

A

Seminar report

On

Artificial Eye

Submitted in partial fulfillment of the requirement for the award of degree
Of CSE

SUBMITTED TO:
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Preface

I have made this report file on the topic **Artificial Eye**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude towho assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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Acknowledgement

I would like to thank respected Mr..... and Mr.for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

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Introduction

In the current scenario, where over millions of people are affected by visual anomalies, it was with a challenge that this project came into being. It aims at restoring vision to the blind.

Today, high-tech resources in microelectronics, Optoelectronic, computer science, biomedical engineering and also in vitreo retinal surgery are working together to realize a device for the electrical stimulation of the visual system.

Artificial Eye, which works through retinal implants, could restore sight to millions of people around the world who suffer from degenerative eye diseases. This technology is still in its infancy, but has progressed to human trials. This report aims to present a brief overview about the basic aspects of this technology and where it's headed.

What is artificial eye?

An ocular prosthesis or artificial eye is a type of craniofacial prosthesis that replaces an absent natural eye following an enucleation, evisceration, or orbital exenteration. The prosthesis fits over an orbital implant and under the eyelids.

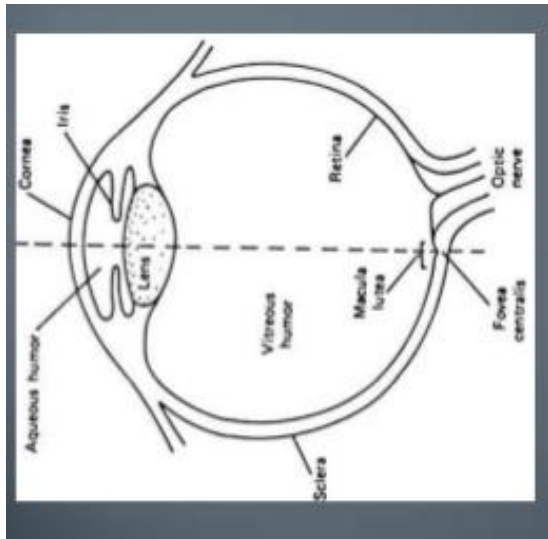
The History of Artificial Eyes

Prior to World War II, ocular prosthetics were made of specialized blown glass that collapsed to form a concave shape. During and after World War II this glass became increasingly difficult to obtain. Soon, acrylic and other plastic polymers were being used for many of the uses previously exclusive to glass. An exciting use of this new material was for artificial eyes, or ocular prosthetics. Acrylic revolutionized the art and process of making ocular prosthetics.

In comparison to glass, acrylic provided better comfort and fit. Glass artificial eyes frequently needed replacing and broke easily. Acrylic improved the techniques for making artificial eyes such as impression molding, blending and allowed for easier changes in shape, color or size of an ocular prosthesis.

How eyes work?

The light coming from an object enters the eye through cornea and pupil. The eye lens converges these light rays to form a real, inverted and diminished image on the retina. The light sensitive cells of the retina get activated with the incidence of light and generate electric signals. These electric signals are sent to the brain by the optic nerves and the brain interprets the electrical signals in such away that we see an image which is erect and of the same size as the object.

