



Department of Computer Science and Software Engineering

2011 Departmental Post-Graduate Conference

September 1-2, 2011

Lecture Theatre 031
Erskine Building (Maths and Computer Science Building)

This conference is sponsored by



Thursday 1st September (Erskine room 031)

Session 1a – Welcome/Keynote

Chairperson: Muhammad Asad Arfeen

9:00 9:15 Coffee / Tea/Orange Juice and muffins

9:15 9:30 Welcome

9:30 10:00 Keynote: Dr. Christoph Bartneck (HIT Lab); intro by Andy Cockburn

Session 1b –Honours

Chairperson: Joey Scarr

10:00 10:20 Will Gittoes: Real-time Vine Model Fitting from Images using Skeletonization.

10:20 10:40 Jin Hong: Green Networking Sleep Mode Algorithms in Wireless Metropolitan Area Network

10:40 11:00 *MORNING REFRESHMENTS*

Session 2 – MSc

Chairperson: Amali Weerasinghe

11:00 11:20 Alexander Chernoglazov: Visualisation and Compression of Spectral CT Datasets.

11:20 11:40 Huaqing Chen: MULTI-FRACTAL FORMULISM FOR SEGMENTING HRCT IMAGES OF THE LUNG.

11:40 12:00 Giles Westerfield: Intelligent Augmented Reality for Assembly and Maintenance.

12:00 12:20 Jacky Tay: Robust Algorithms for Tissue Image Processing using Multifractal and Multi-Scale Techniques.

12:20 12:40 Sang Myung Lee: Maximum Sub-array Problem

12:40 1:50 LUNCH

Session 3 – MSc

Chairperson: Ehsan Tabatabaei Yazdi

1:50 2:10 Ben McDonald: Automated layout for large, shared displays.

2:10 2:30 Geoff Clark: Dynamic Optimisation of a Heterogeneous Wireless Network of Sensors.

2:30 2:50 Samuel Williams: Improved Hybrid Tracking for Mobile Outdoor AR

2:50 3:10 Chunhui Zheng: Vision-based Feature Recognition and Obstacle Detection For Drive Assistance in Indoor Environment.

3:10 3:30 *AFTERNOON REFRESHMENTS*

Friday 2nd September (Erskine room 031)

Session 4 – PhD

Chairperson: Dr. Tim Bell

9:00 9:30 Coffee / Tea/Orange Juice and muffins

9:30 9:50 Muhammad Arfeen: Tracking Superposition of Independent Streams of Teletraffic with Heavy- Tailed inter-arrival times.

9:50 10:10 Kapila Pahalawatta: Airborne Particle Classification with Rayleigh Scattered Images.

10:10 10:30 Thomas Young: Online Biologically-sourced models for time-series prediction.

10:30 10:50 *MORNING REFRESHMENTS*

Session 5 – PhD

Chairperson: Dr. Wolfgang Kreutzer

10:50 11:10 Mofassir Haque: Routing Protocol for Content Centric Future Internet.

11:10 11:30 Stephen Fitchett: AccessRank: Predicting What You'll Do Next.

11:30 11:50 Ansar Ali: Natural Language Processing of Urdu for Information Retrieval.

11:50 12:10 Thammathip Piumsomboon: Toward natural hand interaction for virtual objects manipulation

12:10 12:30 Amali Weerasinghe: Evaluating a General Model of Adaptive Tutorial Dialogues.

12:30 1:30 LUNCH

Session 6 – PhD

Chairperson: Dr. Dong-Seong Kim

1:30 1:50 Ehsan Tabatabaei Yazdi: Adaptive Resource Allocation for Mobile Body Sensor Networks.

1:50 2:10 Mohammed Thaher: Investigating Efficient Algorithms for the Maximum Convex Sum.

2:10 2:30 Joey Scarr: Why the Ribbon Sucks.

2:30 2:50 Amir Shareghi Najjar: Using Example-based strategy in Intelligent Tutoring System.

2:50 3:10 Saghar Izadpanah: Optimal energy-aware resource allocation in data intensive networking applications.

3:10 3:30 *AFTERNOON REFRESHMENTS*

4:00 6:30 Social gathering/Award Ceremony at Erskine Room 447

Abstracts

Keynote: Dr. Christoph Bartneck (Director Postgraduate studies HIT Lab)

Title: Is it good for a robot to look and behave like a human?

Abstract: The research interest in social robotics is currently increasing dramatically. We now have several robotic platforms that are intended to interact with humans. However, little is known about what effect the anthropomorphism of a robot has on how users interact with it. I will present several studies that investigate how anthropomorphism is related to the perception of animacy, intelligence, persuasive power and embarrassment.

