High-resolution microscopy without a lens

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(Phys.org)—Over the past several years, major advances have been made at UCLA in the field of lens-less computational imaging technology, particularly in the design of lens-free holographic microscopes, which, because of their small size, power and flexibility, hold a number of advantages over conventional optical microscopes. In new research, UCLA's Aydogan Ozcan and his colleagues present emerging results for this high-resolution, wide-field on-chip microscopy and describe the challenges the technology faces going forward, shedding light on future directions and applications.

The researchers demonstrate the highest resolution optical images generated to date using a lens-free on-chip microscope, achieving a numerical aperture of ~0.9 across a very large field-of-view of more than 20 square millimeters. One of the great advantages of lens-free computational on-chip imaging, the researchers say, is that the degree of resolution will continue to improve rapidly as new digital sensor arrays—such as CMOS and CCD imagers—become available. These sensor advances are driven mostly by cell phone and digital camera manufacturers, who produce more than 1 billion new camera modules every year, and lens-free on-chip microscopy is on track to benefit from this trend.

Lens-free computational imaging tools have become more powerful in their ability to create wide-field microscopic images of transparent specimens on a chip and can currently achieve around 1 billion to 2 billion useful pixels in each image. In addition, the researchers point out, the current trend in the image-sensor industry toward smaller pixel size

and larger megapixel imager chips will continue to improve the resolution and field-of-view of lens-free computational microscopes, further enhancing a unique on-chip microscopy platform in which resolution and object field-of-view are not necessarily tied to each other.

The research represents a collaboration among the departments of electrical engineering and bioengineering at UCLA's Henry Samueli School of Engineering and Applied Science; the California NanoSystems Institute at UCLA, the department of surgery at the David Geffen School of Medicine at UCLA; and the department of physics and engineering at China's Nanjing University of Science and Technology.

Ozcan's UCLA research group has developed a number of lens-less computational imaging technologies for use in a variey of applications, particularly in the field of telemedicine, where the technologies have the potential to bring better health care and screening to underserved areas of the globe. "We believe that they will continue to find broader applications and use in physical and biomedical sciences, especially for high-throughput imaging needs," Ozcan said.

The research was published Aug. 30 in the journal Nature Methods.

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