

# OPN

Optics &  
Photonics  
News

## Optics in 2011

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## 22 Introduction

## 23 Bio-Optics

The diffusion of light allows biologists to study tissue at various depths below the surface of a person's skin. One novel development is the construction of a biological laser from a single cell.

## 25 Detection

A key component in any optical system is the detector that is used to transform light into a measurement.

## 26 Diffraction

Microstructured optical fibers constitute a versatile platform for developing novel optofluidic, sensing and actuating devices—bringing together photonics and microfluidics.

## 27 Imaging

Spectral imaging is particularly important in the biosciences. Raman scattering provides unique spectral signatures that can be used in the study of cell chemistry.

## 28 Interferometry

A key optical tool for metrology allows us to use a ruler calibrated in wavelengths of light.

## 30 Nonlinear Optics

Nonlinear optics allows us to generate sources in new spectral regions and to provide increased signal propagation capability.

## 32 Photonic Structures

We have learned how to construct ordered index-of-refraction-modulated structures that allow us to control the propagation of light. Initially, researchers were simply interested in fabrication; now they are exploring limitations in the structures.

## 35 Plasmonics

Surface plasmons have the unique capacity to confine light to very small dimensions, but the losses that occur when they propagate have limited their utility.

## 37 Quantum Optics

Exciting work is being done in quantum information theory and the detection of low light levels.

## 41 Terahertz Technology

The atmosphere is nearly opaque at wavelengths from the far-infrared to the millimeter wave, but there are applications that work around this restriction.

## 42 Transformation Optics

A new design concept for optical devices comes from the mathematical view of space-time in general relativity. The desired optical path is determined by coordinate transformations.

## 45 Ultrafast Optics

Techniques that use optical pulses extending from the picosecond to the attosecond have become an important adjunct to nanoscale science.

## 49 3-D Recording and Display

The display of 3-D objects has always been fascinating. Recent research explores new possibilities in holographic imaging and 3-D television.

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COVER: The organization of particles in tailored light fields. Illustration by C. Alpmann, Institute for Applied Physics, University of Muenster, Germany. (See Alpmann et al. p. 28.)  
This page: Artist's impression of a wavefront-shaped ultrashort pulse focused in space and time through a thick bone sample. (See Katz et al., p. 45.)



# Optics in 2011

**PANEL CHAIR:** Robert D. Guenther,  
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**T**his special issue of *Optics & Photonics News* (OPN) highlights the most exciting peer-reviewed optics research to have emerged over the past 12 months. The areas covered in 2011 include bio-optics, detection, diffraction, imaging, interferometry, nonlinear optics, photonic structures, plasmonics, quantum optics, terahertz technology, transformation optics, ultrafast optics and 3-D recording and display.

This year's issue includes 30 summaries representing the work of more than 150 authors from 15 countries. Submissions were judged on the basis of the following criteria:

- ▶ The accomplishments described must have been published in a refereed journal in the year prior to publication in OPN.
- ▶ The work should be illustrated in a clear, concise manner that is readily accessible to the at-large optics community.
- ▶ The authors should describe the topical area as a whole and then discuss the importance of their work in that context.

As we did last year, OPN has incorporated multimedia elements into our December issue. We are pleased to offer 15 summaries that are accompanied by videos. You can access them through our December digital edition, available at [www.opnmagazine-digital.com/opn/201112](http://www.opnmagazine-digital.com/opn/201112), or through our main website, at [www.osa-opn.org](http://www.osa-opn.org).

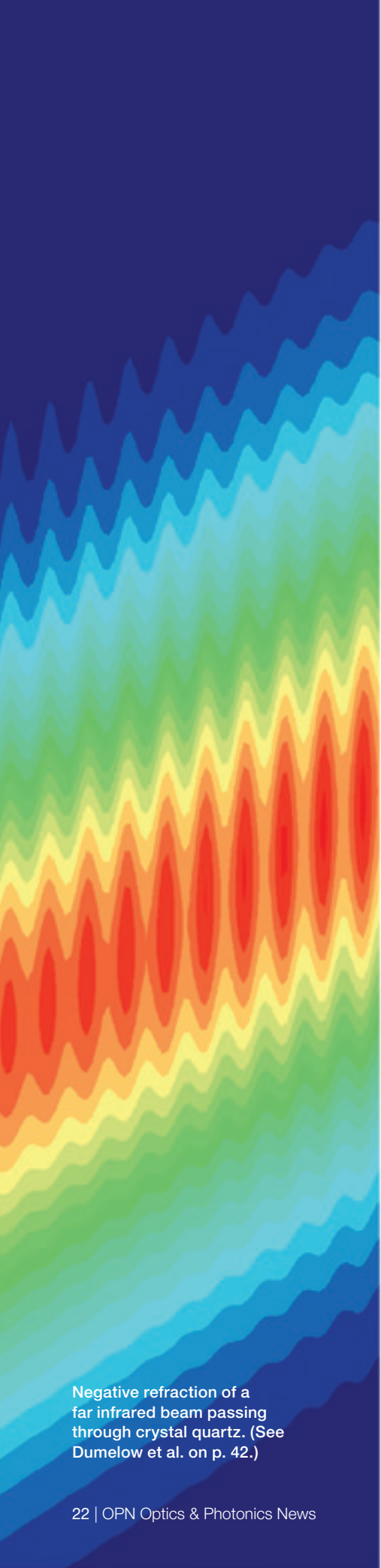
We plan to continue adding multimedia to our summaries from now on, and we'd love to hear your suggestions for how to improve our digital offerings. Please email [opn@osa.org](mailto:opn@osa.org) with your feedback, or send us research summaries with multimedia that we can use to experiment for next year.

