IJCSC International Journal of Computer Science & Communication Vol. 1, No. 2, July-December 2010, pp. 251-253

Bionic Eye, Restores Sight to the Blind

V.P.Vaidya[1], S.A.Ingole[2], L.K.Gautam[3], R.N.Gadbail[4] & V.S.Gulhane[5]

[1,2,3,4,5]Department of Comp Engg/IT, Sipna's C.O.E.T, Sant G.B. Amravati University, India
Email: [1]vanishavaidya_2007@rediffmail.com, [2]shilpa.ingole@gmail.com, [3]leena_gautam@rediffmail.com, [4]rashmi_gadbail@rediffmail.com, [5]v_gulhane@rediffmail.com

ABSTRACT

Bionic eye, also called a Bio Electronic eye, artificial retina or robotic retina, is the electronic device that replaces functionality of a part or whole of the eye.It restores vision to people who have lost sight during their lifetime. This device will bring artificial vision to those blind due to retinal degeneration as in age related macular degeneration(AMD),the major cause of vision loss in senior citizens over age 65. Each year, 700,000 people are diagnosed with AMD, with 10 percent becoming legally blind, defined by 20/400 vision. Many AMD patients do retain some degree of peripheral vision. Other than AMD sufferers there are 1.5 million people in the world who suffer from retinitis pigmentosa (RP), the leading cause of inherited blindness.There are millions of rods and cones in the back of every healthy human eye. They are biological solar cells in the retina that convert light to electrical impulses, impulses that travel along the optic nerve to the brain where images are formed. Without them, we're blind and this blindness is due to malfunctioning of rods and cones. Indeed, many people are blind or going blind because of malfunctioning of rods and cones. Retinitis pigmentosa and macular degeneration are examples of two such disorders. Degenerative retinal diseases result in death of photoreceptors—rod-shaped cells at the retina's periphery responsible for night vision and cone-shaped cells at its center responsible for color vision. In these diseases the photoreceptor cells slowly degenerate, leading to blindness. However, many of the retinal neurons that transmit signals from the photoreceptors are preserved for a prolonged period of time. Retinitis pigmentosa tends to be hereditary and may strike at an early age, while macular degeneration mostly affects the elderly. Together, these diseases afflict millions of people; both occur gradually and can result in total blindness.If those damaged rods and cones are replaced with artificial ones, then a person who is retinally blind might be able to regain some of their sight. For achieving this the microchip is implanted behind the retina of the blind person.The patient would wear goggles mounted with a small video camera. Light enters the camera, which then sends the image to a wireless wallet-sized computer for processing. The computer transmits this information to an infrared LED screen on the goggles. The goggles reflect an infrared image into the eye and on to the retinal chip, stimulating photodiodes on the chip. The photodiodes mimic the retinal cells by converting light into electrical signals, which are then transmitted by cells in the inner retina via nerve pulses to the brain.Our paper aims at describing the problems that cause blindness,the need of bionic eye and thus explains the electronic system designed for robotic retina as an electronic eye.
Keywords: Bionic Eye, Real Time Vision, Technology

1. STRUCTURE OF THE HUMAN EYE

Figure 1 shows the essential components of the eye optical system:

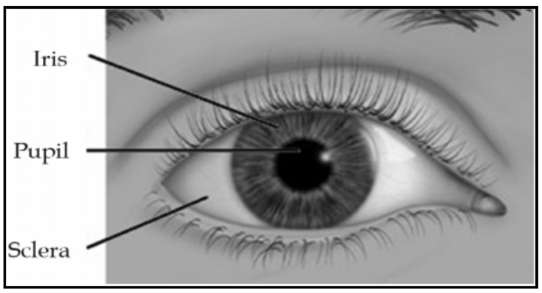


Fig. 1: Essential componenets of the eye optical system

Figure 2 shows a simplified horizontal cross section of the human eye:

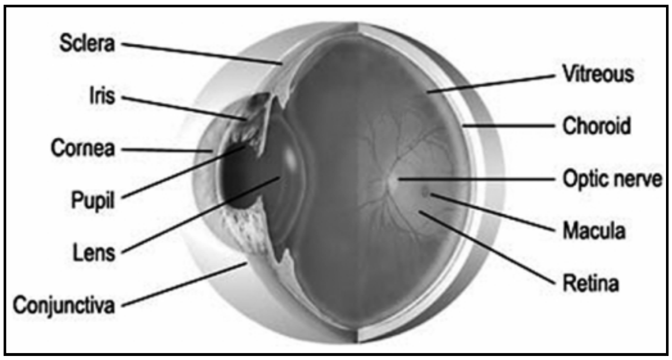


Fig. 2: Anatomy of Eye

The eye is nearly a sphere, with an average diameter of approximately 20 mm. Three membranes enclose the eye: the cornea and sclera outer cover; the choroid; and the retina. The cornea is a tough, transparent tissue that covers the anterior surface of the eye. Continuous with the cornea, the sclera is an opaque mem-brane that encloses the remainder of the optic globe.The choroid lies directly below the sclera. This membrane contains a net-work of blood vessels that serve as the major source of nutrition to the eye. Even superficial injury to the choroid, often not deemed serious, can lead to se-vere eye damage as a result of inflammation that restricts blood flow. The choroid coat is heavily pigmented and hence helps to reduce the amount of ex-traneous light entering the eye and the backscatter within the optical globe. At its anterior extreme, the choroid is divided into the ciliary body and the iris diaphragm. The latter contracts or expands to control the amount of light that enters the eye. The central opening of the iris (the pupil) varies in diameter from approximately 2 to 8 mm. The front of the iris contains the visible pig-ment of the eye, whereas the back contains a black pigment.The lens is made up of concentric layers of fibrous cells and is suspended by fibers that attach to the ciliary body. It contains 60 to 70% water, about 6% fat, and more protein than any other tissue in the eye. The lens is colored by a slightly yel-low pigmentation that increases with age. In extreme cases, excessive clouding of the lens, caused by the affliction commonly referred to as cataracts, can lead to poor color discrimination and loss of clear vision. The lens absorbs approximate-ly 8% of the visible light spectrum, with relatively higher absorption at shorter wavelengths. Both infrared and ultraviolet light are absorbed appreciably by pro-teins within the lens structure and, in excessive amounts, can damage the eye.The innermost membrane of the eye is the retina, which lines the inside of the wall's entire posterior portion.

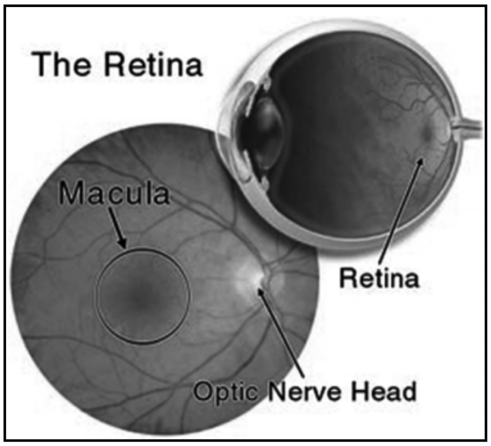


Fig 1.1: Shows the Structure of Retina

When the eye is properly focused, light from an object outside the eye is imaged on the retina. Pattern vision is afforded by the distribution of discrete light receptors over the surface of the retina. There are two classes of receptors: cones and rods. The cones in each eye number between 6 and 7 million. They are located primarily in the 'central portion of the retina, called fovea, and are highly sensitive to color. Humans can resolve fine details with these cones largely because each one is connected to its own nerve end. Muscles controlling the eye rotate the eyeball until the image of an object of in-terest falls on the fovea. Cone vision is called photopic or bright-light vision.The number of rods is much larger: Some 75 to 150 million are distributed over the retinal surface. The larger area of distribution and the fact that sever-al rods are connected to a single nerve end reduce the amount of detail dis-cernible by these receptors. Rods serve to give a general, overall picture of the field of view. They are not involved in color vision and are sensitive to low lev-els of illumination.For example, objects that appear brightly colored in day- light when seen by moonlight appear as colorless forms because only the rods are stimulated. This phenomenon is known as scotopic or dim-light vision.

The distribution of receptors is radially sym-metric about the fovea. Receptor density is measured in degrees from the fovea (that is, in degrees off axis, as measured by the angle formed by the visual axis and a line passing through the center of the lens and intersecting the retina).Cones are most dense in the center of the retina (in the cen-ter area of the fovea). Rods increase in density from the center out to approximately 20° off axis and then decrease in density out to the extreme periphery of the retina.The fovea itself is a circular indentation in the retina of about 1.5 mm in di-ammeter.The fovea can be viewed as a square sensor array of size 1.5 mm × 1.5 mm. The density of cones in that area of the retina is approxi-mately 150,000 elements per mm^2.

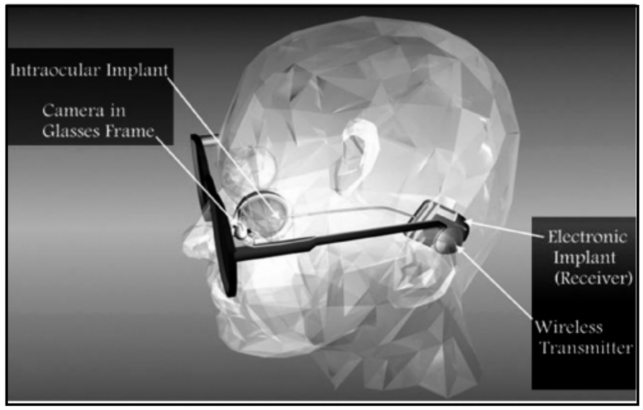
2. NEED OF BIONIC EYE

The healthy human eye has many millions of biological solar cells in the retina, called rods and cones that convert light into electrical signals, which are then sent along the optic nerve to the brain where images are formed. In cases where the retina fails, the nerves behind the retina, which carry electrical impulses, still function. Many people are blind because of malfunctioning rods and cones. Retinitis pigmentosa and macular degeneration are examples of two such disorders. Retinitis pigmentosa tends to be hereditary and may strike at an early age,while macular degeneration mostly affects the elderly.

