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Bionic Eyes for the Blind

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ABSTRACT

Bionic eye is a wonderful visual mechanism which can fulfill the dream of blind people to see the beauty of nature. Among all species of life, human birth is very precious. To lead a complete life, human body plays a dominant role. Eye is a most important organ of sense in human body. About 1.3 billion people around the world are visually impaired. The major reasons for blindness and low vision are retinal diseases, macular degeneration, cataract, diabetic retinopathy, glaucoma, vitamin A deficiency and hereditary diseases of the eye. Damage to nerves with in the eye and brain also leads to blindness. As pacemaker to heart patient and hearing aid to deaf people, bionic eye gives hope to the people with inability to see. In this paper recent research and future development of bionic eye is presented which benefits a lot for society.

KEY WORDS: ARTIFICIAL EYE, RETINAL IMPLANTS, RETINITIS PIGMENTOSA, SILICON RETINA

INTRODUCTION

Eye is the most sensitive and most important part of the human beings body. Some people are born blind and some defects or partially loss their vision. The World Health Organization has estimated that Globally 1.3 billion people have some form of vision impairment. With regards to distance vision, World Health Organization (WHO) estimated that there are about 826 million people live with near vision impairment (WHO 2018). Currently, India is a home for 1/3rd of world blind population. India has largest blind population in the world which is nearly about 15 million people, which shows the need of bionic eye is very high for world, particularly India.

Due to improper treatment, people suffering from low vision are unable to get perfect vision and undergoing various surgeries that sometimes further lead to loss of vision. The various reasons for blindness are i) Glaucoma, ii) Macular degeneration, iii) Cataracts, iv) Optic neuritis, iv) Retinitis pigmentosa, v) Tumors.

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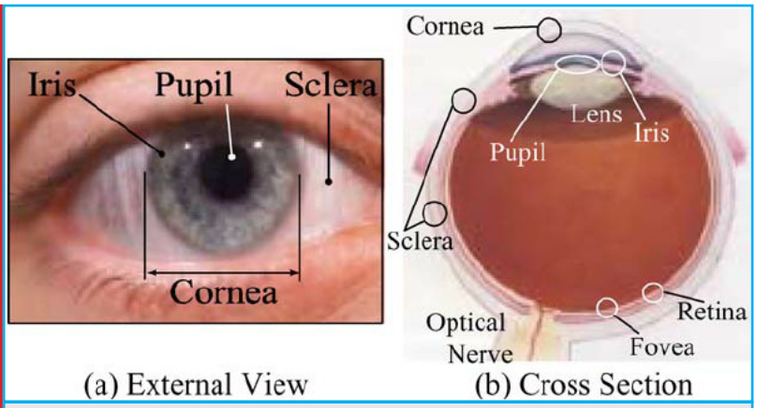

Figure 1. Structure of the Eye

Glaucoma: There is always a stable production and drainage of fluid substance in the eye which is known as aqueous humor. This keeps the eyes always wet. But when the production of fluid is high or very low, the disease called Glaucoma causes. This increases the pressure in the eye (Weinreb *et al.* 2016). Macular Degeneration: Macular degeneration is the main reason for blindness in aged people. It is due to the defect in midpoint of retina. To prevent the risk of infection at eyes, doctors usually recommend antibiotic drops. However this does not completely cures the eyes. The patient may still face vision problems (Yonekawa *et al.* 2015).

Cataracts: Cataracts are the root cause for cloudy vision. Optic Neuritis: Optic nerve inflammation leads to short-term or stable loss of eye sight. In certain case, this kind of eye defect heals on its own. Retinitis Pigmentosa: Retinitis pigmentosa is an eye defect which comes due to genetic disorders. The people affected by this kind eye defect could not see at night, as well as their side view of eye sight also affected. It mainly affects the retina and leads to blindness only in rare cases. Since it is due to genetic disorder and involves retinal cell damage, it occurs from the onset of night blindness to the gradual vision loss (Anjaneyulu *et al.* 2017).Tumors: Generally tumors affects the retina and become a reason for blindness.

