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An Overview on the Artificial Eye System using MEMS Technology

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Abstract: The world of today is full of colors and joys. To enjoy this color of nature we need the eyes. But one of the major conditions which damage the human eyes capability of seeing is blindness. Blindness effects on our education, employment and prosperity, and also participation in civil, social and political life. World's largest number of blind people is in India. Around 40 million people across the globe, who are blind, over 15 million are from India. In India, the requirement of optometrists is 40,000 but there are only 8,000. 75% cases of blindness could be avoided but for the shortage of optometrists and donated eyes for the treatment of corneal blindness.[1]

In 21st century MEMS and NEMS is the most promising technology. Now a days it plays very important role in the revolution of industrial and consumer products by combining silicon based microelectronics with micromachining technology. The main function of bionic eye is to restore basic visual cues for those people who are suffering from eye diseases such as retinitis pigmentosa. In bionic eye a micro video camera fitted to the Goggle used by patient, it will capture the image and process it. After that image are sent via wireless medium to a bionic eye, which is implanted at the back of eye, it generates optic signals to stimulates optic nerves to generate points of light, it forms the basis of images in the brain. Thus a blind one can also watch that object.

Keywords: Cause of Blindness, Bionic Eye & MEMS Technology.

I. INTRODUCTION

MEMS and NEMS is now in trend and one of the most promising technologies in this Century and has the capacity to revolutionize both industrial and consumer products by combining silicon-based microelectronics with micromachining technology. Its techniques and microsystem-based devices have the potential to dramatically effect of all of our lives and the way we live. MEMS and NEMS have become the fastest-growing area of scientific research, with inventions of new devices. Technology has done wonders which help the mankind. Prosthetics use to help overcome handicaps.

II. CAUSES OF BLINDNESS

There are mainly two causes of blindness:-

- 1) Retinitis Pigmentosa
- 2) Age-related macular degeneration

A. What is a Retinitis Pigmentosa?

Retinitis pimentos (RP) is the major cause of inherited blindness, affecting 1.5 million people worldwide (a prevalence of one in 5000).RP is characterized by the progressive loss of photoreceptor cells and supporting vision and is related with night-vision difficulties. Most commonly, patients lose their sight slowly, eventually developing tunnel vision and possibly complete blindness in the late stages of the disease. Patients with RP have difficulty with mobility, navigation and night-vision.[1]

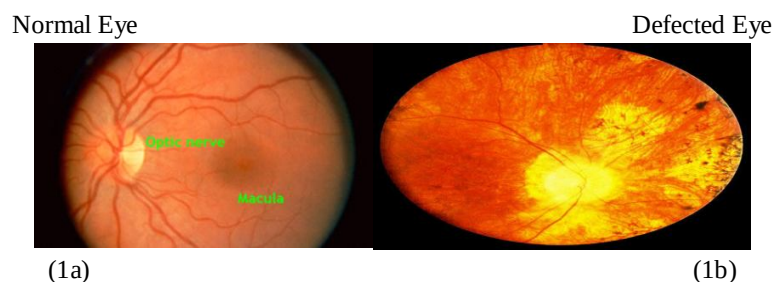


Fig. 1: (1a) Normal eye (1b)Defected eye

B. What is Age-Related Macular Degeneration?

Age-related macular degeneration (AMD) is the cause of almost half of all legal blindness in India. It results in vision loss in the center of the visual field and usually affects people over the age of 65. AMD causes cells in the retina, the light sensing part of the eye, to stop converting absorbed light into electro-chemical signals. As the brain does not receive the signal, a complete image is not formed. Patients with AMD have difficulty performing tasks that rely on central vision, such as reading and recognizing faces.

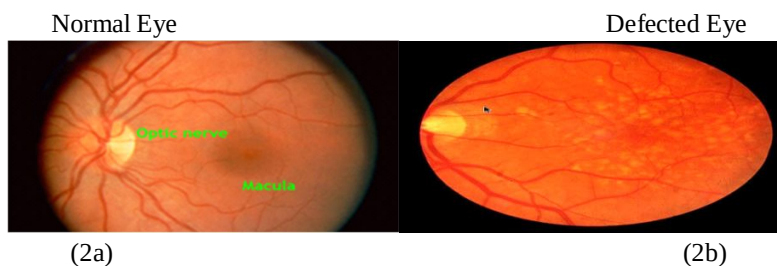


Fig 2: Normal eye(2a) ,Defected eye (2b)

