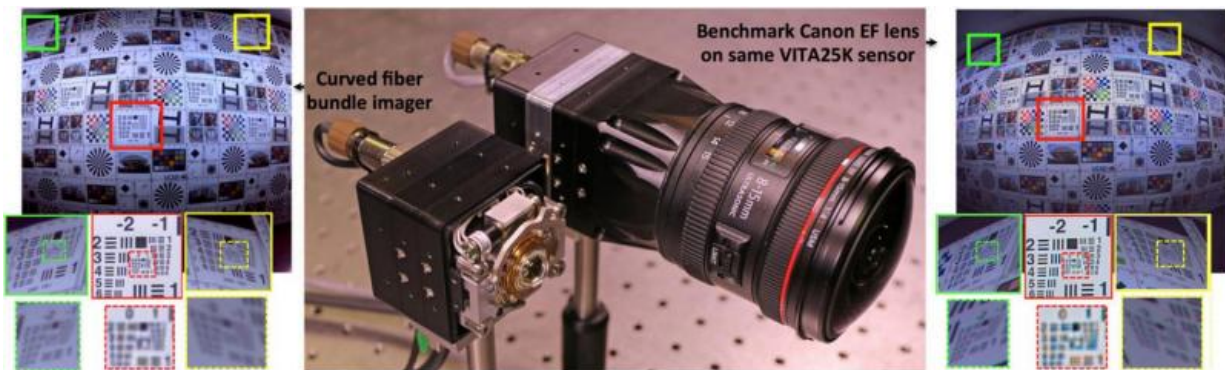


# Compact videocamera captures panoramic images in high resolution

December 19 2016



Center: Photograph of the 126° field curved fiber bundle imager integrated with a 25 megapixel sensor, next to a conventional lens on the same sensor. Example images obtained from both setups are shown (on the left and right). The smaller F/1.35 (i.e., curved fiber bundle) monocentric lens causes less image distortion and collects more light (left) than the F/4 conventional lens (right). Credit: UC San Diego Photonic Systems Integration Laboratory

By combining 3-D curved fiber bundles with spherical optics, photonics researchers at the University of California San Diego have developed a compact, 125 megapixel per frame, 360° video camera that is useful for immersive virtual reality content.

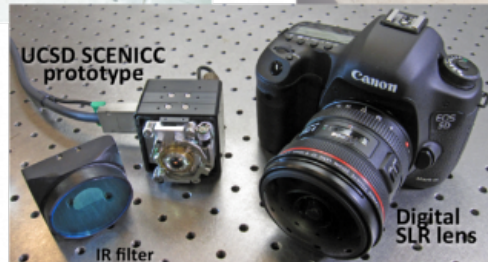
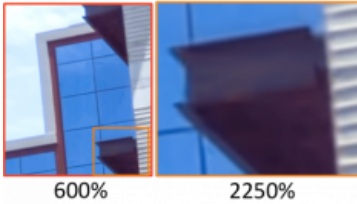
The work, led by electrical engineering professor Joseph Ford at the UC San Diego Jacobs School of Engineering, was presented at the SPIE

Defense + Commercial Sensing 2016 Conference.

The panoramic "photonic mast" (PMast) video imager can capture cinematographic-grade immersive video content without the obtrusive bulk of more conventional multicamera rigs. "The advantage of the research prototype is its small size compared to bulky conventional lenses required by DSLR and cinematic videocameras, and its high resolution and light collection relative to small systems like the GoPro camera arrays," Ford said.

Although compact 360° cameras can be made from an array of small-aperture smartphone imagers, their small (typically 1.1  $\mu\text{m}$ ) pixels provide low dynamic range. And while digital single-lens-reflex and cinematographic imagers have 4–8  $\mu\text{m}$  pixels, they require correspondingly longer focal length lenses, which are bulky and have low light collection (typically F/2.8 to F/4, where F is the focal length divided by the lens aperture).

**SCENICC monocentric lens & curved fiber bundle**  
External filter & full image processing chain, including (slow) BM3D denoising



