Micromirrors Correct Optical Errors

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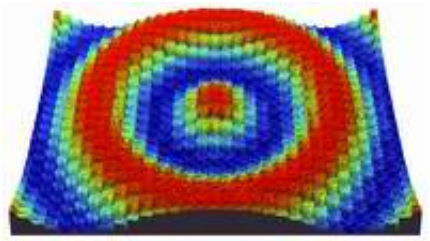

Before undergoing laser eye surgery, patients are given a glimpse of their future vision through an array of movable miniature mirrors. The technique originated in astronomy, where secondary mirrors in terrestrial telescopes correct distortions caused by the Earth's atmosphere.

"Can you still read the bottom line? – No? – And now?" Spectacle-wearers know the routine: The optician displays rows of letters on the wall. In each successive row the letters become smaller and more difficult to read, until they merge into an indecipherable blur. When the optician inserts the right correction lens, the blurred dots suddenly rearrange to sharply defined letters. Until now, opticians have relied on the subjective judgment of their patients. The arrival of wavefront correction may change this.

The technique is used in telescopes to obtain more detailed images from space. Turbulent layers of air diffract the incoming light from galaxies and stars in a variety of ways. The wavefronts of the propagating light

becomes malformed – leading to blurred images. Astronomers use special sensors to measure these disturbances. To correct the images, they reconstruct the deformed wavefronts using adjustable mirrors. The adapted optical path length then compensates for the distortion in the reflected light beam.

Human vision is also impeded by disturbed wavefronts. Here, the problem is caused by optical defects in the cornea, lens or vitreous body of the eye. Researchers at the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden have developed a microchip comprising so many tiny mirrors that it perfectly allows to correct such eye aberrations. “Patients can be given a foretaste of how their vision will be improved after laser surgery or being fitted with a new pair of spectacles,” says Andreas Gehner of the IPMS. “A Shack-Hartmann sensor measures the light reflected back by the retina and calculates all refractive optical errors. The obtained data are used to drive the mirror chip.” Nearly 50,000 square mirrors are integrated on an area of a thumbnail. Each element measures just 40 micrometers across – roughly half the diameter of a human hair. An underlying address circuitry allows each mirror to be individually lowered to the desired level.

The system is currently undergoing tests at the company 20/10 PERFECT VISION in Heidelberg, a partner of the IPMS. The technique is expected to become commercially available in one or two years. The high-resolution optical correction system is not only interesting to opticians. It could also prove useful in microscopy, helping to compensate for errors when researchers look through biological cell tissue. Or it could even be used to sharpen laser beams.

Source: Fraunhofer-Gesellschaft