nz national eye centre

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Auckland Retinal Modeling Initiative (ARMI)

Where: **Main Seminar room, Bioengineering Institute, Level 1 – 70 Symonds st**

When: **Thursday, 2nd of February, 8:30 – 17:00**

Who: **Biography of the presenters is attached**

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The human retina is a unique component of the nervous system in that throughout life it is continuously exposed to optical radiation. The retina is also unique in the sense that is has the highest energy-consumption per weight in the human body. This means that the constant supply of blood (therefore oxygen) to this sensory tissue is vital to maintain a healthy vision. A disturbed retinal homeostasis (e.g. diabetes, aging, malnutrition) will result in direct deterioration of human vision which is irreversible in many cases. The most common forms of retinal pathologies are Age-related Macular Degeneration (AMD), Diabetic Retinopathy (DR) and Diabetic Edema (DE). In 2004, an estimated 20.5 million people were affected by one these pathologies in the United States alone.

At ARMI we are aiming at bringing multiple international groups with extensive expertise in different aspects of retinal-biomedical research. This multidisciplinary international gathering is consisted of business experts in the field of commercial medical imaging, bioengineering specialists with a track record in ocular tissue modeling, retinal prosthesis R&D scientists, optometrists and ophthalmologists. We believe it is the right time to bring these very different and yet cohesive retinal researches together, in order to produce a comprehensive commercially-viable system approach to early detection, continuous monitoring, and treatment of various common retinal pathologies. The following is a brief introduction of the presenters of the ARMI meeting in Auckland, February 2012.

Auckland Bioengineering Institute (ABI)

Peter Hunter: Prof Hunter holds engineering degrees from Auckland University and a DPhil (PhD) in Physiology from Oxford University. He is currently a Professor of Engineering Science and Director of the Bioengineering Institute at the University of Auckland, and a Director of Computational Physiology at Oxford University. As the co-Chair of the Physiome Committee of the International Union of Physiological Sciences he has been helping to lead the international Physiome Project, which aims to use computational methods for understanding the integrated physiological function of the body in terms of the structure and function of tissues, cells and proteins. He is interested in helping to develop models of the retina using the multi-scale modeling framework developed for the Physiome Project and the resources available from the Auckland Bioengineering Institute.

Ehsan Vaghefi: He received his BSc in Biomedical Engineering from the Polytechnic University of Tehran in 2005 and then obtained his MSc in Biomedical Sciences with high distinction at the University of New South Wales, 2006. He then completed his PhD at ABI on modeling and imaging the fluid dynamics of the ocular lens using high-resolution MRI in 2010.

Dr Vaghefi is an expert in the imaging-based computational modeling of ocular tissues, using a wide range of imaging modalities. By implementing multi-modal imaging data in computational models, he has characterized the fluid dynamics of the ocular lens. His research has led to a number of publications in high ranked peer reviewed journals. He is currently expanding the imaging-based computational modeling approach to the retina, in order to construct a comprehensive computer model of the fluid dynamics of the human eye.

Industrial Research Limited (IRL)

Evan Hirst: He holds a PhD in Engineering from Massey University. His research concerned the design and use of SAW devices as biosensors, using the concept of binding energy-dependent bond rupture. Some of this work was carried out at Industrial Research Limited (IRL) where he has subsequently been employed as a Research Engineer. Evan's main project at IRL has been the development of RWC retinal speckle device. He played a major role in the adaptation of the fundus camera optics, and is responsible for data acquisition and the development of processing algorithms.

Mike Andrews: In the distant past Mike Andrews, gained a PhD in Space Physics from Imperial College. Since then he has worked on many projects, frequently linked by the thread of wave propagation. Latterly he had an 8-year association with the Australasian timber industry, which resulted in the commercial development of several instruments now used internationally in forestry for predicting the engineering properties of sawn wood by sonic and optical means. The use of laser light scatter there developed into an investigation of biospeckle, and its use in the measurement of dermal blood flow. He and Oliver Thompson, now completing a Ph.D at ABI, devised a method of quantifying speckle measurements, which put the technique on an equal footing with Doppler measurements. The retinal project with Evan is about applying speckle to measurements within the eye, where the targets are both general perfusion and the directed flow encountered within the discrete vessels. Mike is a Distinguished Scientist at IRL.