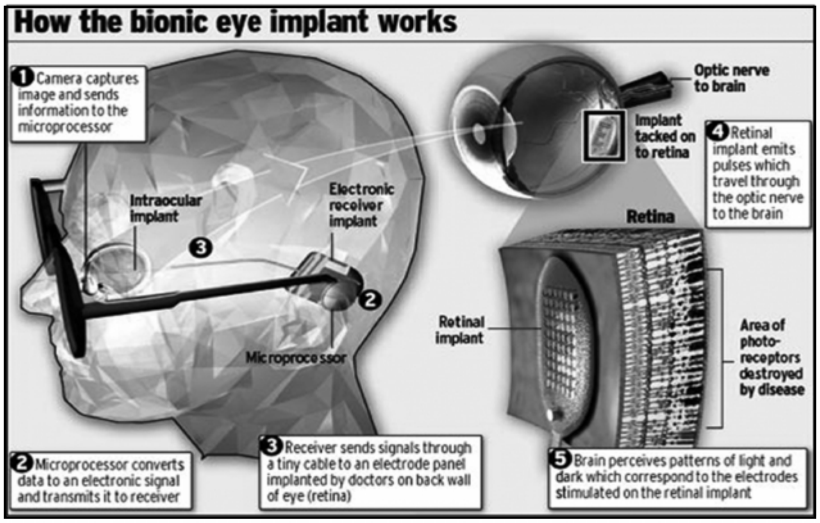
Retinitis pigmentosa (RP) is the name given to a group of retinal degenerative disease characterized by a breakdown of the retina the thin layers of light-sensing cells in the back of the eye.Macular degeneration describes a group of retinal degenerative diseases that is characterized by a breakdown of the macuIa, the small center portion of the retina. The macula provides the sharp central vision needed for reading small print and for recognizing faces at a distance. Symptoms of macular degeneration may include seeing dark or empty areas in the center of vision, and seeing distortions of lines and shapes in every day actvities. The device will bring artificial vision to those blind due to retinal degeneration as in AMD.

3. BIONIC EYE TECHNOLOGY

It uses a small video camera-equipped device to capture images, encode them and send them into the eye implant (a silicon chip inserted into the eyeball) via a laser beam that also powers the chip's solar cell. Photo sensors convert the light and images into electrical impulses, which charge a plate that stimulates the nerves and transmits visual information to the brain. The laser and camera can easily be mounted on eyeglasses without having to wear bulky headgear. The patient would wear goggles mounted with a small video camera. Light enters the camera, which then sends the image to a wireless wallet-sized computer for processing. The computer transmits this information to an infrared LED screen on the goggles.The goggles reflect an infrared image into the eye and on to the retinal chip, stimulating photodiodes on the chip. The photodiodes mimic the retinal cells by converting light into electrical signals, which are then transmitted by cells in the inner retina via nerve pulses to the brain.The goggles are transparent so if the user still has some vision, they can match that with the new information - the device would cover about 10° of the wearer's field of vision.The device involves a miniature video camera fitted to a pair of glasses. The camera sends compressed digital images to a bionic implant on the back of the eye.Thousands of tiny electrodes in the bionic chip then stimulate the optic nerve, sending a signal to the visual centre at the back of the brain, where it is translated into an image.



Working:



4. CONCLUSION

The bionic eye restores sight to the blind. Researchers throughout the world have looked for ways to improve people's lives with artificial, bionic devices. Bionic devices are being developed to do more than replace defective parts. This has given a way to work on bionic arms, toungues, noses etc.Above all. Bionic eye is a boon to the blind people.

REFERENCES

[1] L.C.Jain, U.Halici, I.Hayashi, S.B.Lee and S.Tsutsui, 2005, *Intelligent Biometric Techniques in Fingerprint and Face Recognition*.

[2] D. Maio and D. Mmaltoni, "Direct Gray- Scale Minutiae Detection in Fingerprints", *IEEE Trans, on Pattern Analysis and Machine Intelligence*, **19**, No. 1,January 2005.

[3] A.K. Jain, L. Hong and R. Bolle, April 2005, "On-Line Fingerprint Verification", *IEEE Trans, on Pattern Analysis and Machine Intelligence*, **19**, No.4, April 1997.

[4] A.K. Jain, L. Hong, S. Pankanti, and R. Bolle, September, 2005, "An Identify- Authentication System Using Fingerprints", *Proceedings of the IEEE*, **85**, No. 9, September 2005.

[5] M.Faundez Zanurry, "Vulnerability of Biometric Security Systems", *Proceedings of IEEE*, **36**, No 10, December 2005.