Bio: Dr. Christoph Bartneck is a senior lecturer and director of postgraduate studies at the HIT Lab NZ of the University of Canterbury. He has a background in Industrial Design and Human-Computer Interaction, and his projects and studies have been published in leading journals, newspapers, and conferences. His interests lie in the fields of Social Robotics, Design Science, and Multimedia Applications. He has worked for several international organizations including the Technology Centre of Hannover (Germany), LEGO (Denmark), Eagle River Interactive (USA), Philips Research (Netherlands), ATR (Japan), Nara Institute of Science and Technology (Japan), and The Eindhoven University of Technology (Netherlands). Christoph is a member of the New Zealand Institute for Language Brain & Behavior, the IFIP Work Group 14.2 and ACM SIGCHI.

Honours:

Will Gittos: Real-time Vine Model Fitting from Images using Skeletonization.

Skeletonisation is an important low-level problem in computer vision, with many applications in shape finding, motion tracking, character recognition and segmentation. This presentation looks at how skeletonisation can be used to find and model the path of grape vines in an image. Several methods of skeletonisation are assessed by comparing the resulting skeleton to a ground truth. Skeletons are quantitatively compared based on accuracy, connectedness, computation time and thinness. The best single skeletonisation method is found to be morphological thinning, due to the highly connected nature of the skeleton; however several other skeletonization methods are shown to be valuable because of features that allow easy construction of graphs or motion tracking. A combination of these skeletonisation methods is presented that best supports the creation of a model based on the grape vine images. Morphological thinning is used to create a minimal discrete skeleton, which is followed by a graph-simplification algorithm to construct a topological graph. This graph is used to initialise an active contour model, which refines and connects the skeleton based upon highly accurate localisation information provided by an adaptive steerable filter. This hybrid skeletonization method quickly creates an accurate, continuous graph of vine segments captured from an image.

Jin Hong: Green Networking Sleep Mode Algorithms in Wireless Metropolitan Area Network.

Wireless technology grows rapidly and it is difficult to supply a sufficient amount of energy to the growing number of wireless devices. Modern wireless devices are capable of 3G network. However, peripherals that operate the 3G network services consume significant amount of energy.

To address this problem, sleep mode (or smart standby) is applied on mobile stations to reduce the energy cost. Various problems have been identified in standard sleep mode used, so new sleep mode algorithms are introduced to fix these problems.

In this project, various sleep mode algorithms are examined and compared to determine the best energy saving sleep mode algorithm. Five sleep mode algorithms that are recently proposed for IEEE 802.16e WiMAX technology have been selected and they are compared by analytical and simulation model. Top two algorithms are further examined in various environment conditions. Further, new method that combines some of these algorithms to improve the current best performance is introduced and evaluated. Finally, an evaluation of these algorithms on how they can be applied to other technologies such as LTE, and future network systems such as 4G network.

MSc students:

Giles Westerfield: Intelligent Augmented Reality for Assembly and Maintenance.

The capacity of Augmented Reality (AR) to visually convey abstract concepts and 3D spatial information in context with real world objects makes it an ideal tool for training and educational purposes. My masters thesis project investigates the use of AR to assist with training for manual assembly and maintenance tasks. Improving on prior research, I am combining an AR interface with an Intelligent Tutoring System back-end to provide a more robust and interactive learning experience that adapts uniquely to each student. To evaluate the system, I am developing a prototype that teaches the user to assemble hardware components on a computer motherboard.

Alexander Chernoglazov: Visualisation and Compression of Spectral CT Datasets.

Spectral CT (Computed Tomography) is a novel area of research in medical imaging which involves measuring X-rays of different wavelengths separately, essentially building up a colour image of the object being scanned. There are numerous medical benefits of this technique, among them the ability to differentiate between various tissue types and contrast agents used in radiology.

The MARS-CT project is a multidisciplinary collaboration that has the aim of developing a spectral CT scanner along with relevant image reconstruction and image processing algorithms. Visualisation of spectral CT datasets also requires new approaches, but is sometimes restricted by the size of datasets being studied. Spectral CT datasets can exceed several gigabytes in size, but contain a significant amount of redundant information that can be taken advantage of during compression.

This research project is concerned with finding the most appropriate ways to visualise large spectral CT datasets by rendering directly from compressed data stored inside the memory of a GPU. In addition, methods for improving the image quality and speed of spectral CT rendering algorithms are examined.

Huaqing Chen: MULTI-FRACTAL FORMULISM FOR SEGMENTING HRCT IMAGES OF THE LUNG.

This research proposes a fully automatic method for identifying the lung diseases in High-Resolution Computed Tomography (HRCT) images. Due to the late and inaccurate lung disease detection problem, Computer Aided Diagnosis (CAD) systems help radiologists to characterize the distribution

of the disease patterns base on the HRCT images. Accurate and rapid lung segmentation technique is greatly helpful for early disease detection, analysis of disease progression.

