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Researchers capture image on sheet of transparent plastic

The new imager, which resembles a flexible plastic film, uses fluorescent particles to capture incoming light and channel it to sensors

BY CANADIANMANUFACTURING.COM STAFF ON FEBRUARY 21, 2013 10:42AM

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The luminescent concentrator could be used to control computers and tablets by mere gestures. PHOTO: Optics Express

WASHINGTON—Austrian researchers have developed an entirely new way of capturing images on a flat, flexible, transparent, and potentially disposable plastic film.

The team describes their new device and its possible applications in a paper published today in the Optical Society's open-access journal *Optics Express*.

The new imager, which resembles a flexible plastic film, uses fluorescent particles to capture incoming light and channel a portion of it to an array of sensors framing the sheet. With no electronics or internal components, the imager's elegant design makes it ideal for a new breed of imaging technologies, including user interface devices that can respond to a simple gesture.

"To our knowledge, we are the first to present an image sensor that is fully transparent—no integrated microstructures, such as circuits—and is flexible and scalable at the same time," says Oliver Bimber of the Johannes Kepler University Linz in Austria, co-author of the paper.

The sensor is based on a polymer film known as a luminescent concentrator with tiny fluorescent particles that absorb a very specific wavelength (blue light for example) and then reemit it at a longer wavelength, such as green light.

Some of this light is scattered out of the imager, but a portion of it travels throughout the plastic sheet to the outer edges, where optical sensors capture the light. A computer then combines the signals to create a gray-scale image.

"With fluorescence, a portion of the light that is reemitted actually stays inside the film," says Bimber. "This is the basic principle of our sensor."

For the luminescent concentrator to work as an imager, Bimber and his colleagues had to determine precisely where light was falling across the entire surface of the film. This was the major technical challenge because the polymer sheet cannot be divided into individual pixels like the CCD camera inside a smartphone. Instead, fluorescent light from all points across its surface travels to all the edge sensors. Calculating where each bit of light entered the imager would be like determining where along a subway line a passenger got on after the train reached its final destination and all the passengers exited at once.

The solution came from the phenomenon of light attenuation, or dimming, as it travels through the polymer. The longer it travels, the dimmer it becomes. So by measuring the relative brightness of light reaching the sensor array, it was possible to calculate where the light entered the film.

The researchers scaled up this basic principle by measuring how much light arrives from every direction at each position on the image sensor at the film's edge. They could then reconstruct the image by using a technique similar to a CT scan.

The 32×32 pixels resolution from this image sensor is low because the low-cost photodiodes used in the prototype have limited signal-to-noise ratio.

The researchers can enhance the resolution by reconstructing multiple images at different positions on the film.

"This does not require better photodiodes," notes Bimber, "and does not make the sensor significantly slower. The more images we combine, the higher the final resolution is, up to a certain limit."

Researchers think the technology would give computer operators or video-game players full gesture control without the need for cameras or other external motion-tracking devices.

The polymer sheet could also be wrapped around objects to provide them with sensor capabilities. Since the material is transparent, it's possible to use multiple layers covering different wavelengths to capture colour images.
