HYPERSPECTRAL WASTE MANAGEMENT:

Hyperspectral Imaging's Role in Sorting Compostable Plastics using HySpex Baldur cameras

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In an era marked by environmental concerns, the need to address waste management has become more pressing than ever. A critical aspect of this challenge lies in dealing with the variety of packaging materials that part of our daily lives. Compostable plastics, such as utensils, lids, and packaging, have gained importance in recent times due to their potential to alleviate the environmental burden of conventional plastics. The global market for compostable plastics is projected to expand significantly, indicating a growing commitment to sustainable alternatives. Yet, the benefits of these materials are realized only through proper industrial composting practices. Unfortunately, existing waste management systems often treat compostable plastics as contaminants in recycling streams, mitigating their potential positive impact.

The environmental repercussions of mishandling compostable packaging are significant. Without proper sorting, these materials can find themselves in landfills or incineration.

To combat this issue, researchers from the Plastic Waste Innovation Hub, the Department of Mechanical Engineering and the Department of Chemistry at the University College London, have focused on improving sorting technologies that can effectively distinguish compostable from conventional plastics, facilitating enhanced composting rates and compost quality.

Harnessing the innovative technique of hyperspectral imaging (HSI) [1], the researchers are unlocking new avenues for sustainable waste management. Recognised as one of the most suitable non-destructive techniques for identifying compostable packaging [2], HSI's capabilities align seamlessly with the needs of waste sorting systems. By combining imaging technology and spectroscopy, HSI presents a comprehensive solution for differentiating between compostable and conventional plastics.

Hyperspectral imaging utilizes the power of light to acquire information about the chemical and molecular properties of surfaces without physical contact. In this study, the spectral response of various plastic materials in the wavelength region between 950 and 1,730 nm was explored, collecting high-resolution, high-quality data with the HySpex Baldur S-640i N camera. This camera can capture detailed spectral information at a spectral resolution of 3.36nm across 232 wavelength bands, collecting data from a 1m distance with a spatial resolution of 0.44mm (pixel size). This technique provides insights into various compostable and conventional plastics, including polylactic acid polymers (PLA), polybutylene adipate terephthalate (PBAT), as well as materials derived from sugarcane and palm leaves.

The experimental process involved not only data collection (see Figure 1) but also sophisticated data analysis techniques. Preprocessing algorithms, such as mean centring (MC) and standard normal variate (SNV), were employed to mitigate external sources of variability and highlight spectral differences. Deploying Prediktera's Breeze software, Principal component analysis (PCA) and partial least square discriminant analysis (PLS-DA) were utilised for segmentation and classification modelling, allowing for accurate differentiation of materials.

