Docket #: S23-004

Spectral routers for snapshot multispectral imaging

Stanford researchers working as part of the E. L. Ginzton Laboratory, an interdisclplinary research lab for applied physics, have developed a new device, called a spectral router, which can separate light into spectral components without loss of photons in a (sub)wavelength size footprint. This spectral router enables single-chip snapshot spectral imaging sensors and systems that are highly (up to ~100%) photon efficient to provide spectral information without sacrificing spatial information. A spectral router in a single-chip snapshot imaging system with N spectral channels can improve photon efficiency N-fold, in a much smaller footprint, compared to a conventional multispectral filter array. While spectral routers benefit all spectral imaging applications, this extremely compact and photon efficient solution can also further increase multispectral imaging use cases by enabling photon-efficient, high-spatial resolution systems on highly portable platforms (e.g., smart phones, tablets).

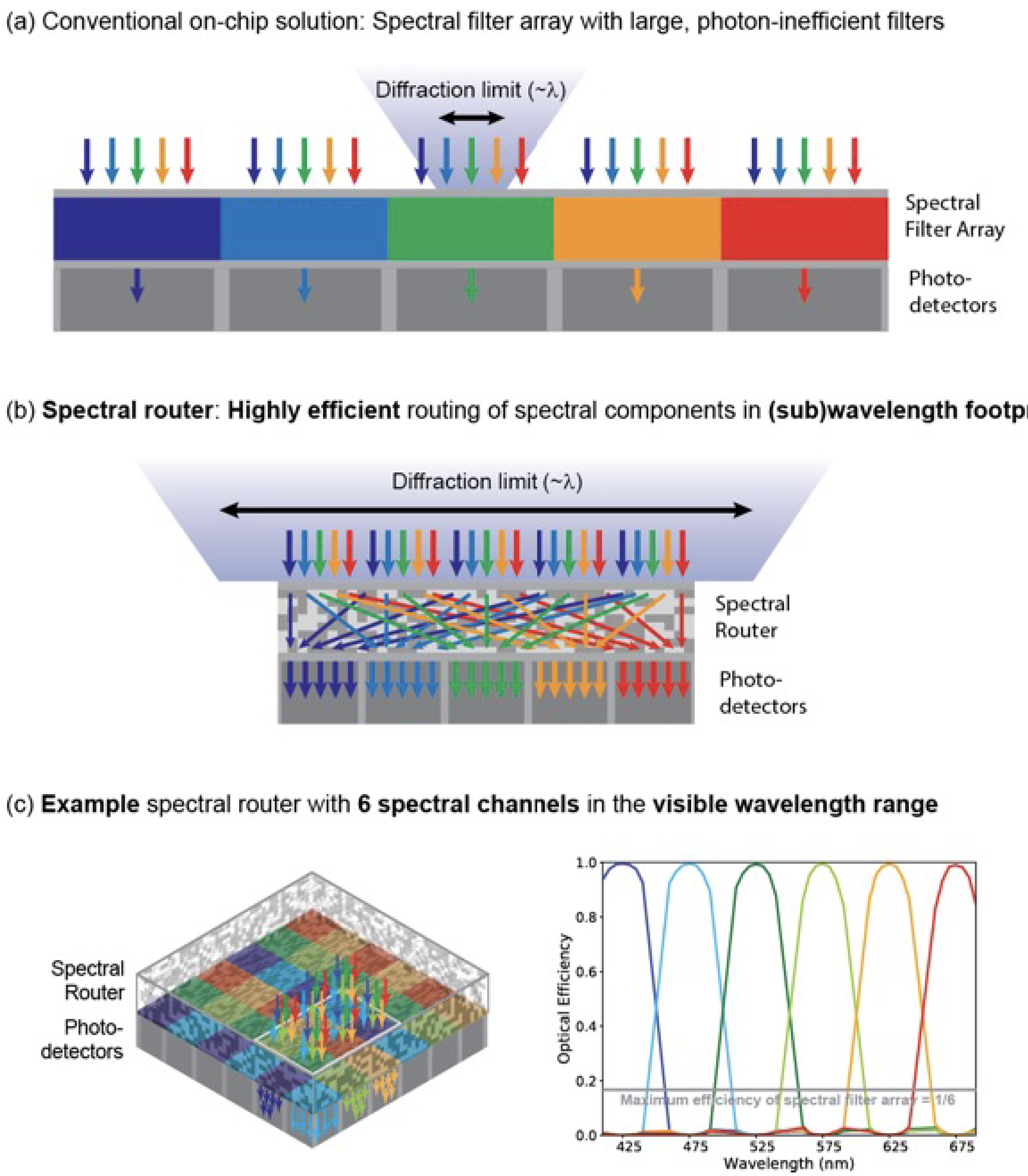

Figure Description:(a) Conventional on-chip solution for single-chip spectral imaging systems based on spectral filter array with photon-inefficient spectral filters which are larger than the wavelength and thus limit the spatial resolution of the captured image, (b) Spectral router providing highly efficient routing of spectral components in a (sub)wavelength footprint without sacrificing spatial resolution in the image, (c) Example spectral router with 6 spectral channels, in a 2 by 3 channel layout, in the visible wavelength range. The optical efficiency of the router can be ideal (~100%) for the 6 channels with negligible (~0%) crosstalk between channels. For comparison, the gray line in the graph shows the maximum theoretical efficiency (=1/6) of a spectral filter array.

Stage of Development

- Proof-of-concept
- Prototyping

Applications

- **Spectral imaging and imaging spectroscopy applications including but not limited to:** Bio-medical imaging, microscopy, precision agriculture, food inspection, machine vision, forensics and counterfeit detection
- **Single-chip spectral imaging systems** based on solid state image sensors and (infrared) focal plane arrays, CMOS image sensors, CCD image sensors that can be used in smartphone cameras, security cameras, and automotive cameras

Advantages

- High (~100%) photon efficiency across spectral channels
- Negligible (~0%) crosstalk between spectral channels
- Extremely compact (sub)wavelength size to allow spectral imaging without sacrificing spatial resolution at the image plane
- Flexible design (spectral shapes, number of channels, channel separations, …)
- Can operate in many spectral ranges (visible, infrared, …)
- Standard semiconductor nanolithography processing, including CMOS Image Sensor (CIS) processing

Publications

- Spectral router for the short-wave infrared wavelength range:
- Catrysse, Peter B., and Shanhui Fan. "Multispectral Routers for Snapshot Spectral Imaging." In CLEO: Applications and Technology, pp. ATu3K-5. Optica Publishing Group, 2023.
- Spectral router for the visible wavelength range:
- Catrysse, Peter B., and Shanhui Fan. "Spectral Routers for Snapshot Imaging." In Imaging Systems and Applications, pp. IM4E.3. Optica Publishing Group, 2023.

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