An Automated Differentiation Method of Recyclable Textiles via Hyperspectral Imaging

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Textile waste is currently the second-largest global pollution source—as staggering amounts of waste are incinerated and buried in landfills, the process of decomposition leaches toxic chemicals into the environment, generating greenhouse gases linked to climate change issues. The root cause of low textile recycling rates is the current inefficient recycling process, as sorting is performed manually and does not reach sufficient speed or endurance levels. To increase textile recycling rates, the researcher proposed an automated differentiation system by integrating hyperspectral imaging (HSI), an analytical technique that captures spectral information based on materials' chemical compositions. In this work, the classification objective focused on the differentiation between fiber content and fabric composition. Captured images were stacked into a 3D hypercube representation from data in the 400-1000 nanometer range in 61 bands. Endmembers, or spectrally unique signals, were plotted to evaluate the distribution of sample spectra; the mean and standard deviations of wavelengths reaching the benchmark 120 reflectivity value were then calculated. Following experimentation, 100% dyed and printed cotton samples produced consistent spectra, and denser fiber types displayed lower variability as opposed to a looser weave. For fiber content, cotton was demonstrated to reach the reflective value at a shorter wavelength (627 ± 0.6 nm, $n=40{,}000$) as compared to polyester (686 ± 1.2 nm, $n=40{,}000$); with a p-value <0.001, the differences in the values were statistically significant. The marked differentiation between textile types and compositions are indicative of promising insights into the potential application of automated textile recycling.

Awards Won:

ASU Rob and Melani Walton Sustainability Solutions Service: Award of $1,000