



A Mobile-Based Diet Monitoring And Advisory System For Obesity Management

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Abstract

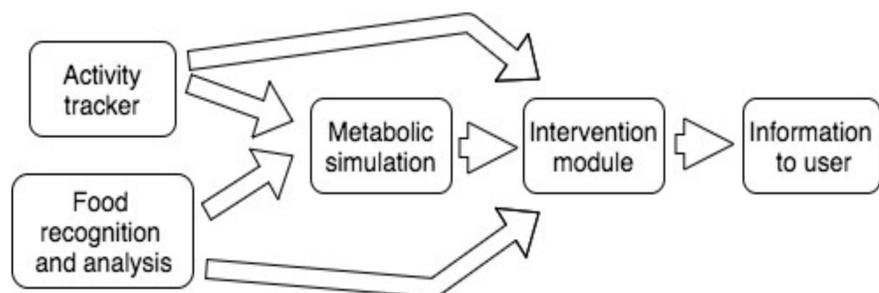
Obesity has become a major public health crisis internationally. For people who present obesity and seek weight control, it is important while difficult to monitor their diet. Manual techniques for keeping meal log suffer from drawbacks such as underreporting and low adherence. To address these issues, smartphone-based applications have demonstrated great potential to recognize food items and assess nutrient from meal images. However, due to several technical challenges, most state-of-the-art systems still show low performance (less than 60%).

We present a new automated mobile system that integrates image-based food classification, weight estimation, and nutrition assessment to count the energy intake from each meal after the user uploads the food images. In addition to the novel design that overcomes challenges in food image segmentation, classification, and weight estimation, one particularly unique feature of this system is to monitor the real-time energy balance through a personalized metabolic network simulation. As a proof-of-concept, we have demonstrated the use of this system through an Android app.

Objectives

The main objectives of our long-term project include the development of four functional modules:

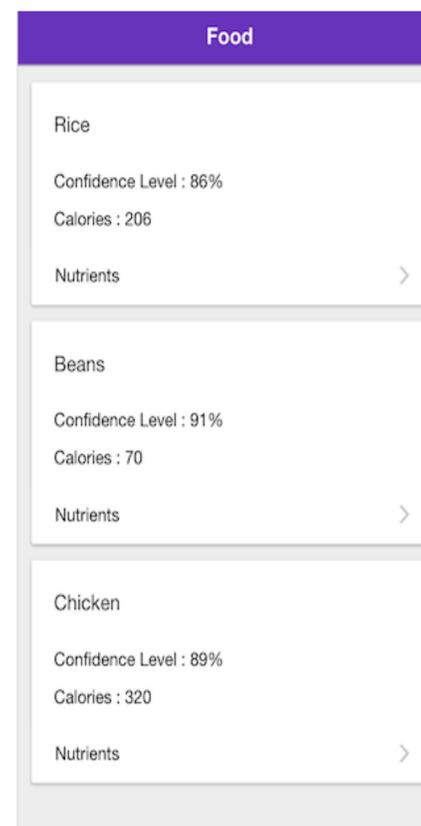
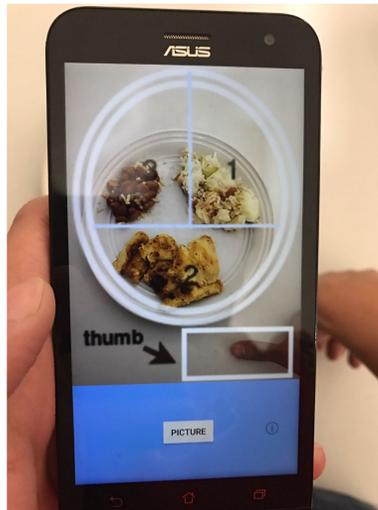
- An interactive classification system to recognize and assess food items from the images using a smartphone app.
- An activity tracker to detect exercise episodes using wearable devices.
- Metabolic network model to monitor individual's energy balance.
- An intervention module able to learn user's food habits and therefore generate insights, meals recommendations and alerts to users.