The Structure of eye is shown in Figure 1to Figure 4. The structure of Human eye has three coats as outer, middle and inner. Sclera and cornea are outer coats. Sclera is the white portion of the eye. The eye ball shape is maintained by sclera. In the eye ball the outer portion is cornea and the cornea has no blood vessels. Then in the middle coat there are three important parts are there. They are Choroid, Ciliary body and Iris. The choroid is very near and adjacent to sclera and contains a large amount of blood vessels. Pigmented cells in choroid

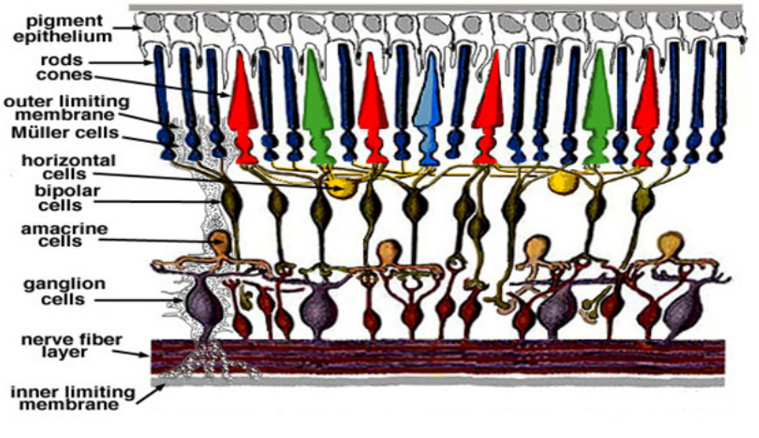

Figure 2. The Retina

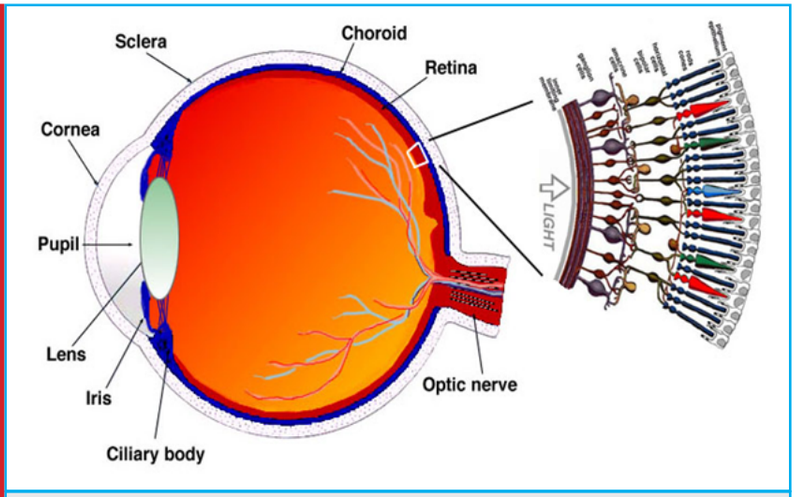

Figure 3. The Eye with Retina

absorb light. Ciliary body helps to hold the lens in place. The iris is giving colour to eye. Next the inner coat is called as retina. Retina is a nervous coat. In the eye ball, retina is a sensory layer (Dobelle 2000).

The function of eyes is, from the moment the light rays enter our eyes, the cones and rods cells perceives the images. From there, optical signals into electric impulses are sent via optic nerve to the brain. Defects in eye such as retinal pigmentosa and macular degeneration are damage these cells. Better understanding of the function human eye gives intelligence to replace the defective eye by bionic eye which is artificially designed to support visually challenged people.

A bionic eye imitates the function of the retina of human eye. It helps to restore sight for the people who were affected by serious vision loss. Here a retinal implant is joined to a video camera. This convert images into electrical impulses. Due to this the remaining retinal cells are activated which allow to carry the signal back to the brain. The brain interprets these as dark or light spots in pixelated image format.

BIONIC EYE

BIO+ELECTRONIC=BIONIC. Bionic eye indicates bio electronic eye. The electronic device normally sub-

