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Transparent 0.3 mm film functions as 3D scanner by processing light and shadow

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Scientists at the Johannes Kepler University Linz (JKU) in Austria have developed a 0.3-millimeter-thin transparent plastic film that functions as a 3D scanner. The device could be used with devices like smartphones and tablets.

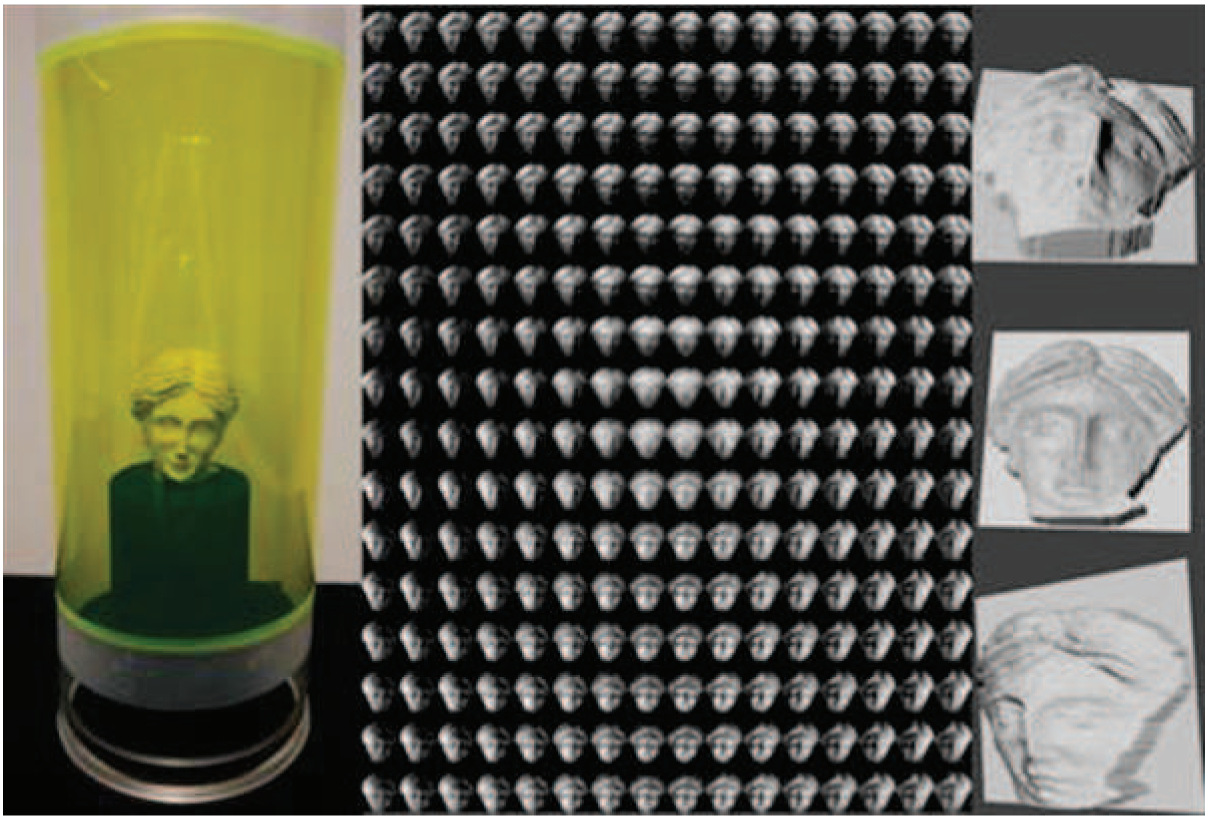
Johannes Kepler University, where the 3D scanning research took place

Earlier this week, scientists from Johannes Kepler University's computer graphics department presented a new kind of 3D scanning device that consists of a transparent plastic film just 0.3 millimeters thick. While most 3D scanning systems contain a large number of optical elements such as lenses and sensors, this new device is compact enough to be used with other equipment, potentially bringing the technology into the hands of new users. "It can take any shape and size," said Professor Oliver Bimber, director of the department. "This will make it easier to integrate into our daily lives."

Bimber notes that, at present, 3D scanning equipment "is not found in products such as tablet computers, mobile phones, and other interactive objects." This, however, could all change with the introduction of the slender transparent film developed at JKU. Since no optical elements like lenses are required for the 3D scanner to work, it could easily be integrated into even the most compact of mobile phones, laptops etc.

Unlike a typical 2D smartphone camera, which is able to detect the shape of an object in front of it, the new 3D scanning film is also able to detect the *distance* of the object. (We'll explain how in a minute.) So, by detecting how far certain aspects of the object are from itself, the scanner is able to gather enough data to form a 3D image.

The unusual 3D scanning film works thanks to a special fluorescent dye, which efficiently collects light from the object, and a tiny external picoprojector which projects random light patterns onto it. By seeing how this light reflects off the object, the scanner is able to determine its distance and surface specifics. "The advantage of this new technology is its ability to diffuse reflected light from the object onto the film in order to calculate its shape and distance," explains Bimber.



(l-r) The thin film surrounds an object; the object is subjected to 256 different lighting conditions; the result

In order to process the data available to them through the 3D scanner, Bimber and his team are using a relatively new sampling theory called Compressed Sensing, a signal processing technique used to acquire and reconstruct signals. In this case, 256 views of the object, which differ only in their shading, are obtained from the light measurement. From this information, the geometry of the object can be determined by means of a conventional reconstruction method: Photometric stereo.

Photometric stereo, sometimes known as "shape from shading," is a method of determining the 3D structure of an object using only 2D images, by assessing how that object appears under different lighting conditions.

In other words, by noting where shadows fall when a light source is moved around an object, it becomes increasingly clear how that object is shaped.

The researchers at JKU believe that this 3D scanning method will be adopted on a much larger scale as companies seek to incorporate 3D scanning technology into new devices. However, Bimber believes that the process will be a lot more effective after a few stages of refinement: "In the future, the random noise patterns that are necessary for scanning will no longer generated by an external picoprojector, but rather by a coded diaphragm directly within a second film layer," the professor said.

This futuristic 3D scanning device would take the form of a completely lensless, transparent, and flexible film camera, which could be just one millimeter thin.

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