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The Light Field Equation

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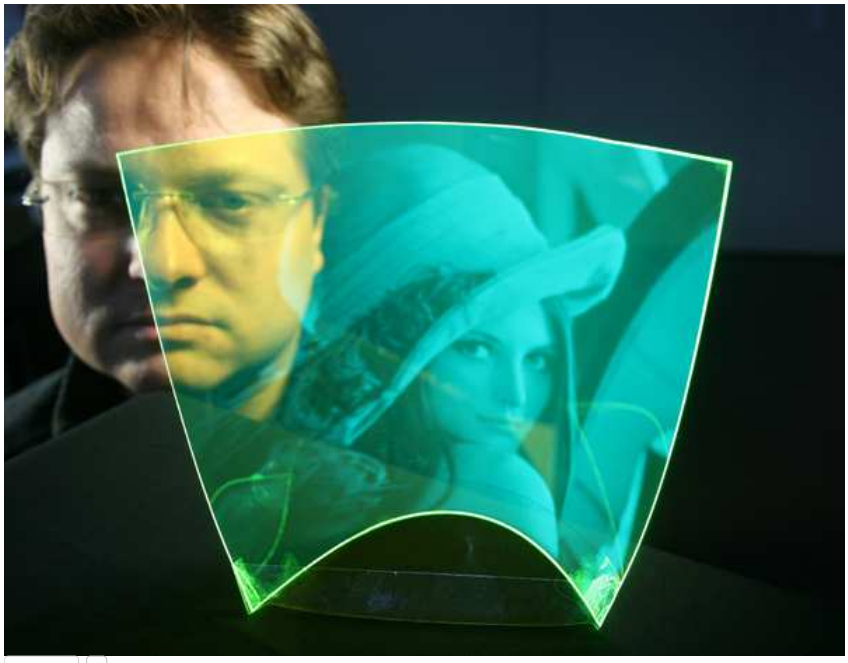

How transparency and flexibility will take image sensors to the next evolutionary stage

Taking a picture is a quick and long lasting way to capture memorable moments, unfortunately it often happens that the greatest shots are ruined because the cameras focus was set on the wrong section of the picture. Professor Oliver Bimber from the Johannes Kepler University in Linz, Austria has developed a new image sensor that will be able to solve this problem. In fact he and his colleague Alexander Koppelhuber's foundational research project has caught Microsoft's eye and is being financially backed and supported for the next 3 years.

Mr Bimber has set up camp on many different grounds before, from the Bauhaus-University in Weimar over the Frauenhofer Institutes in Germany and the US to the Technological Universities in Darmstadt and Munich. The flexible image sensor project was a child of the light field research he did at the JKU and is based on all the basic knowledge he had gathered in the field.

"The flexible sensors' key technology lies in the capturing of the light field, that is expanding within the used sensor film"

A reconstruction of the image displayed on the sensor is only possible because of this light field. The sensor in question primarily consists of a thin plastic film studded with fluorescent particles. These particles play a very important part in the process. When an image is displayed on the sensor surface, light penetrates the film and the fluorescent particles are responsible to transform this light from one wavelength into another. The transformed wavelength is then trapped within the film and transported to the edge of it.

"So the film works as a light guide." Once the wavelengths have reached the edge of the film they can be measured as a light field and "similar to a computer tomograph" these measurements make it possible to reconstruct an image from the sensor.

The current image sensor prototypes have a size of 20x20cm and fundamentally offer the same services ordinary CMOS and CCD sensors do. However the fact that Mr Bimber's image sensors are additionally transparent and flexible opens up a whole new spectrum of possibilities. The transparency enables the piling of several sensor films on top of each other, with every layer receptive to another colour or brightness level. The distinction of colour layers prevents the loss of image resolution and different brightness levels stored on top of each other make it possible to create high-dynamic-range sensors, which can prevent over or under exposure.

"The sensor's flexibility principally allows to turn any every day object into an image sensor – by simply sticking the sensor-film on it"

A feature that will take user interfaces far beyond today's plane touch screens. On top of that the flexible image sensor can be used for the realisation of cameras without lenses. These cameras use special optics to record the amount of reflected light rays – in other words a light field – and allow the focus on a picture to be changed after it has been taken. The sensor can also be moulded into a curved form imitating the human retina, which will solve the

problem of partly blurry pictures taken with wide-angle cameras.

When the project first started, it was only Mr Bimber and Mr Koppelhuber who worked on it, but since October last year Microsoft Research is on hand with help and advice, as well as two supporting researchers based in Cambridge. “Microsoft especially contributes with Know-how in the field of sensors and user interfaces.” The JKU duo on the other hand is first and foremost interested in the research foundation, the mathematic image reconstruction and the optics involved, both of these areas have proven to be the most challenging ones for the scientist so far.

The team’s schedule for the next years is already filled with plans for improvement. Among them are an enhanced way to reconstruct image quality, sensors in a variety of shapes and colour sensors. “Of particular interest is, naturally, the experimenting with new sensor applications. For instance touch-interfaces/sensors, that need not be touched anymore.”

The time it took current digital sensors to evolve from a first prototype to a market-ripe product was more or less three decades. However times are moving faster nowadays and maybe it wont be too long till a flexible image sensor can be found sitting in a camera shell in an electronics store somewhere.

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