Fractal Interconnects for Neuro-Electronic Interfaces, Including Artificial Retinas

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Technology description

In conditions such as macular degeneration and retinitis pigmentosa, impaired vision is caused by a loss of function in the photoreceptor cells (the rods and cones), which lie within the retina at the back of the eye. However, the rest of the visual system, including the optic nerve and the visual processing centers in the brain, remain intact. If one can devise a viable work-around for the initial signal processing by the lost photoreceptors, one can replace the broken link in the system and restore vision. This is the aim of various researchers working on artificial retina implants.
A key piece of any artificial retina implant is the interface of an electronic signal with the neurons of the plexiform layer of the retina. Whether one uses fabricated photoreceptors placed within the retina itself (as in a subretinal implant) or in an external camera (as in an epiretinal implant), the crucial task of connecting the signal to the retina's processing neurons is an important step. Traditionally this connection is accomplished using an array of electrodes to send the signals to the neurons.
A University of Oregon and University of Canterbury research project aims to improve the traditional electrode connection to the neurons by using the novel technology of "fractal interconnects". The fractal interconnects will present a "biophilic" interface to the retinal neurons by mimicking nature's own processes. It is known, for example, that retinal neurons have a fractal dimension of D = 1.7 (roughly speaking, the fractal dimension characterizes the degree of branching of the neurons). By presenting the retinal neurons with a fractal interconnect with similar branching properties, the connectivity will be enhanced, signals will be better processed and sent on to the optic nerve, and an improved artificial retina will be achieved.
The fractal interconnects are constructed from a suitable conducting material on a nonconducting substrate and are connected to the underlying electrodes supplying the signal. This can be accomplished by taking advantage of a self-assembly process that favors the growth of fractal structures under certain conditions. In the future, other methods such as nano-lithography may be possible, but the underlying mechanism of the biophilic fractal interconnects will remain the same—using an artificial branched structure to connect to a biological branched structure.
The fractal interconnects have a variety of other applications as well, ranging from improvingin vitroconnections to neurons in petri dishes, to reestablishing deteriorated connections between different regions of the brain.

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