Adjustable Fluidic Lenses for Eyesight Correction Applications

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(PhysOrg.com) -- Researchers from the University of Arizona have created a fluid-based opthalmic lens in which the amount of fluid can be constantly adjusted to provide customized eye correction. The lens may one day be incorporated into the tools that eye doctors use to determine prescription strength.

Similar lenses have been produced for telescopes to provide an adjustable field of view and zoom, removing the need to mechanically move optical components and yielding smaller, lighter telescopes. The University of Arizona group has taken these principles and applied them to opthalmics.

"Our main goal is to develop a phoropter, the instrument used in an eye exam to determine the patient's eyeglass prescription," the study' corresponding scientist, David Mathine, told *PhysOrg.com*.

He continued, "Currently, the patient sits behind the phoropter and lenses are switched in and out until the prescription is determined. The instrument we are developing would be much smaller, potentially like a pair of eyeglasses, and would be automated so the patient may be able to determine his or her own prescription by controlling a joystick. This should speed up the process."

Incorporating a fluidic lens in the phoropter would allow the wavefront of light presented to the eye to be continuously varied such that individual lenses, switched in and out until the patient sees clearly, would

not be needed. The phoropter would also be much more compact.

Mathine and his colleagues made then lens using the organic polymer polydimethylsiloxane (PDMS), a clear elastic material often used to make contact lenses. PDMS was placed in a glass mold and a vacuum was applied to remove any tiny air bubbles left in the PDMS as a result of the mixing process used to produce it. The membrane was finally heated, removed from the mold, cured, and mounted into a holder.

The holder consists of three parts. The top section secures the PDMS membrane, the middle piece holds the fluid, and the bottom section secures the glass plate that seals the setup.

When fluid is added or removed, the PDMS membrane stretches or contracts to become more or less concave (curving inward) or convex (bulging outward). This changing lens shape can be used to control the shape of the light wavefront—the surface of the wave.

The group fabricated two types of lenses that, together, could allow an eye-care patient to obtain a complete prescription. The first lens is spherical, the second lens is rectangular. In combination they could accommodate patients with astigmatism, a condition in which the cornea is irregularly shaped.

They tested the lenses with a "model eye," a chamber filled with saline fluid that includes a fake pupil, a lens to simulate the cornea, and another lens to simulate astigmatism. The object "seen" by the eye was a photograph; digital images were recorded with a camera. The researchers adjusted the fluid volume until the astigmatism was eliminated and then made additional corrections until the images of the photo were crisp.

This research is described in the February 15, 2009, online edition of

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