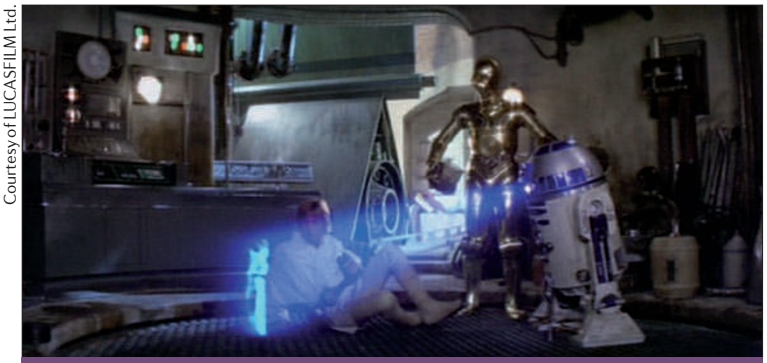

Courtesy of LUCASFILM Ltd.

MILESTONE 7

Ghosts of images past

Holograms have become familiar, common even. They appear on credit cards and money, in fashion shows, television programmes and works of art, and beyond. Originally, the inventor Dennis Gabor simply wanted to improve the electron microscope — itself a great improvement on the resolving power of the light microscope — in order to image an atomic lattice.

In 1947, electron microscopy was limited to a resolution of 12 Å, although the theoretical limit was 5 Å. To get around the limiting factor, which was the electron lens, Gabor thought about the wave nature of light. Photographs record light intensity. Suppose, however, that the phases of light were also recorded? For that there would have to be a reference phase with which to compare the phase of the wave originating from an object. Interference of the reference and object waves would create fringes, with maxima recorded on a photographic film where the two waves are in phase. When this image is illuminated by the same reference wave, it will transmit light only from the reference wave if it is identical to the original object wave. Therefore, the original object appears as a reconstructed image, as if it were there. Using a mercury arc lamp, with the reference source and the object on the same axis, Gabor was able to reproduce a grainy two-dimensional image.

Unfortunately, Gabor was ahead of his time. His proposed holographic electron microscope suffered from insufficient coherence of the electron wave, which led to poor reconstructions. Little wonder that holography did not become popular until after the invention of the laser in 1960 (MILESTONE 9), which provided a supply of highly focused monochromatic light. Within 2 years, holograms experienced a step change, literally gaining an extra dimension. Emmett Leith and Juris Upatnieks used a laser and an off-axis configuration to produce a three-dimensional hologram, while Yuri Denisyuk created three-dimensional holograms using white light as a source.

The shimmering futuristic-looking images soon spilled into science fiction, most notably in the 1977 film Star Wars. Some 30 years later, technology has caught up. Companies market systems that create three-dimensional holographic images that walk and talk, without the audience having to wear special glasses. This technique is also used in teleconference systems, where people can 'beam in' from multiple locations.

One of the most promising technological applications, however, uses three-dimensional holograms for data storage. Simply by varying the reference beam, 'pages' of data can be written and then read from the same volume of material, with storage capacity in the terabyte range. That is equivalent to 100 films on a single disc. With the ever increasing amount of digital data available, such as from the Large Hadron Collider (set to produce 15 PB of data per year), we are going to need higher density recording media to store them all.

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