Detecting specific food intake sequences causing glucose dysregulation in individuals using CGM and adaptive algorithms

Isabel Kurth
Master Data Engineering
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Abstract

This poster proposes integrating continuous glucose monitoring (CGM) data with a mobile app employing computer vision algorithms to analyse food intake sequences. By identifying foods and consumption orders causing significant glucose spikes, the app provides personalized dietary recommendations to mitigate these spikes. This approach aims to enhance individual glucose regulation and deepen understanding of glucose response variability.

Background information

Traditional glucose monitoring is done trough skin pricking (invasive method). In recent years, non-invasive CGM systems were developed. They allow for easier and more consistent glucose level tracking (by using a wearable filamentary continuous sensor inserted below the skin) [1].

Problem

→ glucose levels in healthy individuals fluctuate more significantly than previously thought (spikes occur particularly after consuming carbohydrate-rich foods)

→ spikes contribute to increased risks of cardiovascular diseases and diabetes [2]

→ in studies, half of participants failed to regularly track food intake [3]

→ sequence of food intake (impacts glucose spikes according to recent studies) was not considered [4]

→ varying glucose responses among individuals

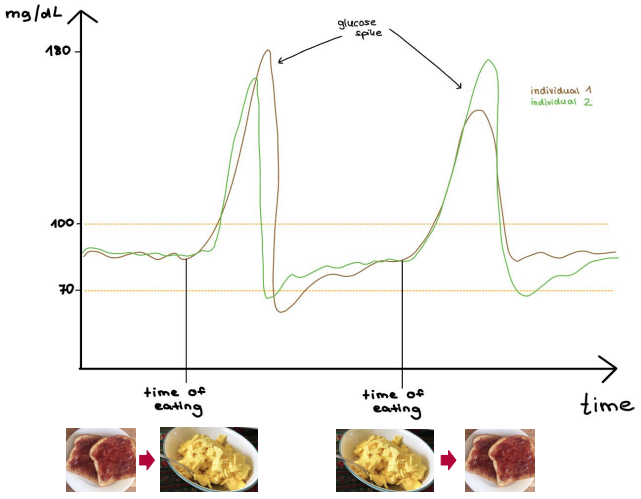

Figure 1: Example blood glucose level measurements using CGM. Range 70 to 100 is considered to be normal. Spiking pattern depends on individual and order of food intake (first jam toast, then scrambled eggs or the other way round).

Goal

continuous data about blood sugar levels
+
food intake (and sequence of it)

identification of food (sequences) that cause high spikes in individuals, show alternatives, change diet and reduce risk of cardiovascular disease

Solution

- track CGM data and display curves in an app
- upload picture of a meal → CV algorithms detect food and create bounding boxes → user orders them in sequence of food intake (fast and easy food logging)
- personalized model trained on CGM and food intake data identifies high spiking food and food sequences
- users gets feedback on food that causes the highest spikes and personalized dietary recommendations

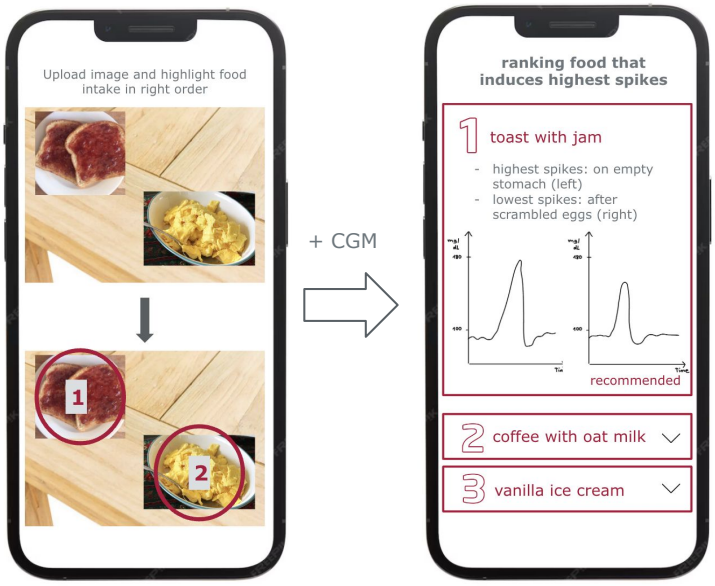

Figure 2: Example application that allows to upload images, mark food intake order and calculates based on these and the CGM a personalized ranking with food that induces high spikes and gives recommendation in which food intake sequence these can be reduced.

Connection to the lecture

Prof. Arnrich's lecture emphasized the potential of connected healthcare and wearables in addressing highly individual medical issues. His group's research, including the EatMaps project, focused on obesity as a primary factor in diabetes development. This project extends that work by targeting dietary habits and glucose regulation, providing a personalized tool for diabetes prevention and management.[5]

Summary

- identification of food that causes high glucose spikes
- CGM and easy to use food logging
- personalized algorithms indicate food and food intake sequences that lead to high spikes
- reduced risk of diabetes and cardiovascular diseases via adapted nutrition

Literature:
[1] Zhang, Changxi et al. "Wearable filamentary continuous sensor for interstitial glucose detection in diabetes management." Analytica chimica acta vol. 1290 (2024): 342169. doi:10.1016/j.aca.2023.342169
[2] Hall, Heather, et al. "Glucotypes reveal new patterns of glucose dysregulation." PLoS biology 16.7 (2018): e2005143.
[3] Zahedani, Ashkan Dehghani, et al. "Digital health application integrating wearable data and behavioral patterns improves metabolic health." NPJ Digital Medicine 6.1 (2023): 216.
[4] Shukla, Alpana P et al. "Food Order Has a Significant Impact on Postprandial Glucose and Insulin Levels." Diabetes care vol. 38,7 (2015): e98-9. doi:10.2337/dc15-0429
[5] Lectured on Connected Healthcare by Prof.Arnrich as part of the Lecture Series