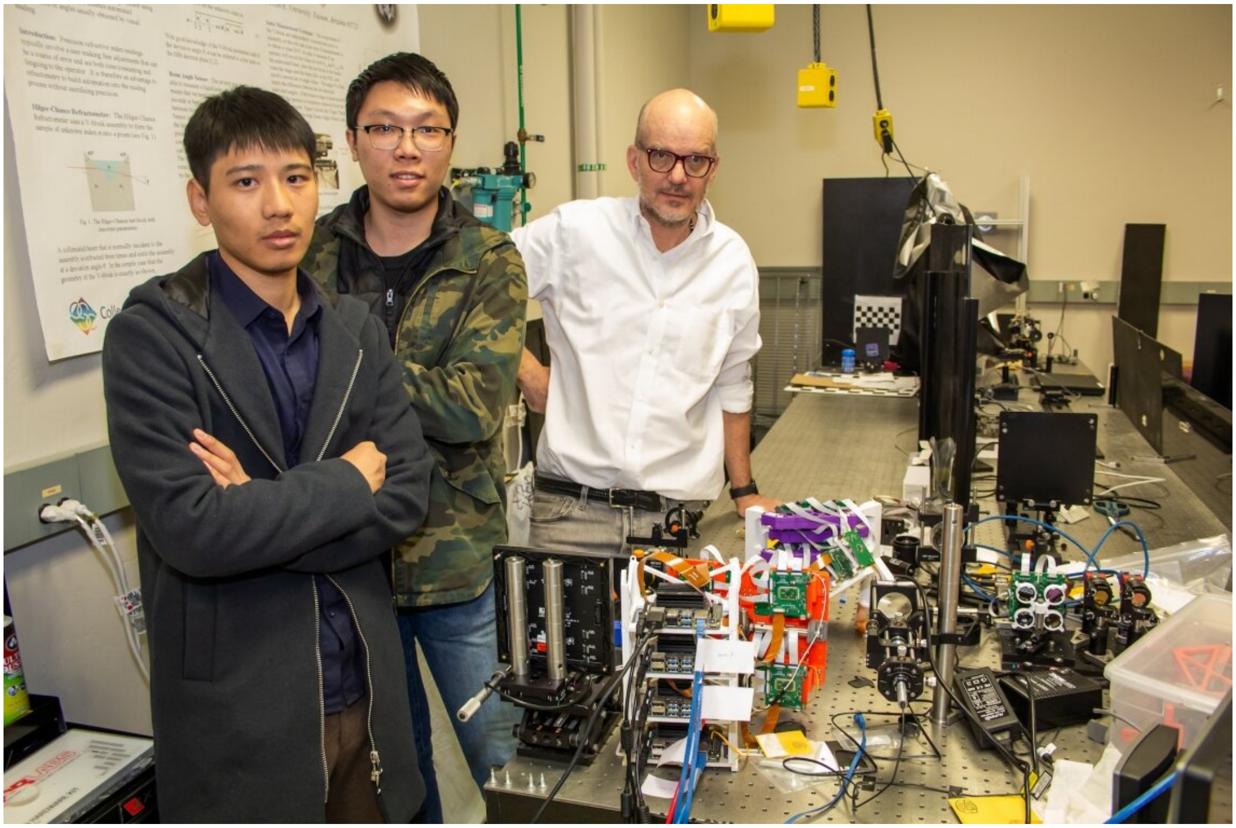
Sparse holography: A novel method for creating 3D images

May 26 2023, by Niranjana Rajalakshmi



David Brady (far right) in his lab with doctoral students Zhipeng Dong (far left) and Xiao Wang. Credit: Amee Hennig

Computational imaging has seen tremendous progress in the last decade. The process involves using a combination of advanced algorithms and hardware to create images that cannot otherwise be captured by traditional cameras.

Using computational imaging tools, David Brady, a professor of optical sciences at the University of Arizona, has developed a novel technique called sparse holography that creates three-dimensional images from two-dimensional holograms.

"Normally, when you look at a hologram, you can see the object as though it was there," Brady said. "But you can't really reconstruct it like it was a real three-dimensional object."

Brady developed the set of algorithms and strategies for measuring a two-dimensional hologram and used those measurements to estimate three-dimensional objects. The resulting image is not a photograph; rather, it is a three-dimensional representation of the scene. A person can view the 3D representation using interactive software or by 3D-printing a model, Brady said.

"The problem in imaging is that photographs and imaging systems only form two-dimensional images, but the world is really three-dimensional," said Brady, whose sparse holography work earned him the 2023 Emmett N. Leith Medal from Optica, an international organization dedicated to optics and photonics.

Brady said his research interests have always revolved around optical imaging, and sparse holography became a natural extension over the years. Sparse holography is part of a broader project on efficient 3D imaging systems that Brady and his research group have been pursuing for 20 years.

"The core research interest for my group is how to push optical measurements to the physical limits of what's possible," Brady said.

In 2012, Brady and his team developed the world's first gigapixel camera by integrating 98 micro-cameras in a single device. The images taken with the camera showed unprecedented detail.

Brady's sparse holography technique can be used in situations where 3D images are needed, including instances in which there are moving objects that need to be made three-dimensional.

Normally, it is not possible to create 3D images of moving objects, such as living tissue or organisms viewed through a microscope, Brady said. Sparse holography makes it a possibility.

"We can form three-dimensional images of a swimming fish or moving things," he said.

Sparse holography can also be used to measure 3D scenes for self-driving cars or video games, he said.

Brady's group has put sparse holography to use in real-world scenarios such as X-ray systems and many types of cameras.

As sophisticated as they may sound, computational imaging tools are becoming more user-friendly and getting better all the time, Brady said.

"We can capture very high-frame-rate images, very high-resolution images, and use these computational imaging tools to push the limits of resolution in space, time and dimensionality," he said.

Brady was awarded the Emmett N. Leith Medal for his work in March. The medal was established in 2006 in honor of Emmett N. Leith, a world-renowned scientist in holography and optical information processing, to recognize seminal contributions to the field.

In the future, Brady's research group is planning to develop "super cameras," out of arrays of micro cameras, that would be akin to supercomputers that are constructed from smaller computers. Brady's team is using holographic measurements on an array of cameras to increase the size of the aperture, which is the opening through which light can enter the camera. Sparse holography enables cameras to resolve features smaller than a human hair from across an area as large as a football field, Brady said.

With recent advances in artificial intelligence-generated images and manipulated "deepfakes," everyone recognizes that we are in the midst of fundamental changes in the nature of imaging systems, Brady said.

"While artificial intelligence will change our interaction with data, the underlying story is the computational imaging is increasing our ability to see the world," he said.

Provided by University of Arizona

Citation: Sparse holography: A novel method for creating 3D images (2023, May 26) retrieved 13 May 2024 from https://phys.org/news/2023-05-sparse-holography-method-3d-images.html