III. THE HUMAN EYE

Light make us able to see the objects through the healthy Eye. When light falls on our eyes, Photo receptors absorb them and convert them in to electrochemical signals that 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. This whole process is too much complex and would not be possible without healthy Eye system and light. Without light, there is no world. The human eye is most important organ which gives us the sense of sight and it allows us to learn about the surrounding world than any of the other senses.[2]

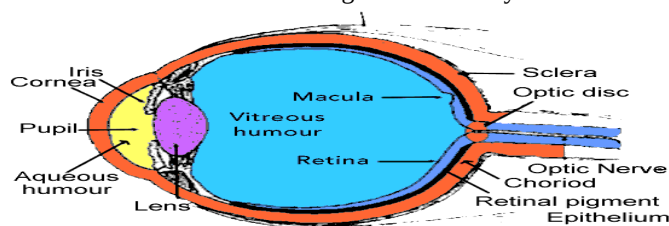


Fig: 3:- Human Eye

IV. THE BIONIC EYE

In this bionic eye system there will be a small digital camera developed using MOMS technology, an external processor and an implant with a Nano chip and stimulating electrodes, these all are surgically placed in the back of the eye. MEMS Technology paved way through a bionic eye to allow blind people to see again.

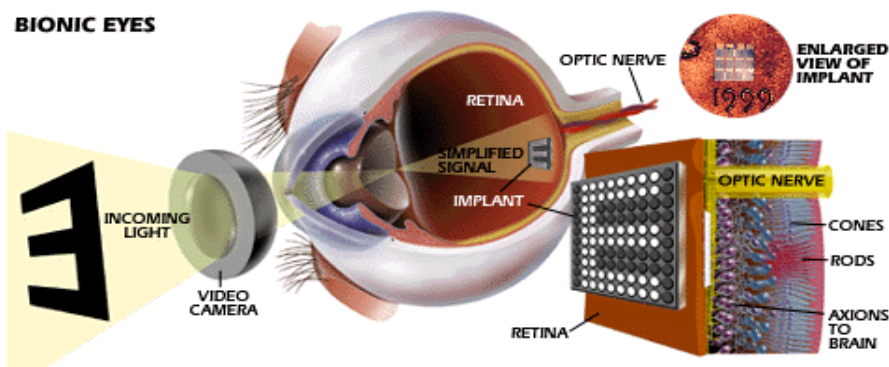


Fig: 4:-The Bionic eye

In artificial Eye system there is an embedded computer chip which is kept in the back of the patient's eye, linked up Google glasses that they wear. The captured images are beamed to the chip, which translates them into impulses and that can be interpreted by the brain. [3]

V. HOW BIONIC IMPLANT WORK

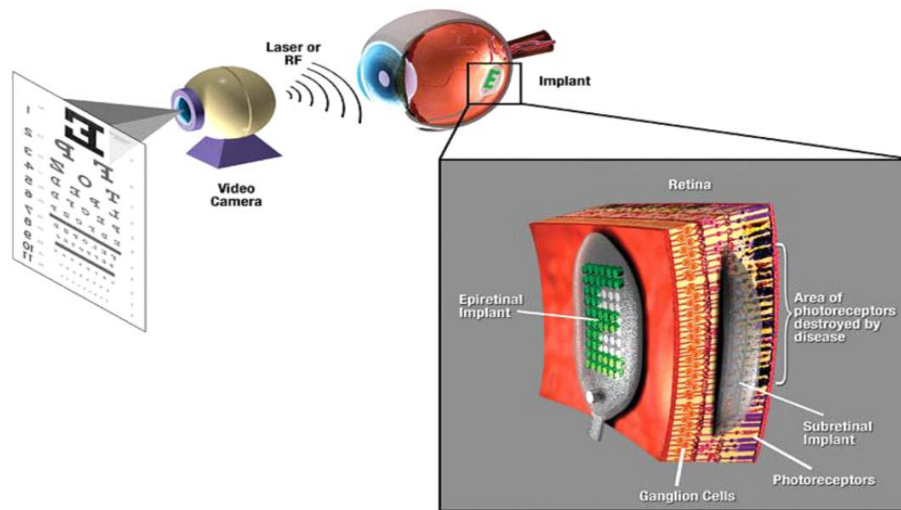


Fig 5:- Bionic eye working

The artificial eye system is connected with Google glasses, which transmits high-frequency radio signals to the embedded microchip implanted in the partially defected retina. The microelectrodes on the implanted chip convert these signals into electrical impulses to stimulate cells in the remaining healthy portion of retina that connect to the optic nerve. These impulses are then converted in to electrochemical pulses by the remaining healthy photoreceptor cells and then passed down along the optic nerve to the vision processing centers of the brain, where they are interpreted as an image.

