DIY HYPERSPECTRAL IMAGING VIA POLARIZATION-INDUCED SPECTRAL FILTERS

ICCP 2021

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MOTIVATION

Hyperspectral cameras are typically only accessible to research or industrial institutions due to their prohibitive cost. We propose a **do-it-yourself hyperspectral imaging system via tunable spectral filters** attached to an ordinary digital camera.

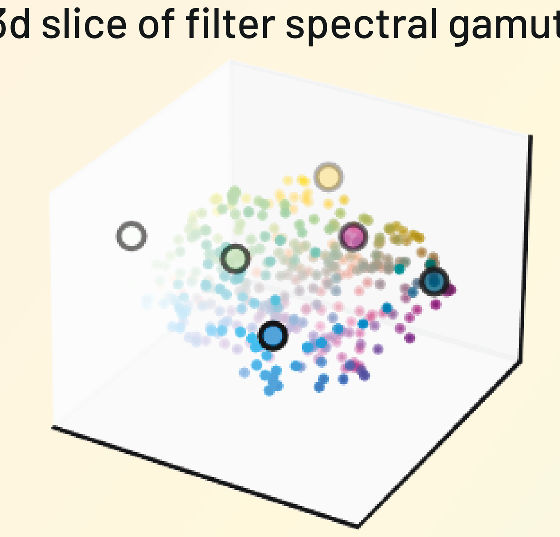
SOLUTION

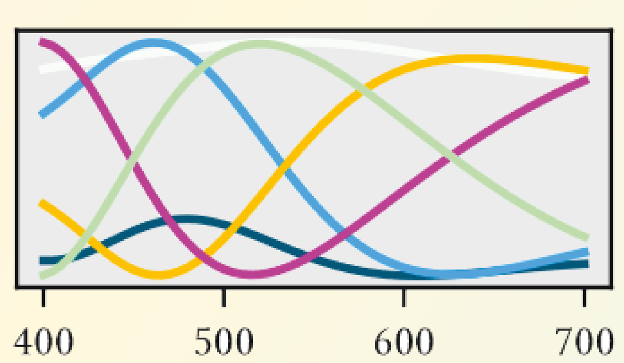
We use **linear reconstruction** to recover reflectance (or transmittance) spectra represented by **low-dimensional basis functions**. This is consistent with prior work in DIY hyperspectral imaging [1-5].

We measure the scene of interest with multiple spectral filters composed of **polarizers and waveplates** (see diagram at top right).

These filters have a **continous spectral gamut** of transmission spectra (some examples at right) that can be **calculated analytically** using Mueller calculus.