Several types of biomedical images are known to consist of statistically self-similar structures with different fractal dimensions, coexisting simultaneously. Multi-fractal based feature descriptors can be used for representing the granularity and regularity of structures present in such images. In the field of medical image analysis, the multi-fractal characteristics of images have recently found a variety of applications such as tissue image classification and retrieval, retinal image analysis, edge detection in CT images, and segmentation of digital mammograms.

The multi-fractal formalism presented in this research is used for local texture and shape analysis of lung parenchyma in High Resolution Computerized Tomography (HRCT) images. Intensity based measures are computed in windowed regions in the neighbourhood of each pixel, to determine the Holder exponents (alpha values) that characterise the local regularity at each image position. The estimated parameters are then used to partition the image into a disjoint set of alpha-slices containing features with distinct fractal properties. This method can yield a segmentation of the image from which regions of pathological interest and specific shape features can be extracted.

Jacky Tay: Robust Algorithms for Tissue Image Processing using Multifractal and Multi-Scale Techniques.

The incidence of breast cancer for women is the most frequent cancer among other cancers. Early diagnosis and medical treatment is the key to cure cancer. Nottingham scoring system is the standard system used by most of the pathologists around the world, which measures the Nuclear Pleomorphism, Tubule Formation, and Mitosis Count of the breast tissue sample. The goal of this research is to develop a system to analyse breast cancer using a novel approach, multifractal techniques.

Multifractal has been an effective tool in biomedical image processing, such as classification, segmentation and etc. This research does not replace the manual work of the pathologists, but it aims to provide a computer aided image analysis tool for grading biopsy samples. During the development of the research, multifractal technique has illustrated the ability to classify epithelial cell and fibroblast, identify potential mitotic cells, evaluate Nuclear Pleomorphism, and estimate Tubule Formation of the cell. These have shown that the early analysed results based on multifractal technique can be applied for breast cancer grading.

Sang Myung Lee: Maximum Sub-array Problem.

The maximum subarray (MSA) problem is to compute a rectangular portion in a given two-dimensional array that maximizes the sum of array elements in it. This problem was first introduced by Grenander and brought to computer science by Bentley with an algorithm of $O(n^3)$. This research is for designing a faster algorithm for the Maximum Sub-array Problem under the conventional RAM model, based on distance matrix multiplication (DMM). This problem has wide applications in graphics and data mining for marketing.

Chunhui Zheng: Vision-based Feature Recognition and Obstacle Detection For Drive Assistance in Indoor Environment.

This project attempts to develop a robust vision-based drive assistant through doorways and hallways where static and dynamic objects are present.

A method has been implemented by fusion of color feature, edge map, motion analysis and stereo vision to detect indoor features, avoid obstacles and calculate movements. However, the stereo vision has drawbacks such as high computational cost and poor resolution depth data. A commercial and low cost Microsoft Kinect RGB-D Sensor is taken the place of stereo camera to provide detail and accurate depth information of the surrounding environment. The proposed system is able to detect indoor features such as ground plane, drop-offs, stairs, doors and corridors. The results show the improvement in feature recognition using Kinect Sensor.

Ben McDonald: Automated layout for large, shared displays.

Advancements in screen technology are enabling larger computer displays at lower costs. Large screens can be found in many places such as airports, malls and public squares. Commonly, the layout of content on public screens is static or changes based on scripted behaviour independent of the audience.

VAL is a content layouts system that is adaptive to audience members' positions and their expressed interests and aims to use layout automation to create an engaging and involving user experience. We discuss how VAL is designed to size and position content to provide clear and comfortable views of images of interest, resolve conflicts of interests between viewers and create a engaging user experience.

Samuel Williams: Improved Hybrid Tracking for Mobile Outdoor Augmented Reality

Outdoor augmented reality provides many opportunities for improving the way in which information is presented and organised. However, to create a coherent and authentic experience, virtual content must be registered in the physical world such that the user's expectations of reality are respected. Modern mobile devices provide a wide variety of sensor data which can assist with achieving this goal, however few existing platforms explore how this data can be intelligently merged together to provide robust camera tracking and object recognition. For the proposed masters thesis project, I will investigate existing tracking algorithms for outdoor augmented reality with a specific focus on modern mobile devices. Improving on prior research, I will design and implement an adaptive tracking algorithm that integrates available sensor data to maximize accuracy. To evaluate the system, I will develop a prototype outdoor augmented reality browser and review the tracking and recognition quality in relation to sensor degradation.

Geoffrey Clark: Dynamic Optimisation of a Heterogeneous Wireless Network of Sensors.

An overview of a research project involving optimisation of a wireless sensor network with respect to energy efficiency and functional network lifetime. The research involves simulations of a heterogeneous sensor network, where one node is battery powered while others are externally powered, in order to study how different scenarios affect battery drain on the sensor. Different parameters are considered, including the number of externally powered nodes available to connect to, and the regularity of fluctuations in the wireless channel.