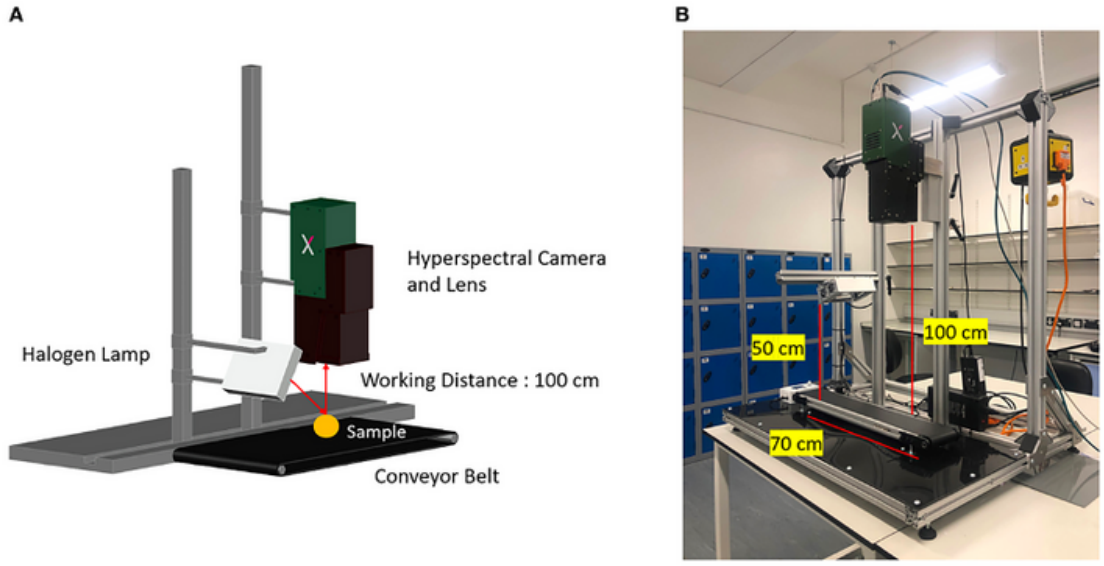

Figure 1: The hyperspectral camera system. (A) Components and (B) the hyperspectral system dimensions.

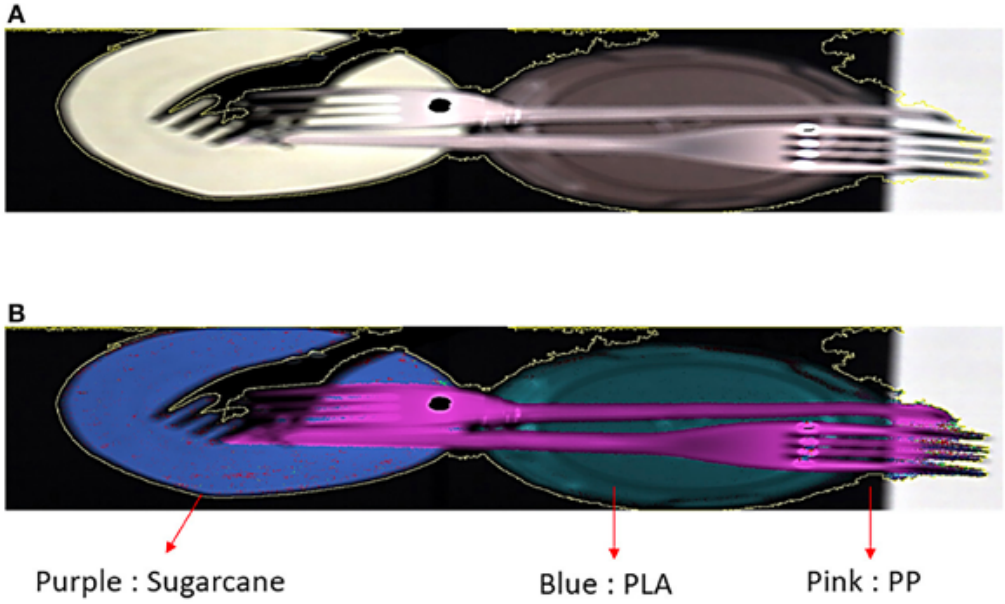

Figure 2: Hyperspectral modelling (PLS-DA) to detect compostable materials in commercially available consumer items (plastic plate, plastic lid and cutleries). (A) False-color image obtained by hyperspectral camera (HySpex Baldur S-640i N). (B) Classified image highlighting different plastic types.

In conclusion, hyperspectral imaging has emerged as a viable technology [DA1] in the quest for effective waste management solutions. By offering a means to accurately identify and sort compostable plastics, this technology paves the way for a more sustainable future. As the global compostable plastics market continues to grow, the integration of HSI could be the key to realizing the full potential of these environmentally friendly materials.

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[1] Taneepanichskul N, Hailes HC and Miodownik M (2023) Automatic identification and classification of compostable and biodegradable plastics using hyperspectral imaging. Front. Sustain. 4:1125954. doi: 10.3389/frsus.2023.1125954
[2] Taneepanichskul, N., Purkiss, D., and Miodownik, M. (2022). A review of sorting and separating technologies suitable for compostable and biodegradable plastic packaging. Front. Sustain. 3, 901885. doi: 10.3389/frsus.2022.901885
[3] Title image by FLY:D from Unsplash