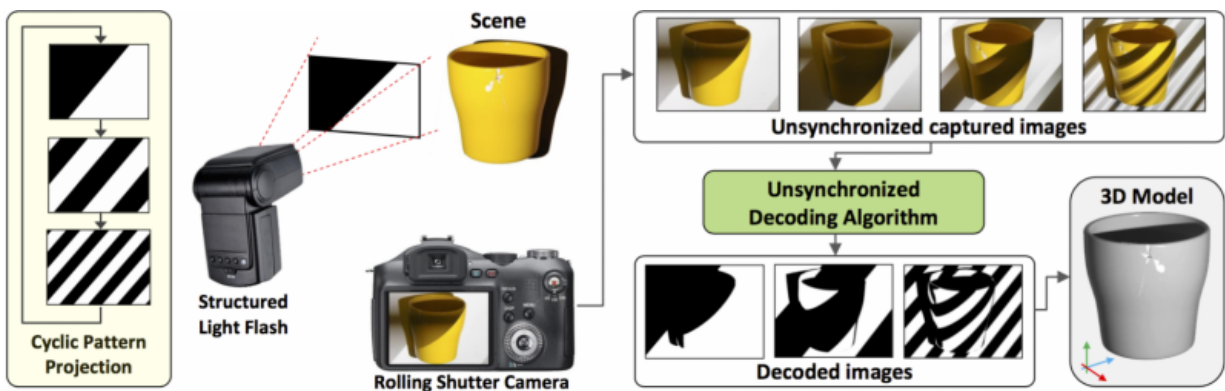


Algorithm helps turn smartphones into 3-D scanners

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Structured light 3-D scanning normally requires a projector and camera to be synchronized. A new technique eliminates the need for synchronization, which makes it possible to do structured light scanning with a smartphone. Credit: Taubin Lab / Brown University

While 3-D printers have become relatively cheap and available, 3-D scanners have lagged well behind. But now, an algorithm developed by Brown University researchers may help bring high-quality 3-D scanning capability to off-the-shelf digital cameras and smartphones.

"One of the things my lab has been focusing on is getting 3-D [image capture](#) from relatively low-cost components," said Gabriel Taubin, a professor in Brown's School of Engineering. "The 3-D scanners on the market today are either very expensive, or are unable to do high-

resolution image capture, so they can't be used for applications where details are important."

Most high-quality 3-D scanners capture [images](#) using a technique known as structured light. A projector casts a series of light patterns on an object, while a [camera](#) captures images of the object. The ways in which those patterns deform over and around an object can be used to render a 3-D image. But for the technique to work, the [pattern](#) projector and the camera have to be precisely synchronized, which requires specialized and expensive hardware.

The algorithm Taubin and his students have developed, however, enables the structured light technique to be done without synchronization between projector and camera, which means an off-the-shelf camera can be used with an untethered structured light flash. The camera just needs to have the ability to capture uncompressed images in burst mode (several successive frames per second), which many DSLR cameras and smartphones can do.

The researchers presented a paper describing the algorithm last month at the SIGGRAPH Asia computer graphics conference.

The problem in trying to capture 3-D images without synchronization is that the projector could switch from one pattern to the next while the image is in the process of being exposed. As a result, the captured images are mixtures of two or more patterns. A second problem is that most modern digital cameras use a rolling shutter mechanism. Rather than capturing the whole image in one snapshot, cameras scan the field either vertically or horizontally, sending the image to the camera's memory one pixel row at a time. As a result, parts of the image are captured at slightly different times, which also can lead to mixed patterns.

"That's the main problem we're dealing with," said Daniel Moreno, a graduate student who led the development of the algorithm. "We can't use an image that has a mixture of patterns. So with the algorithm, we can synthesize images—one for every pattern projected—as if we had a system in which the pattern and image capture were synchronized."

After the camera captures a burst of images, algorithm calibrates the timing of the image sequence using the binary information embedded in the projected pattern. Then it goes through the images, pixel by pixel, to assemble a new sequence of images that captures each pattern in its entirety. Once the complete pattern images are assembled, a standard structured light 3D reconstruction algorithm can be used to create a single 3-D image of the object or space.

In their SIGGRAPH paper, the researchers showed that the technique works just as well as synchronized structured light systems. During testing, the researchers used a fairly standard structured light projector, but team envisions working to develop a structured light flash that could eventually be used as an attachment to any camera, now that there's an [algorithm](#) that can properly assemble the images.

"We think this could be a significant step in making precise and accurate 3-D scanning cheaper and more accessible," Taubin said.

Provided by Brown University

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