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High-Resolution Retinal Prosthesis for Restoring Sight to Patients Blinded by Retinal Injury or Degeneration

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Institution Receiving Award: STANFORD UNIVERSITY
Program: VRP
Proposal Number: VR180018
Award Number: W81XWH-19-1-0738
Funding Mechanism: Expansion Award
Partnering Awards:
Award Amount: $740,945.00

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PUBLIC ABSTRACT

Ocular trauma can result in traumatic retinopathy associated with the loss of sight due to damage of photoreceptors. Similarly, retinal degenerative diseases result in a gradual loss of photoreceptors and associated visual impairment. Retinitis Pigmentosa (RP) is the leading cause of inherited blindness in young people and currently has no effective treatment. Age Related Macular Degeneration (AMD) is the major cause of vision loss in people over 65 years of age in US. Development of wet-type of AMD and associated vision loss can be slowed down pharmacologically, but there is no cure, as there is no treatment for the dry atrophic form of AMD, called geographic atrophy. As life expectancy increases, age-related vision loss is becoming a critical issue. The National Eye Institute estimates nearly 3 million people in the United States alone will have moderate to severe vision loss due to retinal degenerative diseases by 2020.

In these conditions, the inner retinal neurons are preserved, to a large extent, and therefore visual perception can be restored by patterned electrical stimulation of the remaining retinal circuit. Photovoltaic subretinal prosthesis directly converts light into pulsed electric current in each pixel, stimulating the nearby neurons. Visual information is projected onto the retina from video goggles using pulsed near-infrared light. Wireless design of these arrays allows scalability to thousands of pixels and, combined with the ease of implantation, offers a promising approach to restoration of sight in patients blinded by retinal trauma or degeneration. Clinical trial with such implants (PRIMA) having 100-micrometer pixels started in 2018, and results already have confirmed that patients perceive visual patterns, including large letters and numbers, with spatial resolution very close to the theoretical limit for this pixel size (20/400).

We propose to further advance this remarkably successful technology towards highly functional restoration of sight. For reading and face recognition, prosthetic visual acuity should, at least, exceed the threshold of legal blindness (20/200), which requires pixels smaller than 50 micrometers in size. For widespread acceptance in patients with the loss of central vision, acuity of prosthetic vision should exceed 20/100, which requires pixels smaller than 25 micrometers.

We will develop a novel three-dimensional electrode geometry to significantly decrease the stimulation threshold and enable reducing the pixel size down to 10-20 micrometers, which geometrically correspond to visual acuity of 20/40 - 20/80, respectively. If successful, this technology can be rapidly transferred to our industrial partner, Pixium Vision, for clinical testing. Proposed developments should provide prosthetic visual acuity sufficient for ambulation, reading, and face recognition, thereby enabling independent and productive lifestyle to Service members, Veterans, and their family members.

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