Initial Proof-of-Concept of Photoacoustic Neural Stimulation; A Potential Approach to Retinal Stimulation: Preliminary In Vitro Study

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Technology description

Unmet Need

Non-cataract related vision loss affects 22.9 million people worldwide. Many of these patients retain partial functionality in their retinas; even though their outer retinas no longer function, visual stimulation can be achieved by sending messages from the inner retinas through the optic nerves. Present efforts to restore vision to these patients include the use of retinal chips. However, the chips do not provide sufficient resolution to provide sought after macular function. Also, approaches using electrical stimulation by retinal prosthesis electrode array implants have been suggested, as well as a photovoltaic method using light stimulation on an implanted subretinal photodiode array. However, these methods rely on the implantation of array stimulators into the subretinal space, which requires a high level of surgical skill and precision to avoid damaging the retinal neurons. The targeted retinal tissue is incredibly thin, and surgical outcomes can be adversely affected by the varying depth of nerve fibers in the retina and the array design. Thus, there is a need for a high resolution and less skill-dependent method of providing virtual vision that can be reliably implemented into the eyes of severely vision-impaired patients with intact inner retinas.

Technology Description

The technology is an external camera that performs image acquisition and processing and transfers the visual information in real-time via a processor to a photoacoustic imager that is implanted in the eye cavity. The photoacoustic imager converts the received information into a series of laser pulses that are projected via small implanted galvo-mirrors or MEMs actuators onto a light-absorptive layer that covers the macula. The laser pulses are then converted via the photoacoustic effect into highly localized ultrasonic waves (or, alternatively, piezoelectric signals). The waves induce expansion of the light-absorptive layer, which will cause the underlying retinal nerve cells to depolarize, sending a visual signal to the brain. Unlike with existing solutions, this approach eliminates the invasive surgical implantation of electrode arrays in the subretina, minimizing potential loss of vision from operative complications. Also, because the device is located in the eye cavity rather than on the subretinal layers, it offers potentially limitless stimulation control and does not have to rely on resolution limiting electrode contact points. Using the photoacoustic effect also allows the approach to provide enhanced stimulation resolution with deeper penetration than available with conventional current-based methods.

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