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Title: Hyperspectral imaging with a liquid-crystal polarization interferometer

Abstract: A novel hyperspectral imaging system has been developed that takes advantage of the tunable path delay between orthogonal polarization states of a liquid-crystal variable retarder. The liquid-crystal is placed in the optical path of an imaging system and the path delay between the polarization states is varied, causing an interferogram to be generated simultaneously at each pixel. A dataset consisting of a series of images is recorded while varying the path delay; Fourier transforming the dataset with respect to the path delay yields the hyperspectral data-cube. The concept is demonstrated with a prototype imager consisting of a liquid-crystal variable retarder integrated into a commercial 640x480 pixel CMOS camera. The prototype can acquire a full hyperspectral data-cube in 0.4 s, and is sensitive to light over a 400 nm to 1100 nm range with a dispersion-dependent spectral resolution of 450 cm^{-1} to 660 cm^{-1}. Similar to Fourier transform spectroscopy, the imager is spatially and spectrally multiplexed and therefore achieves high optical throughput. Additionally, the common-path nature of the polarization interferometer yields a vibration-insensitive device. Our concept allows for the spectral resolution, imaging speed, and spatial resolution to be traded off in software to optimally address a given application. The simplicity, compactness, potential low-cost, and software adaptability of the device may enable a disruptive class of hyperspectral imaging systems with a broad range of applications.

Bio: Dr. Alex Hegyi is a Member of Research Staff in the Electronic Materials and Devices Laboratory at the Palo Alto Research Center (formerly known as Xerox PARC). He currently works on inventing and developing novel optical detection systems ranging from hyperspectral imagers to fiber optic sensor readouts and flow cytometers.
Dr. Hegyi received his BS in Physics with Honors and Distinction from Stanford University in 2008, and his PhD in Electrical Engineering from UC Berkeley in 2013. His thesis work was performed under the guidance of Prof. Eli Yablonovitch and culminated in the first known demonstration of imaging by optical detection of magnetic resonance through scattering tissue. Dr. Hegyi was a Hertz Foundation Fellow, and his thesis was awarded the Hertz Thesis Prize.