Docket #: S19-424

Wide-field Resonant Electro-optic Imaging Devices and Applications

The Kasevich lab has expanded on an earlier invention (Stanford Docket 18-388: " Efficient wide-field nanosecond imaging methods using Pockels cells for low-light applications") that achieves efficient ultrafast temporal imaging on standard camera sensors. Current fast camera sensors have significant drawbacks and achieve nanosecond resolution only by sacrificing performance and sensitivity. Low-cost nanosecond camera sensors with favorable performance and form-factor are more desirable, especially for applications in LIDAR and fluorescence lifetime imaging.

The Kasevich lab has developed resonant electro-optic imaging techniques and optimized the design of electro-optic crystals to allow compact, low-cost, and wide angular field-of-view imaging. Embodiments include multi-layer structures of low-cost electro-optic crystals and polarization optics, configurations to reduce switching voltage, and integrated systems for wide-field imaging.

This technology is an advantageous approach to Pockels cell LIDAR beyond conventional "flash" imaging mode – combining high distance resolution with large depth of fields, which is not possible with traditional Pockels cell approaches. It is also compatible with mode-locked laser sources and megahertz repetition rates, and facilitates compact and low-cost nanosecond imaging and LIDAR on standard CMOS sensors.

Stage of Development - Prototype

Applications

- LIDAR with enhanced resolution at large depth of field
- Wide field ultrafast imaging

- LIDAR and time-of-flight imaging for remote sensing, mapping, autonomous cars
- 3D cameras, 3D scanners, and foreground object detection
- Fluorescence lifetime imaging microscopy (FLIM)
    - FLIM + wide-field microscopy techniques
    - Single-molecule imaging and super-resolution microscopy
    - Light sheet microscopy
    - Medical diagnostics and endoscopic imaging
- High speed optical switching

Advantages

- Compatible with standard CMOS cameras
- Reduced switching voltage and power requirements
- High photon efficiency
- Compact and inexpensive construction
- Industrially scalable
- Avoids dead-time and throughput limitations of single-photon counting detectors

Publications

- Bowman, A. J., Huang, C., Schnitzer, M. J., & Kasevich, M. A. (2023). Wide-field fluorescence lifetime imaging of neuron spiking and subthreshold activity in vivo. *Science, 380*(6651), 1270-1275.
- Bowman, A., & Kasevich, M. A. (2021). *U.S. Patent Application No. 17/153,438*.
- Bowman, A. J., & Kasevich, M. A. (2021). Resonant electro-optic imaging for microscopy at nanosecond resolution. *ACS nano, 15*(10), 16043-16054.
- Bowman, A. J., Klopfer, B. B., Juffmann, T., & Kasevich, M. A. (2019). Electro-optic imaging enables efficient wide-field fluorescence lifetime microscopy. *Nature communications, 10*(1), 4561.

Patents

- Published Application: 20210223399

- Issued: 11,828,851 (USA)

Innovators

- Adam Bowman
- Mark Kasevich

Licensing Contact

David Mallin

Licensing Manager, Physical Sciences

Email