Automatic food recognition and analysis

The food recognition and analysis system deals with challenging problems such as image segmentation, food classification and weight estimation. Users will be asked to take at most four pictures, one from the top of the plate and one from each of the three sides of the plate.

Currently, this module utilizes a database of 60 common American food classes and has classification accuracy of 80%.



The classified food along with the estimated weight will enable the assessment of various nutrient intake from each meal. Such information will be returned to the user for confirmation and subsequently will serve as input for intervention module and metabolic simulation along with calories consumed captured through a smart band.

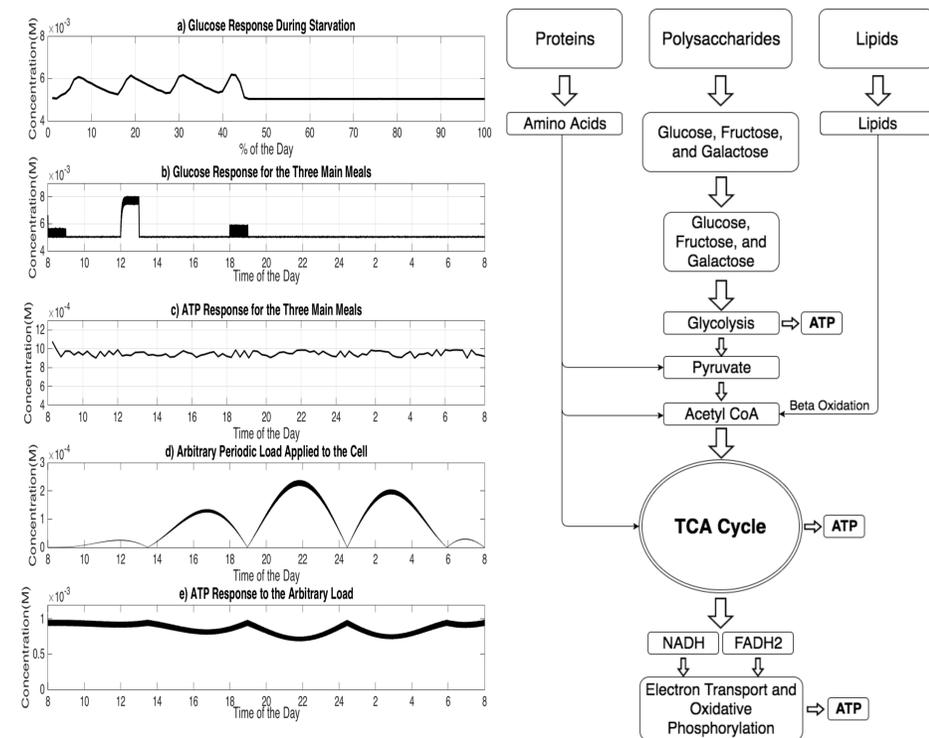
Activity tracker

The activity tracker or smart band (e.g. Fitbit) can capture the real-time physical activity and energy expenditure of an individual during the day. With such information and the total energy consumed in a day, it is possible to build the user's metabolic pathways and have more information for the intervention module.

Metabolic pathway

Metabolism analysis includes all the major ATP-production related metabolic pathways. The nutrients/metabolites from each meal, including mainly proteins, carbohydrates, sugar, and fats will be broken down through three main interconnected pathways of proteins, polysaccharides, and lipids.

By simulating the metabolic network, the energy in terms of ATP production was calculated to give a better understanding on the body behavior in presence of different metabolites derived from food having time variant load in an independent reference cell.



Intervention module

The intervention module is based on automatically learning of food habits from each user. It identifies eating patterns based on the logged meals, activity information and the real-time energy balance. The module has three interventional functions:

- To provide a comprehensive report containing all nutrient and quantity information about a meal.
- To determine if the user is overeating. If so, he/she will be advised to substitute some food items with healthier ones or eat in less quantity.
- To send the user an alert if he/she tend to have a bad eating habit, e.g., overeating after skipping the previous meal.