**Lensfree Wide-Field Fluorescent Imaging On A Chip Using Compressive Decoding**

Tech ID: 27530 / UC Case 2010-595-0

**SUMMARY**

UCLA researchers have developed a compressive sampling algorithm for on-chip fluorescent imaging over an ultra-large field-of-view without the need for any lenses or mechanical scanning.

**BACKGROUND**

Fluorescent imaging has become quite powerful, with various applications in biomedical sciences, ranging from high-throughput screening to sorting and characterization of cells. Rare cell analysis is a big challenge in the fluorescent imaging field. The concentration of the target cell (e.g., a circulating tumor cell) is extremely low with a density of less than a few hundred per mL. One solution to this challenging task involves the use of large-area micro-fluidic devices (e.g., with an active area of $>9 \text{ cm}^2$) to enable screening of a large volume of sample (e.g., whole blood) to capture adequate number of target cells within the device volume. However, imaging field-of-view (FOV) for conventional objective-lens based fluorescent microscopes is typically $<2-3 \text{ mm}^2$. This mismatch between the active-area of the microfluidic device and the FOV of the microscope-objective necessitates the capture of multiple images while scanning the sample. Compressive sampling aims to recover a function (i.e., a signal) from many fewer measurements/samples than normally required according to Shannon’s sampling theorem. This emerging theory has been recently applied to various fields to bring new insights to measurement and imaging science.

**INNOVATION**

UCLA inventors have developed a compressive sampling algorithm for on-chip fluorescent imaging over an ultra-large field-of-view without the need for any lenses or mechanical scanning. The fluorescent samples placed on a chip are excited through a prism interface, where the pump light is filtered out by total internal reflection after exciting the entire sample volume. The emitted fluorescent light from the specimen is collected through an on-chip fiber-optic faceplate and is delivered to a wide field-of-view optoelectronic sensor array for lensless recording of the fluorescent spots corresponding to the samples. A compressive sampling based optimization algorithm is then used to rapidly reconstruct the sparse distribution of fluorescent sources to achieve $\sim10 \mu m$ spatial resolution over the entire active region of the sensor-array, i.e., over an imaging field-of-view of $>8 \text{ cm}^2$.

**APPLICATIONS**

- This on-chip fluorescent imaging platform would especially be valuable for high-throughput imaging of cells within micro-fluidic chips. Specifically, it would be quite important for cytometry applications including rare-cell analysis in large area microfluidic devices.
- This invention also permits simultaneous imaging of vertically stacked micro-channels on the same chip, which is another step forward towards increasing the fluorescent imaging throughput. This invention could also potentially impact micro-array imaging technologies by providing lensless quantification of hundreds of thousands of micro-spots, all in parallel, within a compact chip.
- The compressive fluorescence decoding approach used in this invention may also be extended to lens-based fluorescent microscopy, and in particular to recent fluorescent super-resolution approaches including PALM and STORM to potentially reduce the number of frames that is required for 2D or 3D fluorescent imaging.

**ADVANTAGES**

- This invention achieves a spatial resolution of $\sim10 \mu m$ without the use of any lenses over an ultra-large field of view of $>8 \text{ cm}^2$ based on the compressive sampling theory.
- Compared to the earlier lensfree fluorescent imaging report, this invention allows an improvement of $\sim5$ fold in spatial resolution without a trade-off in FOV, resulting from the use of the fiber-optic faceplate and the compressive sampling based numerical processing.
- With this new on-chip platform, lensfree fluorescent imaging of vertically stacked micro-channels, all in parallel, further increasing the throughput of fluorescent on-chip imaging.

**RELATED MATERIALS**


**PATENT STATUS**

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<td>United States Of America</td>
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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Automated Semen Analysis Using Holographic Imaging
- Extended Depth-Of-Field In Holographic Image Reconstruction Using Deep Learning-Based Auto-Focusing And Phase-Recovery
- Computational Image Analysis of Guided Acoustic Waves Enables Rheological Assessment of Sub-Nanoliter Volumes
- Detection and Spatial Mapping of Mercury Contamination in Water Samples Using a Smart-Phone
- Computational Cytometer Based On Magnetically-Modulated Coherent Imaging And Deep Learning
- Quantum Dot Enabled Detection Of Escherichia Coli Using A Cell-Phone
- Lensfree Tomographic Imaging
- Single Molecule Imaging and Sizing of DNA on a Cell Phone
- Microscopic Color Imaging And Calibration
- Quantification Of Plant Chlorophyll Content Using Google Glass
- Mobile Phone Based Fluorescence Multi-Well Plate Reader
- Rapid, Portable And Cost-Effective Yeast Cell Viability And Concentration Analysis Using Lensfree On-Chip Microscopy And Machine Learning
- Holographic Opto-Fluidic Microscopy
- Design Of Task-Specific Optical Systems Using Broadband Diffractive Neural Networks
- Ultra-Large Field-of-View Fluorescent Imaging Using a Flatbed Scanner
- Wide-Field Imaging Of Birefringent Crystals In Synovial Fluid Using Lens-Free Polarized Microscopy For Crystal Arthropathy Diagnosis
- Revolutionizing Micro-Array Technologies: A Microscopy Method and System Incorporating Nanofeatures
- Tunable Vapor-Condensed Nano-Lenses