**Benchmark Canon ES lens on 5D Mk III**  
Canon default processed image, cropped from 2/3 format to square

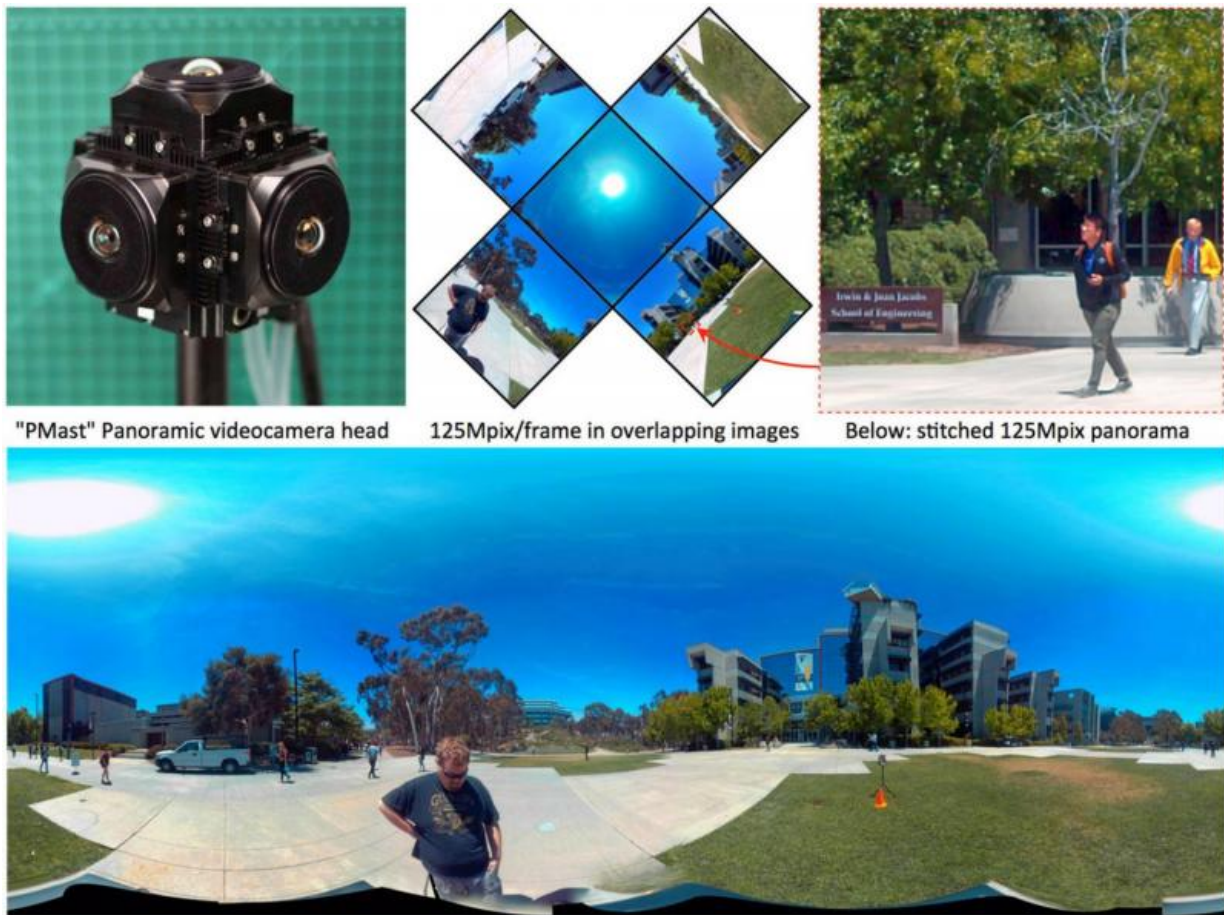


Credit: University of California - San Diego

The panoramic PMAst video imager has the large-pixel sensors and relatively long focal lengths needed for high dynamic range and resolution, Ford explained.

To develop their new system, researchers in Ford's Photonic Systems Integration Laboratory at UC San Diego used an approach to panoramic imaging called "monocentric optics", where all surfaces—including the image surface—are concentric hemispheres. The symmetry of these lenses means that lateral color and off-axis aberrations (astigmatism and coma) are eliminated. In addition, the simple lens structures can be used to correct for spherical and axial color aberrations to yield

extraordinarily wide angle resolution and light collection. The image that is produced can be coupled to a conventional focal plane, via a fiber bundle faceplate (with a curved input and flat output face). Fiber faceplates are solid glass elements made of small, high-index optical fibers separated by a thin, low-index cladding, used for nonimaging transfer of light between the input and output faces.



Photograph of the photonic mast (PMAst) head (top left). Five discrete 25 megapixel images from it are shown (top center), along with a zoomed-in portion of one pixel (top right) and the total stitched panorama (bottom). Credit: UC San Diego Photonic Systems Integration Laboratory



The PMast panoramic videocamera head consists of five identical 25 megapixel imagers, connected by a multimode fiber-optic ribbon cable to a rack of five servers to process and store the video stream (each with 1 TB of solid-state memory). The power (approximately 60 Watts) generated by the imagers when they are running at full resolution and 24 frames per second is dissipated by water cooling. The lenses for this imager are slightly modified (from previous lenses developed in Ford's lab) with a F/2.5 aperture; a fixed protective dome; and a removable IR/color/apodization filter.

Provided by University of California - San Diego

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