SPECTROFOOD: Democratizing spectral imaging in agrifood

Development and testing of spectral imaging and artificial intelligence solutions towards food loss reduction and a more sustainable agriculture from field to storage.

Two challenges modern agriculture and society face are food insecurity and loss

The global population is rising, and modern agriculture has to keep up with the increased demands while reducing its environmental footprint. Optimizing resource use and reducing discarded products could help towards that goal. SPECTROFOOD aspires to develop solutions across the agrifood value chain from pre-harvest and field level to post-harvest and storage. At the core of the solutions are, Spectral imaging and Artificial intelligence, as they can offer a non-destructive quality estimation of fruits and vegetables, eliminating food loss due to random sampling while at the same time allowing for personalized treatments per fruit and vegetable, optimizing the use of resources and product handling.

Spectral imaging chamber, Manuela Zude-Sasse

To showcase the performance, real-life usability, and benefits of proposed solutions, SPECTROFOOD has set up four use cases across Europe, each focusing on a different crop in terms of cultivation, texture, geometry, and quality characteristics. Namely, Apples in Germany, Broccoli in Greece, Leek in Belgium, and Mushrooms in Ireland. For each use case, various AI algorithms have been tested. Examples are CNN, PLS, and PCA.

Drone flying over experimental leek field, Jonathan Van Beek

For leek, research has been focusing on post-harvest and the prediction of general preservability, quality, and weight, with excellent results for predicting dry matter ($R2>0.9$). For broccoli, both pre and post-harvest have been under examination. Starting from the pre-harvest, the focus has been on determining fertilization and irrigation levels to optimize resource use. While for the post-harvest, the focus has been on determining the "crunchiness," the Vitamin C, and moisture content, with the results for moisture being promising ($R2>0.8$). For apples, the focus has been on the design of a novel imaging chamber suited to the needs of the specific crop in order to allow detailed wavelength correction and selection, as well as shape correction. Finally, the following actions have taken place for mushrooms: monitoring the browning effect on mushrooms during storage, with correct identification of >97%, and monitoring moisture content. However, as large amounts of data are needed and data collection is still in progress, results may improve.

Mushroom samples and HIS, setup, Dimitrios Argyropoulos

Summing up all the knowledge gained from conducting a thorough literature review[1] and from the experiments, we concluded that:

i. Data collection might be the most critical step as spectral data are limited and directly determine the robustness and performance of the models,
ii. All models should be tested and evaluated across various datasets, and
iii. The transfer of machine learning and deep learning techniques from other domains can increase performance and adoption of spectral technologies.

Experimental broccoli field, Ioannis Malounas

Relevant link(s)

1 Wieme, Jana, et al. "Application of hyperspectral imaging systems and artificial intelligence for quality assessment of fruit, vegetables and mushrooms: A review." Biosystems Engineering 222 (2022): 156-176.

Author(s) info

Malounas Ioannis (AUA), https://spectrofood.eu/