

Report on Sabbatical

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Purpose and Goals

I have had a long-term interest in the microarchitecture of bone, and wished to develop and broaden this to include an understanding of articular cartilage. The development of non-destructive and objective imaging methods for evaluating the state of articular cartilage has the potential to revolutionize both the diagnosis and treatment of osteoarthritis.

The primary goal of my sabbatical research was to develop a convenient and sensitive measure of collagen fiber alignment in articular cartilage that could be used to describe the severity of osteoarthritis. Such a metric would facilitate the use of magnetic resonance (MR) images by orthopedic surgeons to determine the extent of tissue degradation. Magnetic resonance (MR) images of articular cartilage would be acquired under various conditions, and using various pulse sequences, and compared with co-registered images acquired using polarized light microscopy and predictions from computer modelling.

I was also interested in collaborating with other faculty at Queensland University of Technology (QUT) and in the region on related research projects, and in presenting seminars and lessons on clinical applications of digital image processing as described in my recent book, "Digital Image Processing for Medical Applications".

Outcomes

- I explored various approaches to the development of a fiber alignment metric using computer modelling and MRI images – both DTI (diffusion tensor images) and T_2 -weighted images, using images of animal and human knee cartilage with varying degrees of arthritic degradation. The DTI images were acquired with a Bruker Avance 7T nuclear magnetic resonance (NMR) spectrometer at QUT. Different imaging sequences were employed to minimize cross-talk and noise.

The group had had problems running DTI programs. I wrote MatLab code to extract the orientation and maximum values of the principal eigenvector of the diffusion tensor, and display them as a colorized plot. I also produced "quiver" plots of the projection of the principal eigenvectors. I am continuing to finish off code to extract the 2-D autocorrelation function (ACF) of the projections in both the articular plane and the direction orthogonal to it. When these are completed, I expect to calculate a fiber-orientation metric, and to publish the work.

- I gave a seminar at the Institute of Health and Biomedical Innovation (IHBI) and started ongoing collaborations with faculty there, most notably with Nathan Efron's group on the retinopathy of type II diabetes and with Clayton Adam on scoliosis. In the former case, I am continuing to measure the tortuosity of a large number of diabetic and normal images in ongoing collaboration. The scoliosis work is continuing and will soon result in a joint published article.
- Unfortunately preliminary work on an MRI investigation of the possible benefits of essential fatty acid supplementation in schizophrenia has proved inconclusive and has been terminated.
- Preliminary collaboration with CSIRO (Commonwealth Scientific and Industrial Research Organisation) on bone texture has been initiated.
- I had discussions with faculty (Drs. Andrew Fielding, Stephen Hughes, Esa Jaatinen, Konstantin Momot, Jamie Trapp, Tanya Kairn) and students regarding the teaching of image processing and medical imaging courses.
- I met with the Dean of Research (Prof. Martin Sillence) and the Dean (International and Development (Prof. Acram Taji): and articles on my visit appeared in the QUT News and the IHBI Advances.
- I gave a keynote address at the Image and Vision Computing Conference in Wellington (<http://ivcnz2009.massey.ac.nz/keynote.asp>).
- I visited research groups at the University of Waikato (Prof. Michael Cree) and Canterbury (Profs. Phil Bone, Richard Watts) and presented seminars on my research.
- I visited research groups at the Universiti Teknologi Mara (UITM), University of Malaya and Science University of Malaysia (USM). At each venue I stayed 3-4 days and gave seminars and training sessions, and spoke with the University administration regarding possible faculty/student exchange.
- As a result of these contacts I was invited to be the External Assessor for a faculty application for promotion (USM), and the External Examiner of a Ph.D. thesis (UPM, Universiti Putra Malaysia).
- I submitted an article entitled "Image Analysis in Medical Imaging: Overview and Examples " to the Biomedical imaging and Intervention Journal.
- I was invited to edit a book, "Medical Image Processing: Techniques and Applications" by Springer Books. Several of my new contacts in Australia, New Zealand and Malaysia have agreed to contribute chapters.

Summary

The 6-month sabbatical (taken in conjunction with a Fulbright Senior Scholarship) was invigorating and very productive. It allowed me to concentrate on significant research work with prestigious researchers at QUT and IHBI, the results of which will be written up as three peer-reviewed research papers. It allowed me to visit a number of research groups in the region, which increased my professional profile and lead to an invited keynote address, an invitation to edit a book, a Ph.D. examinership, and several publications in preparation.

As a result of this sabbatical, collaboration in both course development and research will continue between QUT and CSUCI. My experiences with new imaging applications will enrich the Applied Physics and Medical Imaging programs at CSUCI. I am very grateful for this opportunity and am very satisfied with the resulting collaborations.