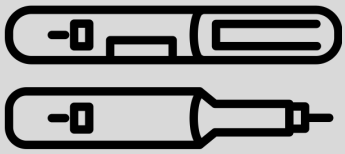
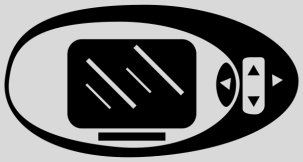
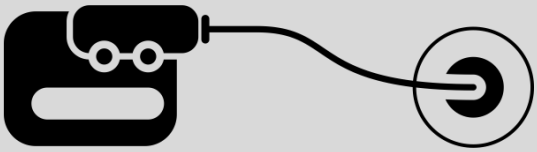
Imperial College London







A Modular Safety System for Insulin Dosing

Glucose forecasting algorithm for long-term prediction horizons

Proposed use

Suite of safety algorithms for insulin dosing and delivery systems such as sensor-augmented insulin pumps, continuous glucose monitoring systems, insulin bolus calculators, and automated insulin delivery (artificial pancreas).

Problem addressed

Delivering insulin in diabetes management is challenging, with significant associated risks. Including robust, validated safety measures is a critical component of any insulin dosing or recommender system. However, existing blood glucose forecasting algorithms fail to provide accurate long-term glucose predictions, which are usually needed in applications such as precision insulin dosing (e.g., an artificial pancreas).

Technology overview

Proposed blood glucose forecasting algorithm is based on a compartmental composite model of glucose-insulin dynamics, which uses a deconvolution technique applied to the continuous glucose monitoring (CGM) signal for state estimation. In addition, the algorithm allows the optional input of meal absorption information to enhance prediction accuracy.

This technology has been developed within the framework of the EU-funded PEPPER project as part of a personalised insulin recommender for people with Type 1 diabetes. The developed safety system is comprised of four modules:

- Predictive blood glucose alerts based on an advanced blood glucose forecasting algorithm using continuous glucose data which is particularly well suited for longer prediction windows, up to 120 minutes.
- A state-of-the-art predictive low-glucose insulin suspension for sensor-augmented insulin pumps.
- An innovative adaptive carbohydrate recommender for hypoglycaemia recovery using continuous glucose monitoring.
- A dynamic bolus insulin constraint that restricts the amount of insulin that can be safely recommended to the user.

The safety, feasibility and effectiveness of the safety system was evaluated as part of PEPPER insulin recommender system on an open-labelled multicentre randomized controlled cross-over study on 54 participants with Type 1 diabetes.

This technology has received the category of 'Tech Ready' by the European Commission's Innovation Radar and a JAVA API is available.

Benefits

- State-of-the-art performance
- Accurate long-term blood glucose forecasting
- Clinically validated
- Each module can be used as a standalone unit or in combination with other modules

Dr Marika Reay

Senior Executive

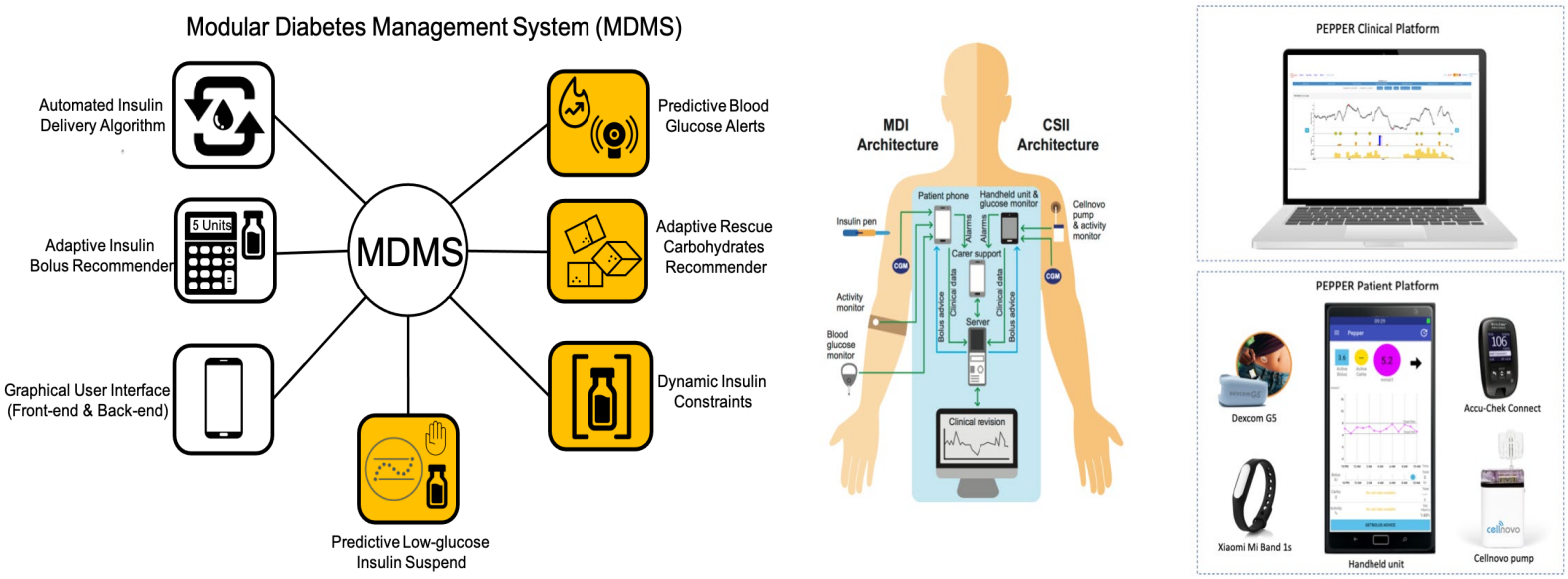
Industry Partnerships and Commercialisation - Engineering

e: m.reay@imperial.ac.uk

t: +44 (0)20 759 46867

Technology reference: 10571

Imperial College London



Left) Modular Diabetes Management System (MDMS). Highlighted icons correspond to the safety system for insulin dosing. Right) The PEPPER platform

Link to published paper(s)

- Avari, P., Leal, Y., Herrero, P., Wos, M., Jugnee, N., Arnoriaga-Rodríguez, M., Thomas, M., Liu, C., Massana, Q., Lopez, B., et al. Safety and feasibility of the PEPPER adaptive bolus advisor and safety system; a randomized control study. Diabetes Technology and Therapeutics. (2020).
- Liu, C., Avari, P., Leal, Y., Wos, M., Sivasithamparam, K., Georgiou, P., Reddy, M., Fernández-Real, J. M., Martin, C., Fernández-Balsells, M., Oliver, N. & Herrero, P. A modular safety system for an insulin dose recommender: a feasibility study. Journal of diabetes science and technology 14, 87–96. (2020).
- Liu, C., Vehí, J., Avari, P., Reddy, M., Oliver, N., Georgiou, P. & Herrero, P. Long-term glucose forecasting using a physiological model and deconvolution of the continuous glucose monitoring signal. Sensors 19, 4338. (2019).

Inventor information

Dr Pau Herrero

Research Fellow, Department of Electrical and Electronic Engineering

Prof Pantelis Georgiou

Professor in Biomedical Electronics, Department of Electrical and Electronic Engineering

Dr Monika Reddy

Clinical Research Fellow, Faculty of Medicine, Imperial College London

Prof Nick Oliver

Wynn Chair in Human Metabolism (Clinical) Faculty of Medicine, Imperial College London