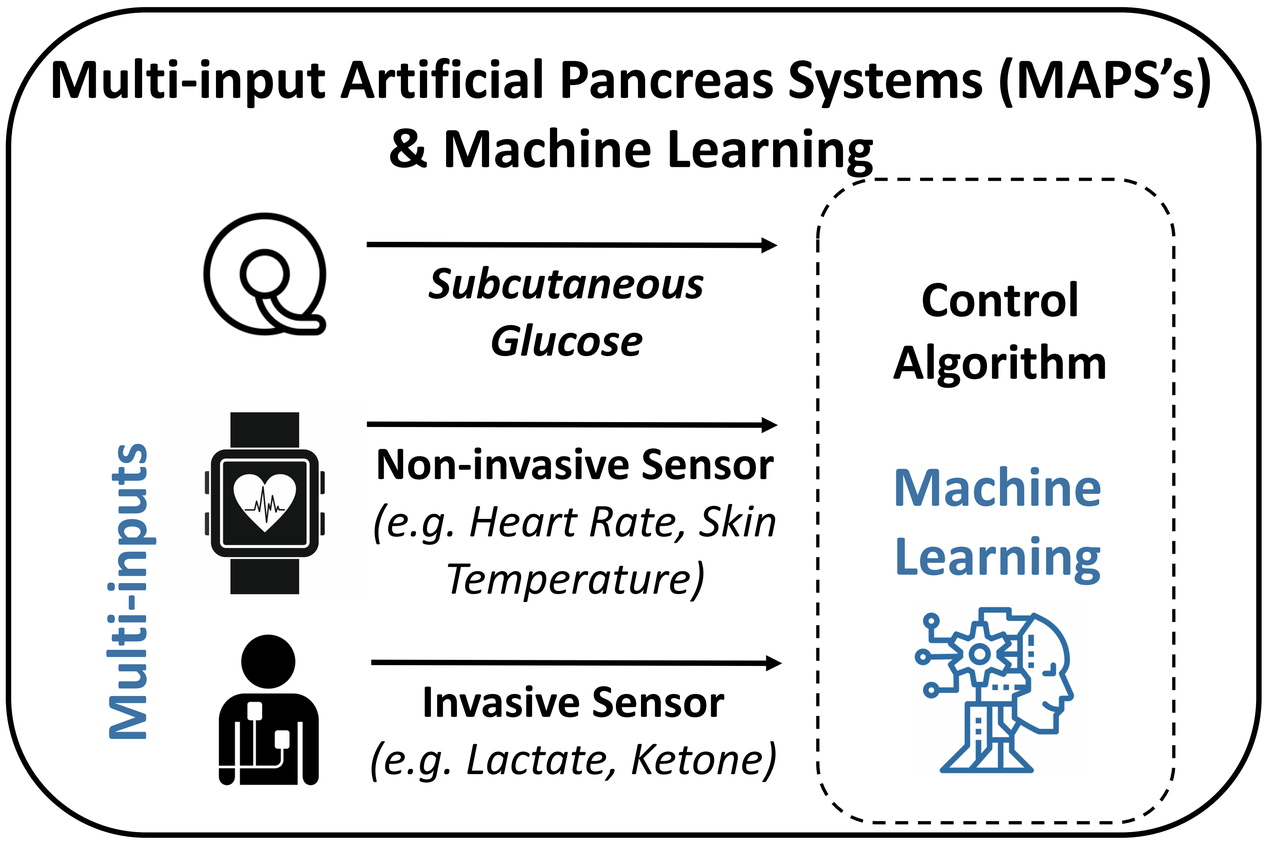
Introduction: Artificial Pancreas System (APS)

Type 1 Diabetes (T1D) is a chronic autoimmune disease which impairs the glucose homeostasis of the body, due to a deficiency in insulin production[1]. External insulin infusion can be identified as the most common treatment method. The Artificial Pancreas is one such treatment method[2]. The glucoregulatory system of the body is a complex dynamical system, which makes glucose regulation a challenging task. The operation of APS's at present, is mainly constrained by complexities arising during meals, exercise, stress, sleep, sensor/insulin delays, and cognitive burden on users[3].



Multi-input Artificial Pancreas Systems (MAPS's) & Machine Learning



Methods: Systematic Literature Review

A systematic review of literature was conducted using the **Scopus**, **PubMed**, and **IEEEXplore** databases, for the period from 2005 to February 2020, to learn about **MAPS's**. Based on the search criteria 1092 articles were initially shortlisted, of which **11** were selected for an in-depth analysis and **6** clinical studies related to the selected articles were also reviewed.

Results & Analysis

- Input signals captured by wearable devices such as **Heart Rate, Accelerometers, Energy Expenditure**, and **Galvanic Skin Response** are most frequently used additional inputs.
- The use of invasive biomarkers such as **Lactate** and **Adrenaline** have also been simulated.
- These inputs have been incorporated to switch the mode of the controller via activity detection, directly incorporated for decision making and for the development of intermediate modules for the controller.
- The validation of the studies has been carried out through clinical trials and different physiological models and simulators.
- Two research groups have focussed on developing multi-input simulators.

Discussion

Effectiveness of multi-inputs

Additional inputs have been effectively utilized to address current limitations in APS's. Majority of these inputs used are from wearable sensors, which is motivated by the rapid growth in wearable technologies.The lack of an FDA approved simulator for testing can be identified as a major constraint towards the development of multiple input artificial pancreas systems. The practical complexities and psychosocial aspects associated with MAPS's need to be evaluated, in order to develop a comprehensive system.

Why Machine Learning (ML) ?

Delays
(Delayed rewards mechanisms in RL)

Complex Dynamics
(Ability to learn complex control policies)

Uncertainty / Disturbances
(Adaptive Learning mechanisms)

Personalization
(Transfer Learning mechanisms)

References:

[1] DiMeglio, L. A., Evans-Molina, C., & Oram, R. A. (2018). Type 1 diabetes. *The Lancet*, *391*(10138), 2449-2462.

[2] Bekiari, Eleni, et al. "Artificial pancreas treatment for outpatients with type 1 diabetes: systematic review and meta-analysis." *bmj* 361 (2018).

[3] Cinar, Ali. "Multivariable adaptive artificial pancreas system in type 1 diabetes." *Current diabetes reports* 17.10 (2017): 88.

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