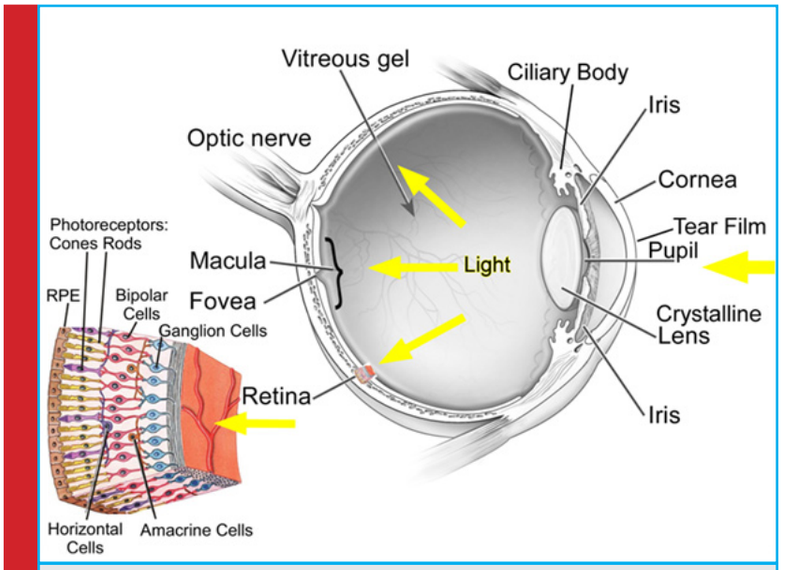

Figure 4. Structure of the Eye

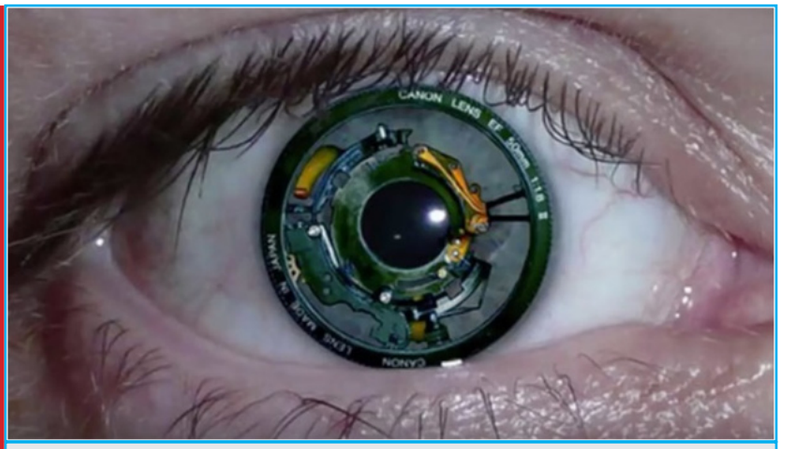

Figure 5. The Bionic Eye

stituted to perform partial or full function of the eye. The various parts of bionic eye are i) Digital Camera, ii) Video-Processing Microchip, iii) Radio Transmitter, iv) Radio Receiver, v) Retinal Implant.

Digital Camera: A digital camera is used to capture images. It is operate in real time. These images are passed to a microchip located in the retina. The Video-Processing Microchip converts these images into electrical pulses. This exactly characterizes the patterns of light and dark. These signals are pass pulses to a radio transmitter. The Radio Transmitter function is to wirelessly transmit these pulses to a receiver. The receiver is usually implanted above the ear or under the eye. Then these pulses are send to the retinal implant using very thin i.e. hair thin implanted wire (Krishnaveni *et al.* 2012). Figure 5 shows the bionic eye and Figure 6 shows the human eye with camera.

BIONIC EYE PROJECTS

Some of the major Bionic eye projects are Implantable Miniature Telescope, Artificial Silicon Retina (ASR), Harvard /MIT Retinal Implant, Dobelle eye, MARC Technology, Argus, Holographic Technology and Virtual Retinal Display (VRD). Here the very important bionic eye Artificial Silicon Retina and Argus-II are briefly discussed.

Artificial Silicon Retina

Artificial retina prosthesis is done using Artificial Silicon Retina. It is a silicon chip. The size is very tiny. It has 2 mm diameter and 1/1000 inch thickness. The ASR has about 3,500 microscopic solar cells. It transforms light into electric pulses. It mimics the function of cones and rods in the eye. ASR detects light and converts into electrical impulses.

