Walls are mirrors with new imaging technique

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(Phys.org) -- A child's dream wanting to come true: putting on a magic cape to see around corners and through walls, solving mysteries and catching criminals. Scientists, meanwhile, are achieving the same optical powers with knowledge and labs if not capes. A study published yesterday, “Looking around corners and through thin turbid layers in real time with scattered incoherent light,” is attracting much attention in its description of the technique, using a spatial light modulator to undo the scattering that makes objects opaque or non-reflecting. Their technique allows real-time imaging through opaque materials and around highly scattering optical diffusers.

The paper, published yesterday in *Nature Photonics*, is authored by Ori Katz, Eran Small and Yaron Silberberg. Prof Silberberg and his colleagues are with the Ultra Fast Optics Group at the Weizmann Institute of Science in Israel. They are being said to have “pushed the limits” of what spatial light modulators (SLMs) can do.

SLMs modify the phase of an incoming light beam. Like a series of ocean waves, the waves in light can be slowed down or redirected when they hit scattering materials. The team’s “wavefront shaping” involves using the SLM so that it refocuses at a desired location. Exploiting the angular range in which a single wavefront pattern inverts scattering allows wide-field real-time imaging through a single process.

“We show that wavefront-shaping enables wide-field imaging through turbid layers with incoherent illumination, and imaging of occluded

objects using light scattered from diffuse walls," the authors said.

"Our results bring wavefront-shaping closer to practical applications and realize the vision of looking through walls and around corners."

This is not the first attempt to explore correcting for scattering, with a number of research efforts in evidence over recent years. In 2010 there was news of a prototype camera that was developed by scientists that can shoot around corners, making use of an ultra-short high-intensity burst of laser light to illuminate a scene.

The Weizmann Institute team provides real-time imaging in a different way. As reported in *Nature Photonics*, the technique is quick, simple and uses natural light rather than lasers.

The main power of the technique is said to be that it can work with incoherent light. Unlike past wavefront approaches, this technique does not require a coherent source, interferometric detection, raster scanning or off-line computational reconstruction.

Earth-based astronomy and deep tissue imaging are two relevant areas that could make use of the study's findings, as both astronomy and deep tissue imaging are challenged by scattering and dense materials.

Talking about future applications, principal investigator Silberberg said, "Our technique for imaging through scattering layers may allow that study of previously inaccessible biological samples by optical imaging, e.g., imaging through thin egg shells for studying embryonic development."

Silberberg further explained what could make a difference. "If you want to look to see an embryo developing inside an egg but the eggshell scatters everything, or you want to look through the skin, scattering is the

main enemy there, and time-of-flight is not a good solution." He was referring to the "time-of-flight" approach with a laser-based camera. He envisions that the primary use for their technique will be in biological and medical studies.

More information: Looking around corners and through thin turbid layers in real time with scattered incoherent light, *Nature Photonics* (2012) doi:10.1038/nphoton.2012.150 (Preprint is available on Arxiv)

Abstract

Imaging with optical resolution through turbid media is a long sought-after goal with important applications in deep tissue imaging. Although extensively studied, this goal was considered impractical until recently. Adaptive-optics techniques, which can correct weak aberrations, are inadequate for turbid samples, where light is scattered to complex speckle patterns with a number of modes greatly exceeding the number of degrees of control. This conception changed after the demonstration of coherent focusing through turbid media by wavefront-shaping, using spatial light modulators. Here, we show that wavefront-shaping enables wide-field imaging through turbid layers with incoherent illumination, and imaging of occluded objects using light scattered from diffuse walls. In contrast to the recently introduced schemes for imaging through turbid media, our technique does not require coherent sources, interferometric detection, raster-scanning or off-line reconstruction. Our results bring wavefront-shaping closer to practical applications and realize the vision of looking through 'walls' and around corners.