Bionic eye system is one of the greatest boons given by the MEMS technology. The application of bionic eye system is infinite. The bionic eye presented in this paper will come as a dream come true for blind people.

The size of this device is 2 millimeters across and contains some 4000 micro photodiodes and is placed behind the retina, this collection of miniature solar cells is designed to convert normal light to electrical signals, which are then transmitted to the brain by the remaining healthy parts of the retina.

In this artificial eye the following components have been integrated with the lens using custom-built optoelectronic components.[1]

- A. Control Circuits
- B. Communication Circuits
- C. Miniature Antennas
- D. LED

The light emitting diode will form the images in front of the eyes and hence we would require around 100s of this LEDs. This will form images such as, words, charts, and photographs. The hardware used in this is a semitransparent because of which the patent will be able to navigate his surroundings without any problem. One of the main reasons for possibility of fabricating the component on single polymer based contact lens is NEMS technology. Because of this technology, we can manufacture these functional devices on such a tiny scale and then incorporate these tiny functional devices on the polymer lens.

VI. FABRICATION PROCESS USING MEMS TECHNOLOGY

The fabrication process involves integration of electronic components like control circuits, communication circuits, miniature antennas and LEDs. In order to fabricate the components for silicon circuits and LEDs, we need to make use of high temperatures and also corrosive chemicals, because of this we cannot manufacture them directly on to lens and we also have to make sure that all the component of lens are miniaturized and integrated onto about 1.5 square centimeters of a flexible, transparent polymer. This problem can be eliminated by the use of self-assembly process.[4]

In Self-assembly a disorganized system of pre-existing components forms an organized structure or pattern as a consequence of specific, local interactions among the components themselves without external direction.

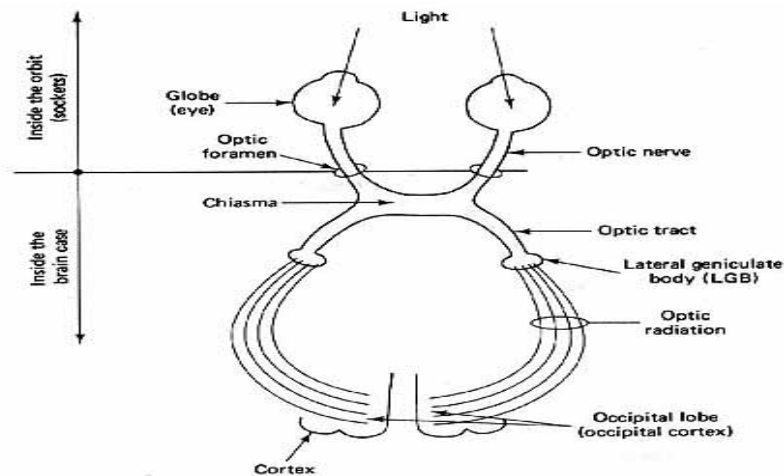


Fig:-6. site of implant

VII. POWER SUPPLY

As we know that this artificial eye system is power operated system hence it requires the power supply for its operation. One of the best sources of power for electronic component integrated with in lens would be Nano generators.

The Nano generators are very effective and small in size; it does not require petrol or diesel like other generators for its mechanical movement instead even a small finger movement of our body will be enough to produce a considerable amount of electricity required.

This generator works on the principle of piezoelectric effect, this could play a vital role in providing the power source for bionic eye cause this will avoid the use of battery which is a toxic instead we can use Nano generator which will produce electricity due to flow of blood which gives it a mechanical force.

Flexing the nanowires (actuators) through vibration (like sound waves) produces a current in the wire. When the wire bends far enough to touch a discharge electrode, the current is transferred. So, the more the nanowire gets bent or vibrated, the more current it produces.[5] The Nano wire used here in Nano generator is zinc oxide. Mechanical vibration which is needed for this generator can be obtained by blood flow or movement of iris. Based on arrays of vertically-aligned zinc oxide nanowires that move inside a novel “zigzag” plate electrode, the Nano generators provides a new way to power bionic eyes without batteries or other external power sources.