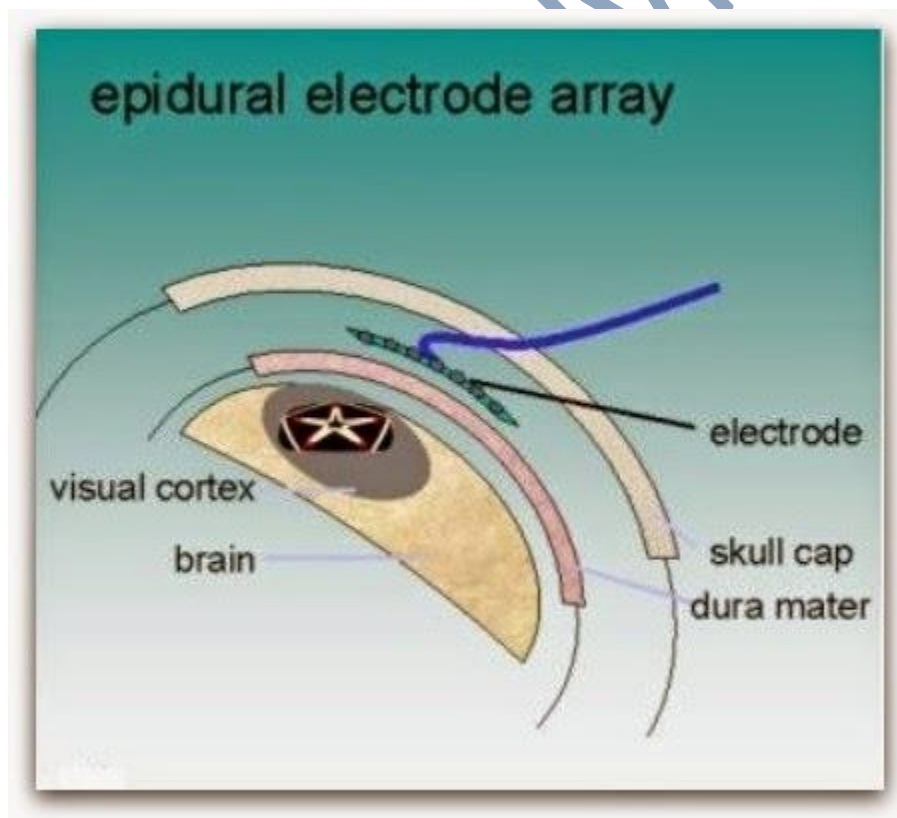


Visual System

The human visual system is remarkable instrument. It features two mobile acquisition units each has formidable preprocessing circuitry placed at a remote location from the central processing system (brain). Its primary task include transmitting images with a viewing angle of at least 140deg and resolution of 1 arc min over a limited capacity carrier, the million or so fibers in each optic nerve through these fibers the signals are passed to the so called higher visual cortex of the brain.

The nerve system can achieve this type of high volume data transfer by confining such capability to just part of the retina surface, whereas the center of the retina has a 1:1 ration between the photoreceptors and the transmitting elements, the far periphery has a ratio of 300:1. This results in gradual shift in resolution and other system parameters.

At the brain's highest level the visual cortex an impressive array of feature extraction mechanisms can rapidly adjust the eye's position to sudden movements in the peripherals filed of objects too small to se when stationary. The visual system can resolve spatial depth differences by combining signals from both eyes with a precision less than one tenth the size of a single photoreceptor.

