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Bionic Eye

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ABSTRACT-

In this entire world for those millions of people whose vision is impaired they have got eye gears for rectification but for the truly blind people whose vision is darkened we don't have any therapeutics. So the recent advancement in the technology has driven the mankind towards various approach like artificial implants for those blind subjects and the bionic eye with retinal, ocular, sub retinal implant technique seems to be promising as it is an integration of electronics, biomedical and the embedded engineering which acts as the artificial eye in interpreting the materialistic images of the world and plays the active role of natural cones and rods for brain image interpretence. Blindness is a devastating disease which can happen due to various reasons such as due to retinitis pigmentosa (RP) and many other age related macular degenerations. In this kind of disease, the photoreceptor cells get degenerated and damages the retina and due to which a person losses his vision power. Therefore, bionic eye plays a vital part by restoring the vision

1.Introduction

Bionic eye," also called a Bio Electronic eye, is the electronic device that replaces functionality of a part or whole of the eye. It is still at a very early stage in its development, but if successful, it could restore vision to people who have lost sightduring their lifetime. The bionic eye work by stimulating nerves, which are activated by electrical impulses. In this case the patient has a small device implanted into the body that can receive radio signals and transmit those signals to nerves.Human eye is an obligatory organ that helps to see the world and its beauty. Human eye can be called as a natural camera. Blindness is a severe disease. From the recent estimate, India is now a huge banyan tree with millions of blindinhabitants. Bionic eye is a short form of Bioelectronics eye. Bionic Eye is a result of bio-electronic bond. It is an electronic device which replaces functionality of a part or whole of the eye. Itis used for replacing functionality or adding functionality to the eye. Since eye is the most sensitive part of our body, some disorders to itmayaffect our entire life style. Eyes are a window to the external world. We cannot even imagine a single defect in it. Bionic eye is mainly introduced into this modern world to overcome the diseases of the eye such as retinitis pigmentosa and macular degeneration. We will come to know about these diseases on the content of this topic. The purpose of this Bionic Eye is to provide a clear vision. A CCDcamera is placed on the glass which we wear and chip is implanted into the retina. When light falls onit, it excites many cells and helps in perceiving an image in brain. Blindness is a dark world. Those who're in this world are wishing to see at least a ray of light.

2. System Overview

Human Eye

We are able to see because light from an object can move through space and reach our eyes. Once light reaches our eyes, signals are sent to our brain, and our brain deciphers the information in order to detect the appearance, location and movement of the objects we are sighting at. The internal working of eye is as follows scattered light from the object enters through the cornea.

1.The light is projected onto the retina.

2. The retina sends messages to the brain through the optic nerve.

3.The brain interprets what the object is

The eyeball is set in a protective cone - shaped cavity in the skull called the orbit or socket and measures approximately one inch in diameter. The orbit is surrounded by layers of soft, fatty tissue which protect the eye and enable it to turn easily. The important part of an eye that is responsible for vision is retina. The retina is complex in itself. This thin membrane at the back of the eye is a vital part of your ability to see. Its main function is to receive and transmit images to the brain. In humans there are three main types of light sensitive cells in the retina. They are,

- Rod Cells
- Cone Cells
- Ganglion cells

They are about 125 million rods and cones within the retina that act as the eye's photoreceptors. Rods are able to function in lowlight and can create black and white images without much light. The information received by the rods and cones are then transmitted to the nearly 1 million ganglion cells in the retina. These ganglion cells interpret the messages from the rods and cones and send the information on to the brain by way of the optic nerve.

The Bionic Eye

The word 'bionic' is derived from a combination of the words 'biology' and 'electronic.' Medical bionics is the field of science at the interface of engineering, biology and medicine, which seeks to
replace lost physiological functions through technical and electronic means. There are three categories of medical bionic devices:

• those that send signals from the brain to another part of the body (e.g. bionic hand)

• those that send signals from the body to the brain (e.g. bionic ear)

