

Bionic Eye PhD projects

Overall aim: To develop an electronic implant capable of restoring reading vision to people suffering from degenerative retinal conditions.

Background: Age-related macular degeneration is the leading cause of visual impairment among people over 65 in Western countries; it is responsible for 48% of all blindness in Australia; in the United Kingdom its incidence has increased by 30-40% over the past 40 years; 700,000 patients are newly diagnosed every year in the US, 10% of whom become legally blind each year. Another degenerative retinal condition, retinitis pigmentosa, is the leading cause of inherited blindness and affects 1.5 million people worldwide. It generally occurs in a younger age group (incidence 1 per 3500-4000 live births).

Research: The focus of this project on development of a visual prosthesis (Bionic Eye) that consists of an array of electrodes implanted on the surface of the retina to stimulate the optic nerve in the eye, acting as a substitute for the photoreceptors that have degenerated or been badly damaged and no longer function effectively. The intraocular component of this prosthesis is implanted surgically and fixed onto the retina. The power required by the implant is transmitted inductively from outside the eye, in a similar way to that used in cochlear implants, enabling the retinal implant to stimulate the optic nerve cells. In the first generation device, the visual image will be captured on a miniature video camera and is transmitted wirelessly by an ultra-high frequency radio link to the implant. This arrangement allows substantial processing of the signal before it is sent to the implant, thereby improving visual perception. By electrically stimulating the appropriate electrodes, the optic nerve is activated and it transmits the signal to the visual cortex of the brain. Retinal prostheses are only viable if the visual pathway from the retina to the brain is intact and functional, as is the case for the most common forms of blindness. Like the cochlear implant, the implanted component is hermetically sealed, so as to avoid any fluids from coming into contact with the electrical components of the implant, and the materials must be biocompatible, in order to avoid any adverse tissue reaction.

Team: The project is carried out at the Bionic Ear Institute in collaboration with our research partners:

- NICTA (National Information and Communication Technology Australia),
- CERA (Centre for Eye Research Australia),
- Department of Ophthalmology, the University of Melbourne,
- Department of Biomedical Engineering, University of New South Wales.

Summary: This comprehensive approach to the development of a Bionic Eye, inclusive of surgeons, neuroscientists, ophthalmologists, and electrical engineers, is unique to this project. Such an approach underpinned the success of the Bionic Ear. Together the development of the Bionic Eye with this strong collaborative environment provides excellent opportunities for PhD projects in disciplines ranging from bioengineering, surgery and visual neuroscience.

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An example of a potential project:

The degenerating retina in blindness: Implications for a bionic eye

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The project: A retinal prosthesis is designed to provide basic visual cues to the blind by selective electrical stimulation of retinal ganglion neurones. The loss of rods and cones sets in place complex degenerative changes in the normally highly organised retina that will have important implications for the efficacy of a bionic eye. Little is known about these neurodegenerative changes. This project will use a variety of microscopy techniques (light, confocal, electron microscopy) to document the changes in the retina over time following loss of vision. It is envisaged that at least two models of blindness will be studied in this project.

The student: We are looking for a highly motivated PhD student with first class honours in neuroscience/pathology. The successful student would need to be familiar and have an interest in neurodegeneration and at least some microscopy experience (preferably using fluorescent microscopy). The project would be jointly supervised by staff from the Bionic Ear Institute, Centre for Eye Research Australia and the Department of Ophthalmology, University of Melbourne. A top-up to an APA scholarship would be available.