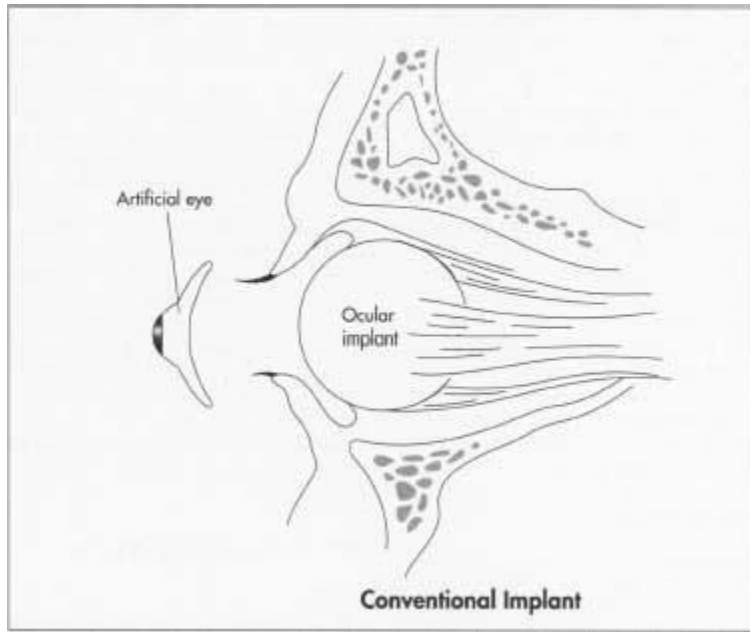


The Manufacturing Process

The time to make an ocular prosthesis from start to finish varies with each ocularist and the individual patient. A typical time is about 3.5 hours. Ocularists continue to look at ways to reduce this time.

There are two types of prostheses. The very thin, shell type is fitted over a blind, disfigured eye or over an eye which has been just partially removed. The full modified impression type is made for those who have had eyeballs completely removed. The process described here is for the latter type.

1. The ocularist inspects the condition of the socket. The horizontal and vertical dimensions and the periphery of the socket are measured.
2. The ocularist paints the iris. An iris button (made from a plastic rod using a lathe) is selected to match the patient's own iris diameter. Typically, iris diameters range from 0.4-0.52 in (10-13 mm). The iris is painted on the back, flat side of the button and checked against the patient's iris by simply reversing the buttons so that the color can be seen through the dome of plastic. When the color is finished, the ocularist removes the conformer, which prevents contraction of the eye socket.
3. Next, the ocularist hand carves a wax molding shell. This shell has an aluminum iris button imbedded in it that duplicates the painted iris button. The wax shell is fitted into the patient's socket so that it matches the irregular periphery of the socket. The shell may have to be reinserted several times until the aluminum iris button is aligned with the patient's remaining eye. Once properly fitted, two relief holes are made in the wax shell.
4. The impression is made using alginate, a white powder made from seaweed that is mixed with water to form a cream, which is also used by dentists to make impressions of gums. After mixing, the cream is placed on the back side of the molding shell and the shell is inserted into the socket. The alginate gels in about two minutes and precisely duplicates the individual eye socket. The wax shell is removed, with the alginate



For a conventional implant, the surgeon removes the eyeball by severing the muscles, which are connected to the sclera (white of eyeball). The surgeon then cuts the optic nerve and removes the eye from the socket. An implant is then placed into the socket to restore lost volume and to give the artificial eye some movement, and the wound is closed.

impression of the eye socket attached to the back side of the wax shell.

5. The iris color is then rechecked and any necessary changes are made. The plastic conformer is reinserted so that the final steps can be completed.
6. A plaster-of-paris cast is made of the mold of the patient's eye socket. After the plaster has hardened (about seven minutes), the wax and alginate mold is removed and discarded. The aluminum iris button has left a hole in the plaster mold into which the painted iris button is placed. White plastic is then put into the cast, the two halves of the cast are put back together and then placed under pressure and plunged into boiling water. This reduces the water temperature and the plastic is thus cured under pressure for about 23 minutes. The cast is then removed from the water and cooled.
7. The plastic has hardened in the shape of the mold with the painted iris button imbedded in the proper place. About 0.5 mm of plastic is then removed from the anterior surface of the prosthesis. The white plastic, which overlaps the iris button, is ground down evenly around the edge of the button. This simulates how the sclera of the living eye slightly overlaps the iris. The sclera is colored using paints, chalk, pencils, colored thread, and a liquid plastic syrup to match the patient's remaining eye. Any necessary alterations to the iris color can also be made at this point.
8. The prosthesis is then returned to the cast. Clear plastic is placed in the anterior half of the cast and the two halves are again joined, placed under pressure, and returned to the hot water. The final processing time is about 30 minutes. The cast is then removed and

cooled, and the finished prosthesis is removed. Grinding and polishing the prosthesis to a high luster is the final step. This final polishing is crucial to the ultimate comfort of the patient. The prosthesis is finally ready for fitting.

