Light, instead of electrodes, could control deformable mirrors

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(PhysOrg.com) -- The field of adaptive optics is advancing in interest as technology makes it possible to use deformable mirrors for a number of applications in optoelectronics. Deformable mirrors usually make use of rigid sections that can be actuated independently, or reflective membranes that make use of segmented electrodes. These methods, though reasonably effective, have limitations. They require complex circuitry in order to manipulate individual sections of the mirror, making deformable mirrors impractical for every day use.

In order to advance adaptive optics so that deformable mirrors can be used in more every day applications, a group of scientists has demonstrated a new kind of deformable membrane mirror. "In our device, we do deformation with light, so we don't need the electrodes to control the mirror," Stefania Residori tells *PhysOrg.com*.

Residori is a scientist at the University of Nice-Sophia Antipolis in Valbonne, France. Along with Umberto Bortolozzo at the same University, Stefano Bonora from the Luxor Laboratory in Padova, Italy, and Jean-Pierre Huignard of Jphopto in Paris, France, Residori has presented the results of a demonstration of this new deformable mirror in Applied Physics Letters: "Continuous photocontrolled deformable membrane mirror."

"A deformable mirror includes a reflecting membrane and a photo-sensitive substrate," Residori explains. "In traditional deformable mirrors, electrodes are applied to get a desired effect. However, this can be complex for electronics when we want to obtain high resolution. Our design allows us to accomplish deformation with light, rather than electrodes."

Instead of using electrodes to apply voltage, Residori and her colleagues activate the membrane by shining light in different photosensitive areas. "This simplifies matter greatly in adaptive optics," she insists. "We need only one voltage line, rather than all of the circuitry required when using electrodes. All you have to do is change the illumination condition. With the current technology of video projectors this can now be realized easily by sending any image, so that we can very well control the deformation of the photosensitive mirror. "

Residori sees applications for this type of deformable membrane mirror in astronomy and astrophysics. "You can use this for corrections of wavefront. When you collect radiation you can use this mirror, since it uses distortion to correct an incoming wave," she points out. Residori also says that this deformable membrane mirror is scalable, so that it is possible to make large mirrors for use in penetrating some of the mysteries of space.

Medical imaging and diagnostics is another area where Residori sees potential. "In medical diagnostics, there is an issue with light propagation - especially if you want to look inside the eye. Our mirror can be scaled down small to be used in different medical applications as well."

Because the design is fairly simple, consisting of a photosensitive membrane that is flexible, and does not require electrodes to deform the mirror, Residori says that it is fairly inexpensive technology. "Relatively speaking, this is not very expensive. The photosensitive substrate can be a little expensive due to the requirement for cutting crystals, but overall this is fairly simple and inexpensive."

“Our deformable mirror can be made reasonably cheap if there is an interest,” Residori continues. “It can be used for standard commercial optics, and as more are produced, the price could fall.”

The next step, though, is to make the device with other types of photoconductive substrates. “We want to develop something more sensitive in other wavelengths. This would make this deformable mirror more useful in medical and biological imaging. We also want to experiment other types of membranes, allowing even larger deformations.”

For now, though, this demonstration represents an advance in adaptive optics, and a promising step forward in optoelectronics. “This has the potential to be very useful in a wide variety of applications,” Residori says.

More information: U. Bortolozzo, S. Bonora, J.P. Huignard, and S. Residori, “Continuous photocontrolled deformable membrane mirror,” *Applied Physics Letters* (2010). Available online: link.aip.org/link/APPLAB/v96/i25/p251108/s1