Diana Siew: She was trained in vibrational spectroscopy, specializing in structure-function of biological and synthetic polymers. Before joining IRL, she was a postdoctoral fellow at the Department of Surgery, University of Auckland in conjunction with the NZ Eye Bank where she was developed micro-Raman spectroscopy into a tool to assess corneal viability prior to transplantation. As part of this work, Diana studied the role of water in biological systems to determine how this affects chemical reactions in the human body.

Diana is presently a science manager, leading the Medical Device Technology Group at IRL. Her strengths are in strategy development and implementation, as well as relationship development. She plays an active role in the medical device sector in New Zealand, and is on the leadership committee of the Emerging Medical Technology Industry Group. Diana also co-leads (with Peter Hunter) the Consortium of Medical Device Technology (CMDT), a national network of researchers in New Zealand focused on medical technology development.

University of Nottingham (UoN)

Kevin Webb: He has established an international track record in the visual system through multiple publications in the ocular lens and retina. He was a Bright Futures Top Achiever Doctoral Scholar during his PhD, applying electrophysiology and imaging to the ocular lens. He was first to obtain alive and characterize in detail the highly specialized fiber cells of the ocular lens, and to confirm their functional role in the volume regulation and physiology of the lens. Kevin continues to apply novel methodologies to both the retina and ocular lens, among them two-photon microscopy, SPR imaging, picosecond ultrasound imaging, and scanning ion conductance microscopy.

Dr Webb, a fellow University of Auckland PhD, is an expert in electrophysiological investigations of ocular tissues, currently based at the Institute of Biophysics, Imaging and Optical Science (IBIOS) at the University of Nottingham (UoN). He was recently awarded a 5 year personal Fellowship by the Royal Academy of Engineering (UK) to design and apply novel imaging and electrophysiological methods to study the physiology and fluid dynamics of the retina.

University of College London (UCL)

Phil Luthert: Following an initial period in clinical medicine he moved into academic neuropathology on a Wellcome Trust Fellowship and studied the pathophysiology of the blood-brain barrier with particular reference to experimental glioma models and optimization of CNS drug delivery. He then moved into neurodegeneration in the context of movement disorders, dementia and HIV infection in parallel with completing my clinical training in neuropathology. He moved to the Institute of Ophthalmology in 1994, attracted by the challenge of building up the Department of Pathology and bringing my previous experience to ophthalmology. Since then he has developed an expertise in ophthalmic pathology with an emphasis on retinal disorders including inherited retinal degeneration and age-related macular degeneration.

On a parallel path, he began to work with Adam Sillito, the Institute Director, over broader management issues and in 1997 he asked me to become Deputy Director after which he worked closely with him over all aspects of Institute management.

In October 2005 he accepted the position of Acting Director of the Institute with a specific brief to resolve a number of internal difficulties facing the Institute and in February 2006 he became Institute Director. Since then, the Institute has become financially stable and more closely integrated with Moorfields Eye Hospital and UCL. He has recently started my 2nd 5 year term as Director.

Alexander Foss: He is an ophthalmologist with interests in medical retinal disorders including diabetic retinopathy and macular degeneration. He is particularly interested in the potential utilization of mathematical modeling in medicine; both as a way to generate hypotheses and as a possible way to improve clinical decision making. Modeling projects to date have been on the photoreceptor outer segment, the retinal ganglion cell axon, oxygen profiling across the retina, retinal metabolism and the retinal venous pulse. These projects have all been undertaken as collaborations with help from applied mathematicians.

University of New South Wales (UNSW)

Nigel Lovell: He received the B.E. (Hons) and Ph.D. degrees from the University of New South Wales (UNSW), Sydney, Australia. He is currently Professor of Biomedical Engineering with the Graduate School of Biomedical Engineering. He has authored 350+ refereed journals, conference proceedings, book chapters and patents, and been awarded over $68 million in R&D and infrastructure funding. His research work has covered areas of expertise ranging from cardiac modeling, telehealth technologies, biological signal processing, and visual prosthesis design. Through a spin-out company from UNSW, TeleMedCare Pty. Ltd., he has commercialised a range of telehealth technologies for managing chronic disease and falls in the older population. He is also one of the key researchers leading an R&D program to develop an Australian bionic eye.