Figure 6. The Human Eye with Camera

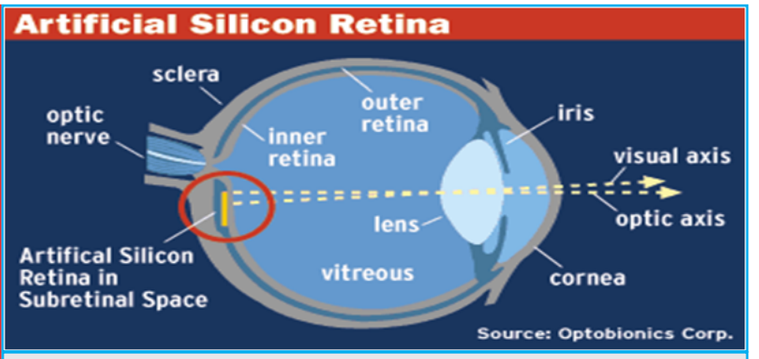

Figure 7. Structure of Artificial Silicon Retina

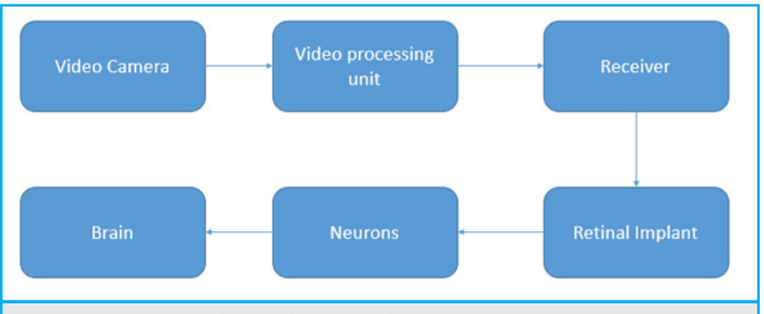

Figure 8. Flow Chart for the function of Artificial Silicon Retina

Approaches towards RETINA: There are two main approaches towards Retina. They are i) Epiretinal Approach, ii) Subretinal Approach. Epiretinal Approach involves a semiconductor based device. It is positioned on the surface of the retina. The main function is to simulate the remaining overlying cells of the retina. In subretinal approach, ASR chip is implanted behind the retina. The main function is to simulate the remaining viable cells (Chow *et al.* 2004). Thus ASR supports the blind people to receive their eye sight.

Argus-II

The Argus II is the world's first approved bionic device. It transmits image from a small eye glass. The patient wears glasses with an attached video camera. These images become an electrical signal. Argus II bionic eye i.e. Argus II Retinal Prosthesis System is dedicated for young people at age 25 (Stronks & Dagnelie 2014). The Cons and Pros of Argus-II are as follows. It has ability to perform good visual tasks and it reduced the stress upon retina. The cost of device is too high. Figure 9 shows the Argus-II bionic eye.

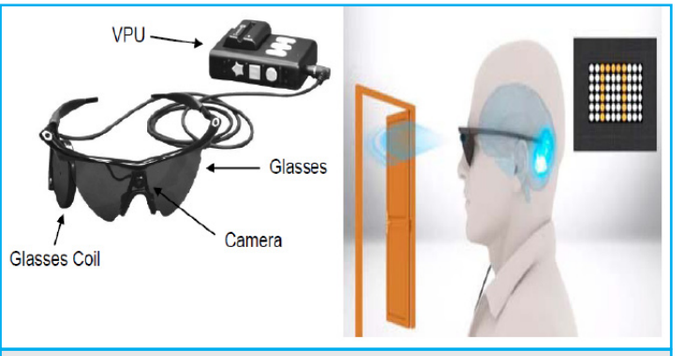

Figure 9. Argus-II Bionic eye

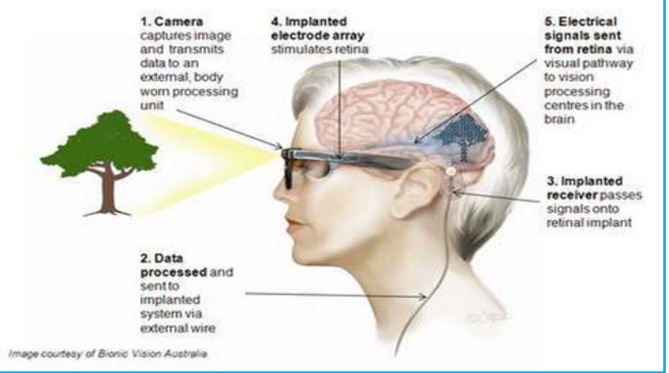

Figure 10. Bionic Eye System

Thus Bionic Eye System provides complete vision to blind people (Deeksha & Shantharam 2016). Figure 10 shows the Bionic Eye System.

CONCLUSION

Bionic Eye is a revolution in medical field and most innovative aid for the blind. It can help in restoring the vision of millions of people affected by eye blindness. Now about 1.3 Billion people suffered due to blindness around the world. If this bionic eye system is fully developed with a cutting edge technology it will transform the life of blind people who struggled all over the world.

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