The eye

the main part in our visual system is the eye. Our ability to see is the result of a process very similar to that of a camera. A camera needs a lens and a film to produce an image. In the same way, the eyeball needs a lens (cornea, crystalline lens, vitreous) to refract, or focus the light and a film (retina) on which to focus the rays. The retina represents the film in our camera. It captures the image and sends it to the brain to be developed.

EPI Retinal Encoder

The design of an epiretinal encoder is more complicated than the sub retinal encoder, because it has to feed the ganglion cells. Here, a retina encoder (RE) outside the eye replaces the information processing of the retina. A retina stimulator (RS), implanted adjacent to the retinal ganglion cell layer at the retinal 'output', contacts a sufficient number of retinal ganglion cells/fibers for electrical stimulation. A wireless (Radio Frequency) signal- and energy transmission system provides the communication between RE and RS. The RE, then, maps visual patterns onto impulse sequences for a number of contacted ganglion cells by means of adaptive dynamic spatial filters. This is done by a digital signal processor, which, handles the incoming light stimuli with the master processor, implements various adaptive, antagonistic, receptive field filters with the other four parallel processors, and generates asynchronous pulse trains for each simulated ganglion cell output individually. These spatial filters as biology-inspired neural networks can be 'tuned' to various spatial and temporal receptive field properties of ganglion cells in the primate retina.

SUB Retinal Implantation

The subretinal approach is based on the fact that for instance of retinitis pigmentosa; the neuronal network in the inner retina is preserved with a relatively intact morphology. Thus, it is appropriate for excitation by extrinsically applied electrical current instead of intrinsically delivered photoelectric excitation via photoreceptors. This option requires that basic features of visual scenes such as points, bars, edges, etc. can be fed into the retinal network by electrical stimulation of individual sites of the distal retina with a set of individual electrodes.

Subretinal approach is aiming at a direct physical replacement of degenerated photoreceptors in the human eye, the basic function of which is very similar to that of solar cells, namely delivering slow potential changes upon illumination. The quantum efficiency of photoreceptor action, however, is 1000 times larger than that of the corresponding technical de-vices. Therefore the intriguingly simple approach of replacing degenerated photoreceptors

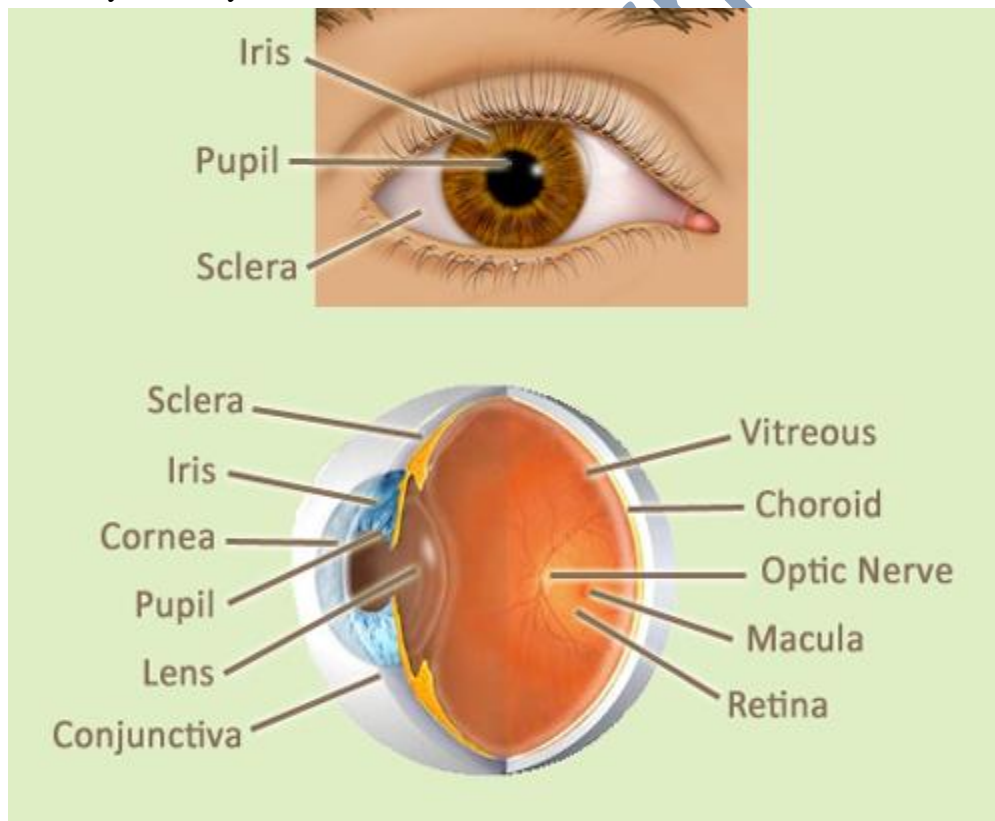
by artificial solar cell arrays has to overcome some difficulties, especially the energy supply for successful retina stimulation.