• those whose action is restricted to one part of the body without becoming part of the nervous
system (e.g. cardiac pacemaker) In the current world about 40 million people suffered from blindness and about 140 million people are suffered from low vision and if we talk about India we are having the world's largest number of people suffering from blindness. The objective of BIONIC EYE is the same as to restore visual signal to whom suffering from eye disease such as retinitis pigmentosa. In this a video camera is integrated with a pair of glasses which will capture and process images. The images are wirelessly sent to small processor which converts it into electronic signal and these signal further transmitted to a retinal implant or electrode which send visual signal to brain for further processing. So by this even blind people also have vision. Retinal Prosthesis is a biomedical implant used to partially restore the useful vision for those who have lost their sight due to this disease. According to a surveying every 5,000 people there is one suffered from that disease. It used to provide pulse signal to the brain by using the retinal implant for the blinded
person. As it is having a mini video camera to get the data which is wirelessly transferred to a video processing unit which converts the data into electronic signal and then the signals transferred to electrodes which generate impulse to interpret with the brain and a blind person is able to see like an normal human, but the vision is not 100% perfect. Bionic eye provides a vision differ from the vision a human used to have. It is an artificial eye which provokes visual sensations in the brain by directly stimulating different parts of the optic nerve. Bionic eye consists of electronic systems which consist of image sensors, processors, receivers, radio transmitters and retinal chips. There are also other experimental implants that can stimulate the ganglia cells on the retina or the visual cortex of the brain itself.

3. TECHNOLOGY

Artificial Silicon Retina

The brothers Alan Chow and Vincent Chow have developed a microchip containing 3500 photo diodes, which detect light and convert it into electrical impulses, which stimulate healthy retinal ganglion cells. The ASR requires no externally - worn devices. The ASR is a silicon chip 2 mm in diameter and 1/1000 inch in thickness.

It contains approximately 3,500 microscopic solar cells called "micro photodiodes", each having its own stimulating electrode.

These micro photodiodes are designed to convert the light energy from images into thousands of tiny electrical impulses to stimulate the remaining functional cells of the retina in patients suffering with AMD and RP types of conditions.

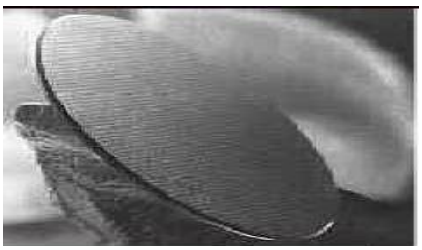

Fig.1 Magnified Image of ASR

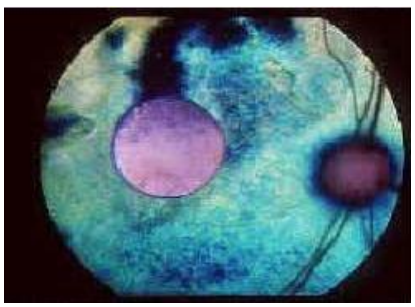

Fig.2 ASR Implant in Eye

The ASR is powered solely by incident light and does not require the use of external wires or batteries. When surgically implanted under the retina, in a location known as the sub retinal space, the ASR is designed to produce visual signals similar to those produced by the photoreceptor layer. From their sub retinal location these artificial "photoelectric"signals from the ASR are in a position to induce biological visual signals in the remaining functional retinal cells which may be processed and sent via the optic nerve to the brain.

Fig.3 The Dot Above the Date on this Penny is the full Size of ASR

MARC System

The intermediary device is the MARC system. The schematic of the components of the MARC to be
implanted consists of a secondary receiving coil mounted in close proximity to the cornea, a power and signal transceiver and processing chip, a stimulation - current driver, and a proposed electrode array fabricated on a material such as silicone rubber, thin silicon, or polyimide with ribbon cables connecting the devices. possible use as a non – intrusive material for an electrode array. Titanium tacks or cyanoacrylate glue may be used A multiple-unit artificial retina chipset (MARC) system to benefit the visually impaired is presented. The rehabilitative device replaces the functionality of defective photoreceptors within patients suffering from Retinal Pigmentosa (RP) and Age- Related Macular Degeneration (AMD).