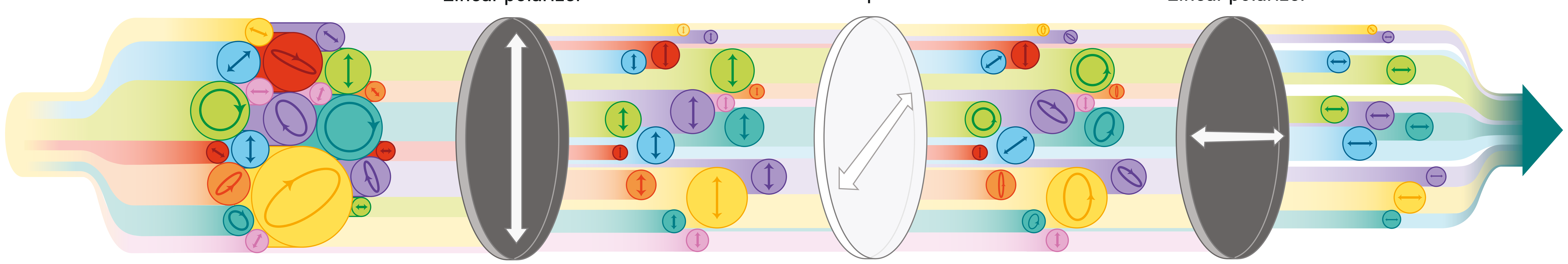
3d slice of filter spectral gamut



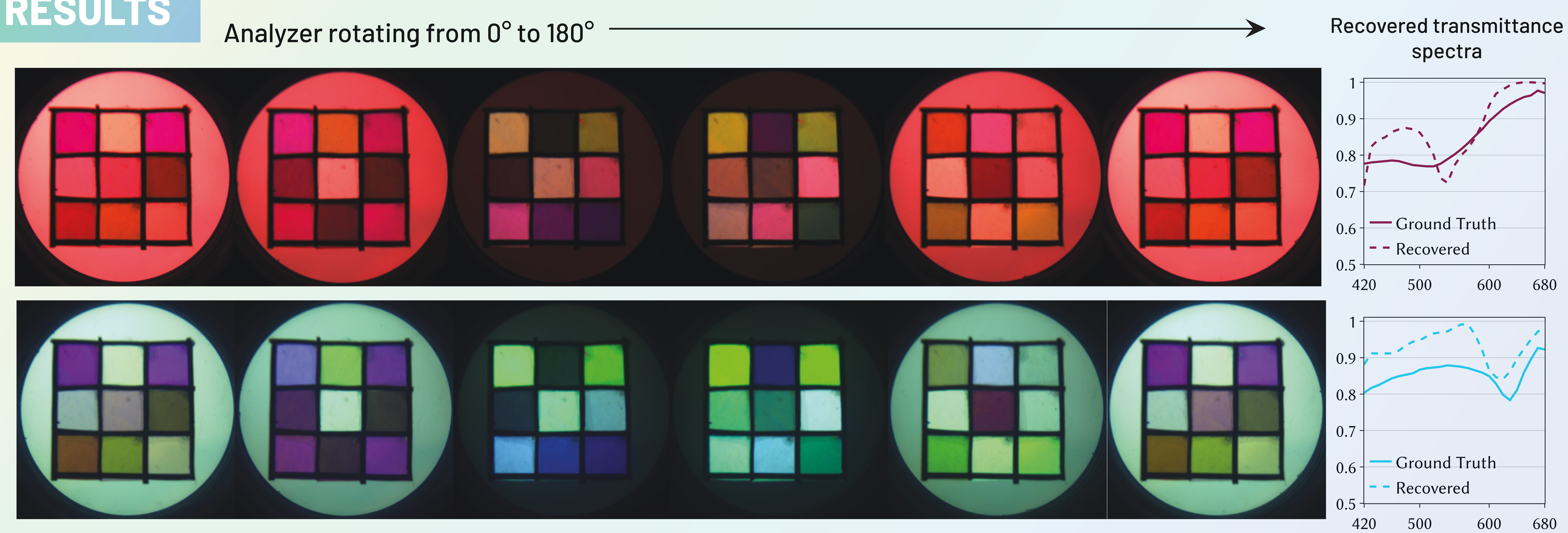


While this design is applicable at any price range, we take advantage of the **cheap polarizing filters** available for casual photography. We use **clear packing tape** as a waveplate.

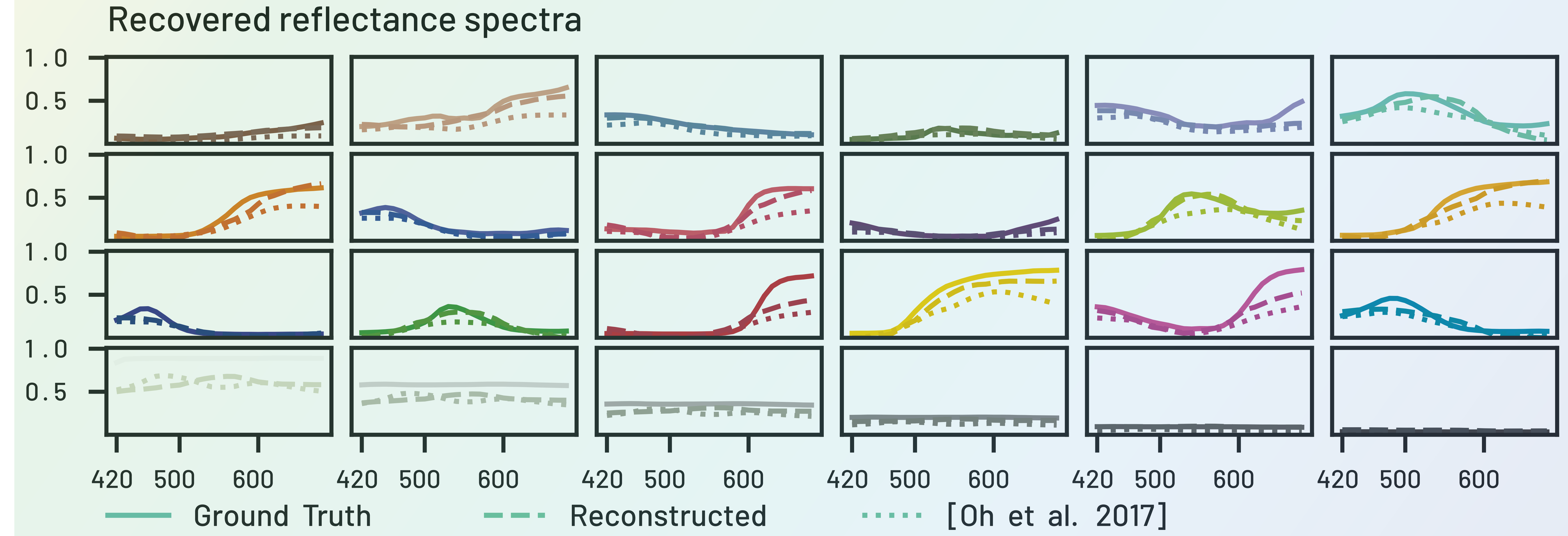
HOW OUR SPECTRAL FILTERS WORK



RESULTS

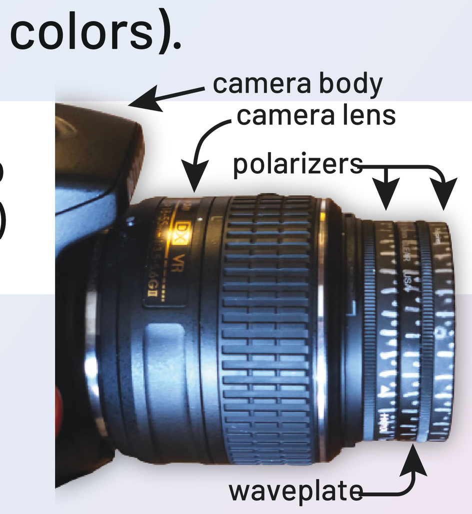


We recover the transmittance spectra of red wine (top) and blue Gatorade (bottom) by spatially multiplexing our filters into a 3x3 grid. Rotating one of the polarizers continuously produces a kaleidoscope of useful spectral measurements (and pretty colors).



We validate our method on a ColorChecker using ten measurements with different filters and achieve slight improvement over prior work.

Physical capture setup (reflectance)



FUTURE WORK

- Smart choice of filters from continuous, high-dimensional space
- Disentangle scattering from absorption in liquids
- More advanced hardware prototypes utilizing higher-quality waveplates, liquid crystals, or computer-controlled rotation

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