Making holograms look more real

June 24 2011

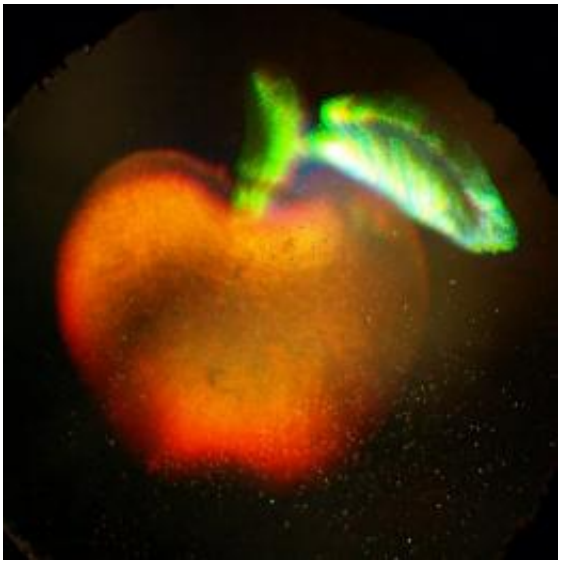

Figure 1: A full-color holographic apple achieved using surface plasmon polaritons in a silver film. Reproduced, with permission from, Ref. 1 © 2011 AAAS

(PhysOrg.com) -- Although human vision is capable of perceiving objects in three dimensions (3D), we spend much of our day looking at two-dimensional screens. The latest televisions and monitors can trick us into perceiving depth, by presenting different images to our left and right eyes, but they require special-purpose glasses, or specialized large-area lenses applied directly to the screen.

Holographic 3D imaging, on the other hand, presents a 'true' representation of an object by exactly reconstructing the light rays that

would come from that object if it were present. However, integrating color into 3D holograms has proved a challenge. Consequently, holograms are usually either monochromatic, or—as in the case of credit card holograms—colored in a way that does not correspond to the real object. Now, creating true, 3D color holograms has become possible using a technique developed by Satoshi Kawata and colleagues at the RIKEN Advanced Science Institute in Wako, Japan.

The researchers' hologram consists of a periodic grating, which is encoded with an interference pattern and covered with a thin film of silver. As with other holograms, when properly illuminated at a later time, the hologram can recreate the light rays that would result from the original object if it were present. The innovation comes in how this grating interacts with the silver film, whose electrons can be excited into density waves called surface plasmon polaritons (SPPs). SPPs are associated with a short-range, non-radiative electromagnetic field. When this field interacts with the grating, it is converted into visible light that can be observed by a viewer at a distance.

Critically, the nature of the SPPs excited in the silver depends on the angle of light that excites them. Therefore a particular type of SPP can be created by illuminating the film at a particular angle, and this in turn leads to a particular image being observed by the viewer. By encoding red, green and blue images into their grating, and then illuminating the grating and silver film simultaneously with three light beams at different angles, Kawata and colleagues produced a full-color hologram (Fig. 1).

To make the hologram easier to operate, the researchers also coated their silver film with a layer of silicon dioxide. This increased the separation between the angles of the incoming beams, and reduced the angular precision required. The team notes that the hologram works with beams of white light, and does not suffer from the 'ghosting' that is apparent with credit card holograms.

More information: Ozaki, M., Kato, J. & Kawata, S. Surface-plasmon holography with white-light illumination. *Science* 332, 218–220 (2011). www.sciencemag.org/content/332/6026/218.short

Provided by RIKEN