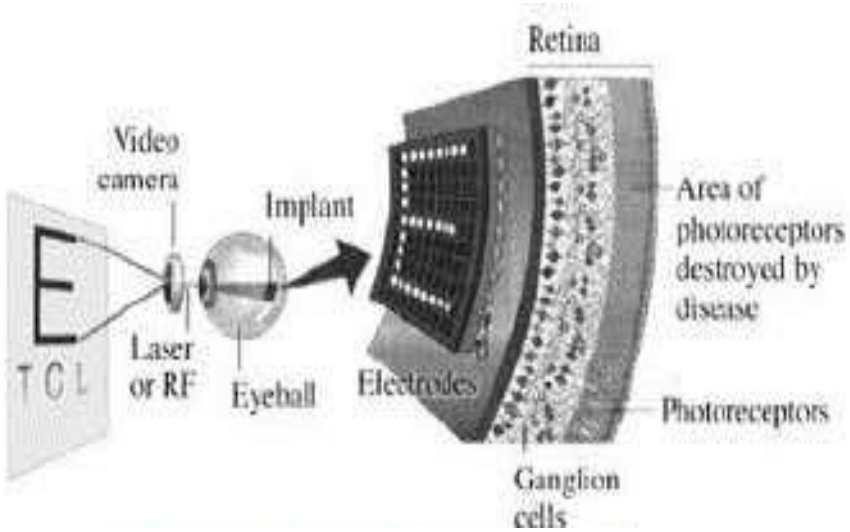

Fig.4 The MARC System

the MARC system, a data signal will be transmitted by modulating the amplitude of a higher frequency carrier signal. The signal will be rectified and filtered, and the MARC will be capable of extracting power, data, and a clock signal. The subsequently derived image will then be stimulated upon the patient's retina. The MARC won't be duplicating the exact functioning of the retina, but rather the device will be an entity that the brain will "learn" to use. Thus we believe that a 15x15 pixel array will facilitate a level of sight which will be of significant value to the patient.the circuit of MARC

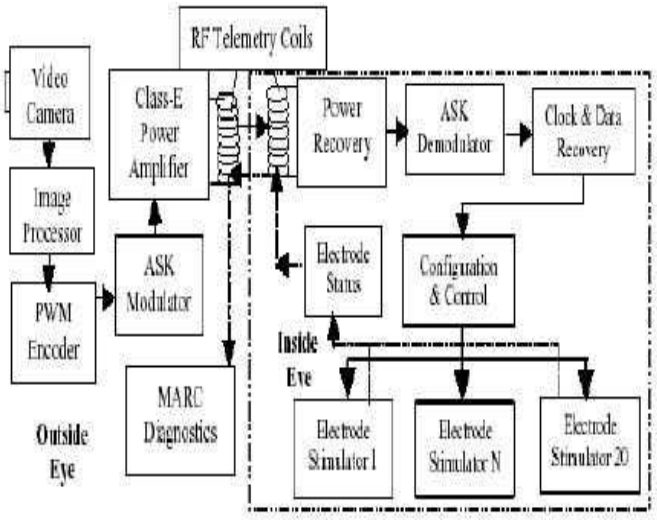

Fig.5 Circuit of MARC System

The MARC system will operate in the following manner. An external camera will acquire an image, whereupon it will be encoded into data stream which will be transmitted via RF.The MARC system would consist of two parts which separately reside exterior and interior to the eyeball. Each part is equipped with both a transmitter and a receiver. The primary coil can be driven with a 0.5 – 10 MHz carrier signal, accompanied by a 10 KHz amplitude modulated (AM/ASK) signal which provides data for setting the configuration of the stimulating electrodes.

3.ADVANTAGES

- Helps correct vision.
- No complicated surgical procedure.
- Can be easily implanted.
- No batteries implanted within the body.
- There is no necessity to suffer from long and short sights.
- It is the one approved by FDA

4.APPLICATIONS

- Treating patient with total vision loss.
- Ceramic detectors are biocompatible.
- Wonderful optical properties.
- Naturally porous structure allows nutrients to flow from the back to the front of the eye.

5.CONCLUSION

The bionic eye has changed the world of the visually challenged people. They are sure that higher quality, better resolution, and even color are possible in the future. Bionic devices are being developed to do more than replace defective parts. 3esearchers are also using them to fight illnesses. If this system is fully developed it will change the lives of millions of people around the world. They may not restore the vision fully, but we can help them at least to find their way, recognize faces, read books, distinguish between objects such as cups and plates, above all lead an independent life. Though there are a number of challenges to be faced before this technology reach the common man, the path has been laid. It has enabled a formerly blind patient to. But with only 1C electrodes, the device does not allow the patient to see a clear picture.

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