Paper-Thin Compound-Eye Camera

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The focal length of a lens means that a camera has to have a certain thickness - or so we might think. Insect eyes show that this need not be the case: A camera chip based on the compound-eye principle can be used for person recognition and is as thin as paper.

If people were insects, books on optics would certainly look different. The camera illustrated as the technical equivalent next to a cross-section of the eye with just one lens, one iris and one retina would not be of the conventional type. A compound camera would have many hundreds of individual eyes. Each light-sensitive unit, consisting of a lens and a photocell, would capture a narrow segment of the environment. All the images together form the complete picture. An insect's compound eye will never achieve a particularly high optical resolution, but the principle according to which it registers images does possess some advantages, and if these were incorporated in a camera it would be very flat and could cover a wide field of view.

It was precisely these advantages which inspired research scientists at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF to develop their ultra-flat camera system. "Our latest prototypes are thinner than 0.4 millimeters," emphasizes Andreas Bräuer, who is in charge of the Microoptics unit in Jena. "You can gain a real sense of how thin that is by picking up three sheets of carbon paper between your fingers." Cameras incorporating conventional "human-eye" optics - such as those used in mobile phones - are at best no thinner than seven millimeters.

This development is targeted at all the applications where the advantages of the stick-on sensors really come to the fore. They are already being produced on wafers like microchips, which is a key requirement if they are one day to be manufactured cost-effectively, on an industrial scale. The next stage of the project is to install the camera in series-production units suitable for use in industry. The most important step will be to connect the lens system with receiver arrays, for example with a CMOS chip. The optical and electronic systems will then be so flat that it will be possible to integrate them in a chipcard with a thickness of 0.8 millimeters. If the chipcard “sees” that it is being used by a stranger it could block the money transfer. Just a vision? Interesting applications are also opening up for driver assistance systems in automobiles: Instead of a gawping camera lens, a discrete gray square would blend in with the car interior. From the driver’s line of vision or eye movements, the compound-eye camera could report to the onboard computer that there is a risk of the driver nodding off. Another possibility: Depending on whether a slightly built woman or a heavy man is sitting in the car, the airbag will activate comparatively gently or strongly.

Source: Fraunhofer-Gesellschaft