

VOYAGE 81

Opportunities in wafer-level optics: the benefits of wide-band color filter arrays

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Company









Tel-Aviv

30% PhDs

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Hyperspectral Imaging



Spectral Resolution



Offering Overview

Material Sensing



Low-Light Imaging





Material Sensing With Existing Cameras

Our **patented** technology **recovers hyperspectral information** from **existing cameras** providing a unique and **low cost** solution for **material sensing**.





Automotive Perception Challenges for Driver Assistance / Autonomy

Shape and color don't tell the whole story

Water or Oil?



Tire on Asphalt



Black Ice



Human or Photo?



Potholes









Shade detection/correction







Other materials Examples: Road types, Block, Wood..







How does it work?







"SIR" – Spectral Information Recovery

A propriety technology* leverages prior knowledge to recover higher order spectral data

Grayscale Image



*[Arad and Ben-Shahar, ECCV 2016]



Low Light Color Filter Array



The RGB Photon "Tax"



Average Transmittance – average amount of photons which successfully pass through color filters relative to those who could be detected by the underlying CMOS sensor:

~33%

Minimum Transmittance – Transmittance of the "darkest" channel. A major limiting factor in low-light imaging:



*66% of light lost in each pixel *Only 3 colors sampled



"Tax Evasion" Attempts

	RGB	RCCB	RGBW	RYYB
Avg. transmittance (relative to RGB)	100%	160%	150%	138%
Min. transmittance (relative to RGB mean)	79 %	79 %	79 %	79 %
Exposure imbalance (relative to RGB)	x1	x2	x2	x1.2
Misc.				



RYYB – Case Study



RYYB Filter (estimated)

Channel Exposure Imbalance

Non-uniform exposure across Y and B/R pixels reduces color quality under medium or high illumination conditions.



RYYB – Case Study



RYYB Filter (estimated)

Lower limit unchanged

Red/Blue channel noise threshold remains similar to RGB, reducing color accuracy in low-light scenes.



Overview

Comparison to other CFAs over real-world test scenes:

	RGB	RCCB	RGBW	RYYB	VOYAGE 81
Avg. transmittance (relative to RGB)	100%	160%	150%	138%	204%
Min. transmittance (relative to RGB mean)	79%	79%	79%	79%	158%
Exposure imbalance (relative to RGB)	x1	x2	x2	x1.2	x1
Misc.					provides hyperspectral data



With **minor customizations** in hardware, significant **gains (>%200)** can be made **in low-light performance** of existing sensor platforms – **no retooling necessary**.





Low Light: Hardware Prototype





Sunlight





Frame Rate (CPU): 7.0FPS Display: 3.1FPS

Exposure: 20ms

Stop

Illumination Improvement: 214.4%



Statistics: Processing: 142.8ms Transfer: 7.0ms Grab: 55.4ms

Pause/Resume

Zoom to ROI





Low Power LED





Frame Rate (CPU): 4.7FPS Display: 1.5FPS

Exposure: 250ms

Illumination Improvement: 198.1%



Statistics: Processing: 212.1ms Transfer: 12.5ms Grab: 285.3ms

Stop

Pause/Resume Zoom to ROI



Under 1 Lux





Under 1 Lux



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Wide Band Filters

Properties:

- High Transmittance
- Wide Band
- Applicable to Small Pixel Size
- Low-Cost

Manufacturing:

- Pigment Based
- Dielectric
- Others...





Additional Opportunities

Agriculture



Medical



Food Safety



Geology



Defense



Research



Consumer



Automotive









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Spectral Reconstruction Challenge

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