Dietary intake assessment using spectroscopy and image analysis

Mireille Baart[1], Yannick Weesepoel[2], Freek Daniels[3], Leontien de Pagter[2], Martin Alewijn[2], Jan Top[3], Edith Feskens[1]

[1] Wageningen University & Research, Division of Human Nutrition and Health, Wageningen, The Netherlands
[2] Wageningen Food Safety Research
[3] Wageningen Food and Biobased Research

Background: Dietary intake is traditionally assessed with questionnaires or interviews. However, these methods are prone to bias due to conscious or unconscious misreports. More objective measurement methods are therefore desirable. The aim of this study is to develop a demonstrator for the identification and quantification of food items using state-of-the-art techniques.

Methods: Our demonstrator combines two analytical techniques, i.e. vibrational spectroscopy, used to determine macro- and micronutrients, and image analysis, used to recognize and quantify food items. To test the demonstrator, two food cases were chosen: 1) butter and 2) vegetables. For case 1, a Specim IQ hyperspectral imaging system was used for analysis of thirty different types of butter or margarine, varying in total and saturated fat content, applied to a sandwich. For case 2, a RealSense camera was used for analysis of plates with three different types of vegetables (carrots, spinach and endive), varying in amount and preparation (raw, cooked), resulting in seven different classes. A setup with and without controlled illumination was used.

Results: Case 1: The system was able to differentiate between bread and butter and, using multivariate modelling, to predict the total and saturated fat content. Furthermore, the surface area of the butter on the sandwich could be estimated by pixel counting, however, estimating the layer thickness of the butter remains challenging. Case 2: Using deep learning models, identification was successful for a seven class problem in 31 of 31 cases with controlled illumination. In the uncontrolled environment, 534 out of 535 classifications were correct. Only one single plate with creamed spinach was misclassified as frozen spinach.

Conclusion: We developed a first demonstrator which was able to do basic measurements. The next step is to reach technology readiness level 4, which means that the demonstrator can be operated in a controlled environment by trained persons. The ultimate aim is to integrate the used analysis techniques into smaller devices such as wearables or smartphones that can be used by consumers themselves, and to combine them with data from other sources such as consumer profiles.

Key words: Dietary intake assessment, spectroscopy, image analysis