OPN and OSA would like to thank all the researchers from around the world who submitted summaries, as well as our panel chair and guest editors.

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**ONLINE EXTRA:** Visit [www.osa-opn.org](http://www.osa-opn.org) to watch a video highlighting the Optics in 2011 research findings.

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Negative refraction of a far infrared beam passing through crystal quartz. (See Dumelow et al. on p. 42.)

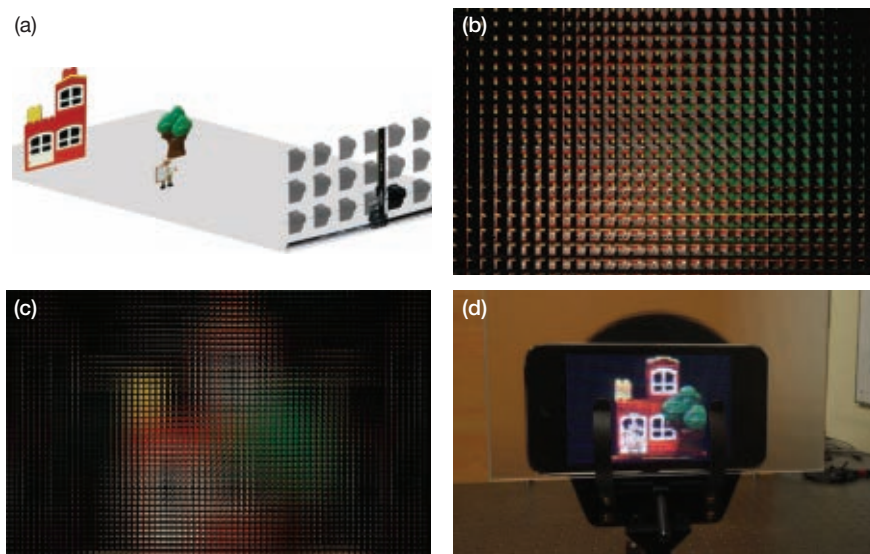
# Full Parallax 3-D TV with Programmable Display Parameters

Manuel Martínez-Corral, Héctor Navarro, Raúl Martínez-Cuenca, Genaro Saavedra and Bahram Javidi

**S**tereoscopic or auto-stereoscopic television monitors usually produce visual fatigue among viewers due to the convergence-accommodation conflict. An attractive alternative to these techniques is the so-called integral photography approach (also known as integral imaging, or InI) that was proposed by Lippmann in 1908<sup>1</sup>—the notion that one can record in a 2-D matrix sensor many elemental images of a 3-D scene, each of which stores information from a different perspective. When this information is projected onto a display device placed in front of an array of micro lenses, any pixel generates a conical ray-bundle. The intersection of these bundles produces the local concentration of light density that permits the 3-D reconstruction of the scene—without special goggles, with full parallax and without visual fatigue.<sup>2</sup>

The Lippmann concept was resurrected about two decades ago due to the fast development of optoelectronic image sensors and displays. One important challenge of the approach is figuring out how to address the structural differences between the capture setup and the display monitor. To tackle this, we developed an algorithm, called the smart pseudoscopic-to-orthoscopic conversion (SPOC), which permits the calculation of new sets of synthetic integral images that are fully adapted to the display monitor characteristics. Specifically, this global pixel-mapping algorithm permits one to select the display parameters such as the pitch, focal length and size of the microlens array (MLA), the depth position and size of the reconstructed images, and even the geometry of the MLA.<sup>3</sup>

The algorithm is the result of applying three processes in cascade: a simulated display, a synthetic capture and the homogeneous scaling. To demonstrate the utility of the algorithm, we generated the



(a) Experimental setup; (b) Integral image obtained experimentally; (c) Collection of synthetic elemental images ready to produce a real orthoscopic image; (d) Reconstruction of the orthoscopic, floating 3-D image through an MP4 device.

synthetic integral image ready to be displayed on a monitor whose parameters are very different from the ones used in the capture. For the capture of the elemental images, we prepared the 3-D scene shown in (a) and picked up the elemental images with only one digital camera that was mechanically translated. In (b), we show the captured image, which was composed of  $31 \times 21$  elemental images with  $51 \times 51$  pixels each.

Our aim was to produce a synthetic integral image for display in an MP4 device that had a matrix display with  $900 \times 600$  pixels of  $79.0 \mu\text{m}$  each. We calculated a matrix of  $75 \times 50$  elemental images with  $12 \times 12$  pixels each. In (c),

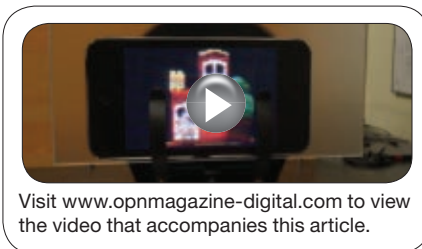
we show the calculated integral image. Finally, we displayed the synthetic integral image in the matrix display of the MP4 device over which we placed the microlens array. In order to avoid a braiding effect, we took care to ensure that the distance between the screen and the microlenses was equal to their focal length.<sup>4</sup> As we show in (d), the display produced an orthoscopic floating 3-D reconstruction of the 3-D scene that can be observed with full parallax. ▲

*This research has been supported in part by the Grant FIS2009-9135, Ministerio de Ciencia e Innovación, Spain.*

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## References

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2. J.-H. Park et al. Appl. Opt. **48**, H77 (2009).
3. H. Navarro et al. Opt. Express **18**, 25573 (2010).
4. H. Navarro et al. J. Disp. Technol. **6**, 404 (2010).



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