Human Eye Conditions

The purpose of this section is to provide some background on human eye conditions that can lead to vision loss and eye removal. The journey that leads one to our office is often not a pleasant one. We feel quite privileged to be involved in the restoration and "return to normalcy" of our patients. We hope this information will be helpful. The various sections we cover are:

- Anatomy of the eye
- 3 types of eye removal
- Orbital eye implants
- Possible conditions leading to an artificial eye
- Possible conditions leading to a scleral shell
- Eye care specialists
- Leading causes of eye loss in children

Anatomy of the eye



- The choroid, which carries blood vessels, is the inner coat between the sclera and the retina.
- The conjunctiva is a clear membrane covering the white of the eye (sclera).
- The cornea is a clear, transparent portion of the outer coat of the eyeball through which light passes to the lens.
- The iris gives our eyes color and it functions like the aperture on a camera, enlarging in dim light and contracting in bright light. The aperture itself is known as the pupil.
- The lens helps to focus light on the retina.
- The macula is a small area in the retina that provides our most central, acute vision.
- The optic nerve conducts visual impulses to the brain from the retina.
- The pupil is the opening, or aperture, of the iris.
- The retina is the innermost coat of the back of the eye, formed of light-sensitive nerve endings that carry the visual impulse to the optic nerve. The retina may be compared to the film of a camera.
- The sclera is the white of the eye.
- The vitreous is a transparent, colorless mass of soft, gelatinous material filling the eyeball behind the lens.

Three Types of Eye Removal

- **EVISCERATION**- removal of the inner eye contents, iris and cornea; leaving the sclera behind with the extraocular muscles still attached. Typically, an orbital implant is placed inside the sclera to replace lost eye volume. A scleral shell is fit following this eye surgery.
- **ENUCLEATION**- removal of the eyeball, leaving the remaining orbital contents intact; extraocular muscles are detached and typically reattached to an orbital implant or fat graft. Indications: tumors, infections, blind painful eye, severe trauma. An artificial eye is fit following this eye surgery.
- **EXENTERATION**- removal of the contents of the eye socket (orbit) including the eyeball, fat, muscles and other adjacent structures of the eye. The eyelids may also be removed in cases of cutaneous cancers and unrelenting infection. A maxillofacial prosthesis is typically recommended following this surgery.

Orbital Implants

Should eye removal be necessary, the surgeon will likely place an orbital implant to recover some of the volume lost in the evisceration or enucleation. The orbital implant is attached to the 4 rectus muscles, providing movement of the implant with the fellow eye. Typically, the better the movement of the implant, the better the motility of the artificial eye or scleral shell.