VII. APPLICATION OF BIONIC EYE

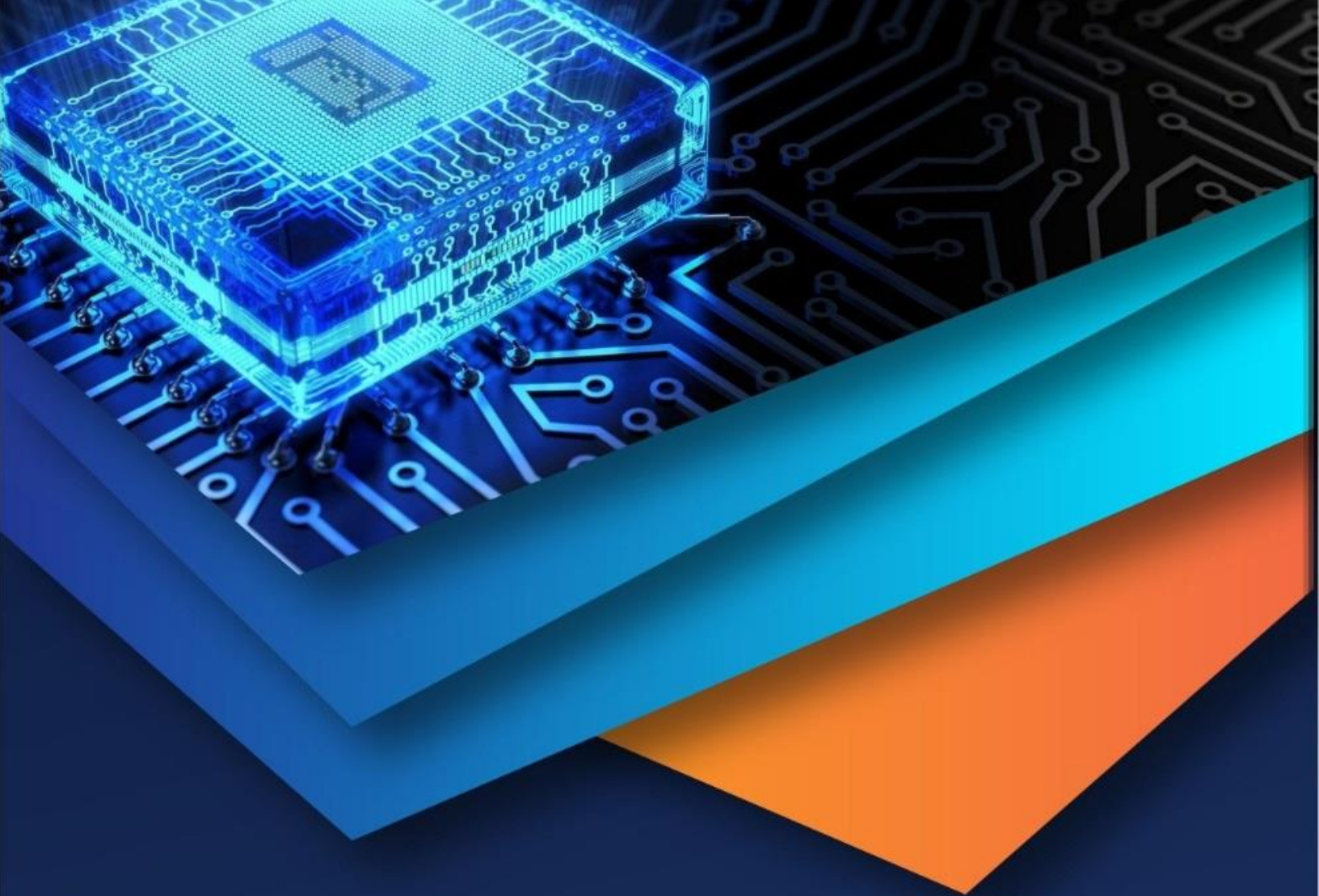
- A. It can play a vital role in the field of medical electronics.
- B. These lenses that can superimpose computer-generated high-resolution color graphics on a user's real field of vision.
- C. Sensors built onto lenses would let diabetic wearers keep tabs on blood-sugar levels without needing to prick a finger
- D. Virtual gamers could use the real world as a backdrop for their adventures.

VIII. CONCLUSION

Now, it's not a dream to restore the sight of a blind people today. Bionic Eyes have made this true. Though there are a number of challenges to be faced before this technology reach the common man, the path has been laid. This paper has tried to present the concept of Artificial Vision called “Bionic Eyes”. It is just a matter of time, may be 4-5 years that the blind will be able to see through these Bionic Eyes, with thanks to Science and Technology.

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