Bionic Eyes: the definitive solution for visually impaired individuals?

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Abstract

Once a topic of folklore and science fiction, the notion of retaining vision to the blind is now much closer to becoming a reality than it ever was before. As the rise of microelectronics and microfabrication has given way to drastic improvements in the field of prosthetic devices. the developing technology has given rise to a plethora of approaches and designs to achieve said purpose. yet these visual prosthetics operate on the same premise: relying on intact neural circuitry whenever possible in order to take advantage of any intact sensory processing available [1]. Thus, lowering the need to deal with the complexity of the neural code for perception. However, as a direct consequence of that, it is highly unlikely that this technology will ever see the light for patients diagnosed with congenital blindness as they often lack a fully developed neural perception system. Although a functioning mechanism may very well be feasible, the rehabilitation of the blind and reintegrating them into society will continue to be a challenge against establishing this technology as a viable solution for the blind.

I. Introduction

Unlike what many would assume, Prosthetic eyes have, in fact, long been in development, with succeeding irritations improving using more microelectrodes that mimic the function of photoreceptors in the human cornea. The Argus II, for example, is the second generation of a prosthetic retinal implant with the goal of vision restoration for patients diagnosed with Retinitis pigmentosa. The implant study was first initiated back in 2002 in which implantation in six patients in the trial proved to be successful. The implant has proven that the device has the potential to allow legally blind patients to detect light, and possibly distinguish between objects. The device is basically meant to take place of photoreceptors.

However, the use of only 16 electrodes in first-generation devices was the most limiting factor in terms of vision fidelity. And henceforth the Argus II comprised 60 electrodes providing higher resolution images. The new device is approximately one-quarter the size of the original device, reducing surgery and recovery times by a significant margin.

II. Mechanism

In its very essence, the retina is merely a matrix of nerve cells firing signals upon being struck by lights of specific wavelengths and degrees. These neurons then send an electrical signal to the brain’s visual cortex in which color, light intensity, edges, and more information are processed to try and work out what the person is seeing. This processing part, in fact, does not simply translate these electrical signals into images interpretable by the human but rather edits out what may be irrelevant and focuses on the more significant pieces of the image such as motion: an incredible process in the very least. Obviously, vision involves much more complexity than is shown, but this complexity is beyond the scope of this paper. Our primary focus here is to make it clear how a prosthetic eye could manipulate this system in order to produce comprehensible images. The bionic eye can be viewed as a replacement for a retina that can no longer perform this function.

III. Improving Vision Quality

Several approaches have been devised to improve vision quality. The most obvious of which was to increase the number of implanted electrodes, allowing them to target certain neurons accounting for more pixels and thus better resolutions. However, normal sized-micro electrodes would not fit in such a confined space. For that reason, attempts at shrinking the size of the microelectrodes have been made [2]. By electrically stimulating retinal ganglion cells using thousands of microscale nitrogen-doped ultra-nanocrystalline diamond (N-UNCD) feedthroughs that act as electrodes. Aside from the expensiveness of the diamond coating, the use of such technology has not yet proven feasible and requires further research.

Another technique is to artificially increase the resolution by sharing electrical current between electrodes, producing additional “virtual electrodes”. These new techniques can possibly improve visual fidelity, reduce blurriness, and give rudimentary control over color: a distinctive feature of natural eyesight.

The ultimate goal would be to fully understand the code sent from the retina to the brain. Theoretically, If the firing patterns of the receptors can be replicated, vision will appear exactly as perceived by a healthy individual’s eye.

IV. The Future of Bionic Eyes

Taking the technology to the next level, there is a possibility to go beyond what a normal human eye could do. Once the code between the retina and the brain has been deciphered, there would be an unlimited potential for the technology from the ability to see infra-red, night vision, or x-ray. To magnifying images naturally, running software that processes images, blocking out bright sunlight, and substituting sunglasses. In fact, being able to watch a movie, scrolling through your newsfeed, or even playing a simple video game, seems equally plausible using the same technology that could, theoretically, help the blind see again.

V. Conclusion

Undoubtedly, the goal of restoring some degree of vision to the blind using bionic eyes certainly seems feasible, but providing them with fully detailed vision like that of healthy individuals while seemingly plausible with the progress the technology is seeing and with its technological challenges continuing to be solved, it is questionable whether these individuals will be able to fully interpret the images processed in the brain, and understand features like their depth, edges, and advanced details like color. Casting further doubt on the subject matter, it is yet to be understood how the brain of a once visually impaired individual would react to perceiving light once again and whether that would influence the recovery speed.

Rehabilitation is certainly going to be needed for a successful recovery. Furthermore, this technology shows no potential for treating cognitive blindness, and it is unlikely to be cured in the next decade. While the bionic eye does not yet seem to be a definitive solution for the blind. There is certain ground to be optimistic about the technology. What is now clear is that the feasibility of this technology is dependent on the mandatory collaboration between physicians, doctors, and scientists from different fields.

VI. References

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