Implant choices may be dictated by the conditions indicating eye removal, the surgeon's preference and your post-removal objectives. Most implants are spherical in shape, but other shapes are possible. Implants can also be coated or wrapped in donor sclera or alloderm materials. Below is a list of typical orbital implants:

- Silicone or PMMA Sphere
- Medpore (porous polyethylene)
- Bio-Eye Hydroxyapatite (HA)
- Fat Graft

While implant type is an important decision to one facing enucleation or evisceration, the most important factor is surgical technique. If you are facing the option of eye removal, we recommend that you contact your local ocularist for a recommendation of oculoplastic or ophthalmic surgeons in your area.

Possible Conditions Leading to an Artificial Eye

The following conditions may lead to the necessity of a custom ocular prosthesis or artificial eye. An artificial eye is fit over an orbital implant that is attached to the existing eye muscles. A custom eye prosthesis made with an impression-fitting technique should move as well as the tissue in the socket moves, depending on the shape and edges of the prosthesis.

ENUCLEATION - Removal of entire eye globe. An implant is placed in the tenons capsule to replace volume lost due to eye removal. The four extra-ocular rectus muscles are attached to the implant for motility.

BLIND, PAINFUL EYE - Condition in which eye has no light perception (NLP) and is causing pain. Enucleation is indicated to alleviate pain and avoid risk of sympathetic ophthalmia.

OCULAR MELANOMA - A type of cancer arising from the cells of melanocytes found in the eye. Melanoma is the most common type of ocular cancer.

DIABETIC RETINOPATHY - A leading cause of blindness in American adults, this disease is caused by changes in the blood vessels of the retina. The vessels either leak fluid or abnormal vessels grow on the surface of the retina. Often there are no symptoms or pain in the early stages.

TUMORS - Many types of cancers can affect the different structures of the eye. If treatment is unsuccessful in removing the tumor, enucleation is typically indicated.

TRAUMA - The most common cause of eye loss, trauma can take many forms; ruptured globe, penetrating or perforating eye injury, blunt force trauma. When risk of infection or pain is high, enucleation is typically indicated.

RUPTURED GLOBE - Full thickness wound of the eyewall caused by a blunt object or blunt force.

PENETRATING EYE INJURY - Injury to the eye that causes an entrance wound and/or an intraocular foreign body.

PEFORATING EYE INJURY - Injury to the eye that causes an entrance and exit wound as in for example a BB pellet that enters in one location and exits another.

CATARACT - A condition in which the lens of the eye becomes cloudy, diminishing vision.

Cataracts are commonly associated with aging but also may be precipitated by trauma

INFECTION - Many types of infections can result in the loss of vision or the necessity to remove the eye to protect the rest of the body from infection. Shingles, uveitis, endophthalmitis, corneal ulcer, etc.

VITREOUS HEMORRHAGE - Bleeding in the vitreous cavity in front of the retina. May be caused by either disease or injury.

ENDOPHTHALMITIS - A serious intraocular bacterial infection, often the result of a penetrating eye injury.

Conclusion and Future Scope

The application of the research work done is directed towards the people who are visually impaired. People suffering from low vision to, people who are completely blind will benefit from this project. The findings regarding biocompatibility of implant materials will aid in other similar attempts for in human machine interface. Congenital defects in the body, which cannot be fully corrected through surgery, can then be corrected.

There has been marked increase in research and clinical work aimed at understanding low vision. Future work has to be focused on the optimization and further miniaturization of the implant modules. Commercially available systems have started emerging that integrates video technology, image processing and low vision research.

Implementation of an Artificial Eye has advantages. An electronic eye is more precise and enduring than a biological eye and we cannot altogether say that this would be used only to benefit the human race. In short successful implementation of a bioelectronic eye would solve many of the visual anomalies suffered by human's to date.

To be honest, the final visual outcome of a patient cannot be predicted. However, before implantation several tests have to be performed with which the potential postoperative function can be estimated. With this recognition of large objects and the restoration of the day-night cycle are the primary goals of the prototype implant

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