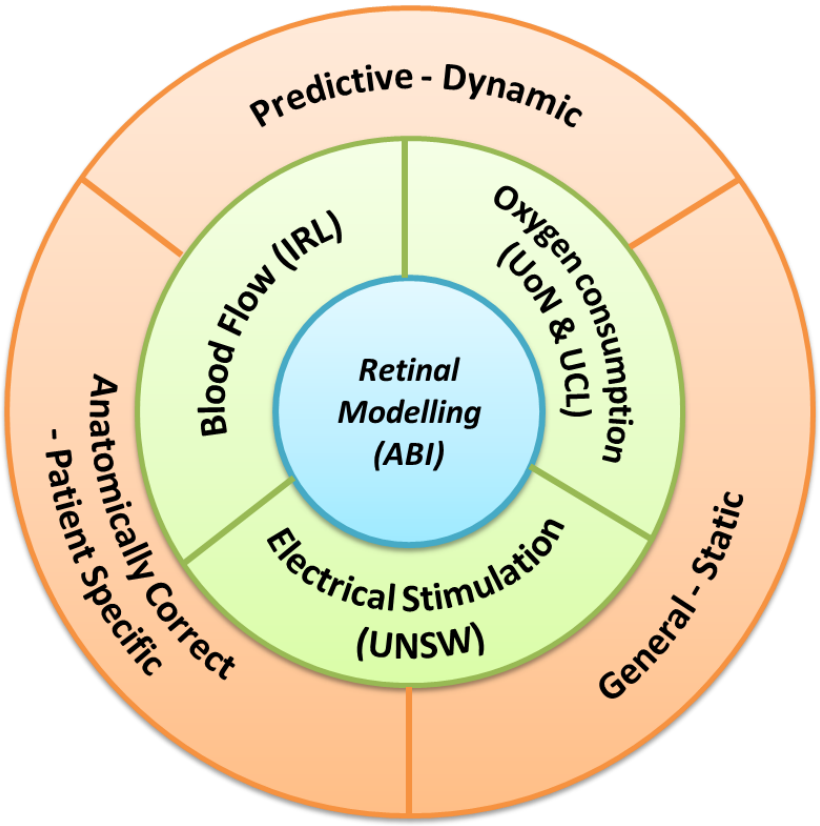
Prof. Lovell was the IEEE Engineering in Medicine and Biology Society (EMBS) Vice President (VP) for Conferences (2004/2005 and 2010/2013) and VP for Member and Student Activities (2002/2003). He was the conference co-chair for the 2003 World Congress in Medical Physics and Biomedical Engineering, held in Sydney Australia, scientific co-chair for the Annual IEEE EMBS conference in Lyon France in 2007, and was awarded the IEEE Millennium Medal for services to the EMBS and the profession.

His interest in the retinal research is sparked by the desire to devise novel stimulation strategies to allow recipients of visual prostheses to perceive a visual scene and thus deliver some form of functional vision in those people who are profoundly vision impaired. There exist very few excitable cell models of the neural retina and even fewer models of the retina's responses to electrical stimulation. Such models will hopefully help inform the design of visual prostheses in terms of electrode geometries, placement and stimulation paradigms.

Socrates Dokos: He received the Ph.D. degree in biomedical engineering from the University of New South Wales (UNSW), Sydney, N.S.W., Australia, in 1996. He is currently a Senior Lecturer in the Graduate School of Biomedical Engineering, UNSW. His research interests include electrical and mechanical properties of cardiac and other excitable tissues using experimental and mathematical modeling techniques. He has authored or coauthored more than 40

papers and abstracts in international journals and meetings. Socrates is senior lecturer in the Graduate School of Biomedical Engineering, University of new South Wales, Sydney, Australia, where his research interests center on modeling the electrical activation of excitable tissues, including the retina.

At present, he is coordinating a number of computational modeling projects within Bionic Vision Australia, a research consortium which aims to develop a vision prosthesis for the blind. These projects include the development of finite-element continuum network models of electrical stimulation of healthy and degenerate retinas, as well as ionic modeling of retinal neuron action potentials using large scale parameter fits to multiple whole-cell patch-clamp data. This work also involves in-vitro experimentation to provide appropriate input to validate the models and fine-tune parameters, in order to accurately model the temporo-spatial dynamics of activation of retinal ganglion cells by bipolar electrode arrays.


Predictive - Dynamic
Oxygen consumption (UoN & UCL)
General - Static
Electrical Stimulation (UNSW)
Anatomically Correct - Patient Specific
Blood Flow (IRL)
Retinal Modelling (ABI)