PhD students

Ehsan Tabatabaei Yazdi: Adaptive Resource Allocation for Mobile Body Sensor Networks.

One of the main problems affecting reliable transmission of wireless devices, like Wireless Sensor Network nodes, is interference caused by sharing the unlicensed 2.4 GHz ISM band. This work acknowledges the impact of the realistic urban IEEE 802.11 RF interference and proposes the need for an adaptive resource allocation extension for IEEE 802.15.4 standard.

Thomas Young: Online Biologically-sourced models for time-series prediction.

Prediction is hard, yet Paul the Octopus correctly picked the winner in eight out of eight matches at the 2010 Football World Cup. Are there lessons from Paul's methods that can be applied to other domains? Unfortunately, no. Paul's success came down to pure luck. However, there are other, more useful, examples in biology of predictive mechanisms that do work. Arctic foxes change coat colour in advance of the seasons; Godwits wait in New Zealand for the weather to improve in the Arctic before migrating (how do they know?) One such mechanism is the influence of environmental signals on the workings of a Gene Regulatory Network (GRN). We examine this concept, and suggest an evolvable GRN model that can (we expect) be used as a general engine for time-series predictions.

Muhammad Arfeen: Tracking Superposition of Independent Streams of Teletraffic with Heavy-Tailed inter-arrival times.

This talk will focus on some interesting classical and new results regarding superposition of teletraffic streams with heavy tailed inter-arrival times. The asymptotic behaviour of counting processes and inter-arrival times are investigated in the light of classical and new theorems. Relevant superposition theorems will be discussed with focus on how good they perform in real teletraffic conditions (limited data and limited time for analysis). The main focus is how to track the degree of superposition i.e. number of streams taking part in superposition process given fixed amount of data and time. Also, in classical models of superposition, Cox(1954), Cinlar(1967) and recently Mitov(2005), packets overlap is permitted but in real traffic this means collision or packet loss! Avenues where relevant heavy-tailed superposition theorems are missing are identified. Also there has been a renewed interest in estimation of tail index in teletraffic data so a discussion of recent real-time estimators of tail index will also be part of the talk.

Mofassir Haque: Routing Protocol for Content Centric Future Internet.

Currently, Internet is primarily being used for content distribution with an annual traffic growth of 50%. Present Internet architecture faces a number of problems like scalability, security, lack of support for ubiquitous computing, management, in-efficient mapping, poor resource utilization etc. Content Centric Future Internet architecture has been suggested to overcome weakness of current architecture. Content Centric architecture is the next step in architectural evolution of Internet. This architecture is based on concept of named data i.e. retrieving contents by name instead of location. It will support wide range of applications and will re-use successful feature of TCP/IP. There are number of challenges like location independent content routing, Quality of Service provisioning, trust management etc. which needs to be addressed. We are working on development of routing protocols for Content Centric architecture as proposing an efficient and scalable routing solution is a challenging

research problem. We will consider both evolutionary and revolutionary solutions for Content Centric routing.

Kapila Pahalawatta: Airborne Particle Classification with Rayleigh Scattered Images.

Considering the selective Rayleigh light scattering behaviour by small particles, this study adopts a new technique to classify nano-scale airborne particles with colour histogram features. Noise was generated using scattered light by five different sized particles with a continuous spectrum of light. Each video frame was divided into its red, green and blue planes and noise was isolated using a modified frame difference method. The mean and standard deviation of the maximum value index of intensity histograms over a predefined number of frames were used to classify the type of particles. Results show that the classifier was able to distinguish the four types of particles, polyurethane smoke, kerosene smoke, water steam and cooking oil smoke, with a 100% accuracy.

Mohammed Thaher: Investigating Efficient Algorithms for the Maximum Convex Sum.

In this presentation, I am going to present a new efficient algorithm for computing the K Maximum Convex Sum Problem (K MCSP). Previous research investigated the K MCSP in the case of the disjoint regions. This new algorithm with $O(Kn^3)$ time is derived for the overlapping case. This overlapping approach has been developed by utilising the simplified (bidirectional) algorithm for the convex shape. The algorithm finds the first maximum sum, second maximum sum and up to the Kth maximum sum, based on dynamic programming. The novel approach of using the K Overlapping Maximum Convex Sums (K OMCS) gives a more precise result; this is when compared with results of the conventional K Overlapping Maximum Subarray Problem (K OMSP), which utilises the rectangular shape.

Stephen Fitchett: AccessRank: Predicting What You'll Do Next.

We introduce AccessRank, an algorithm that predicts accesses in a variety of contexts include file accesses, website visits, window switches, command lines and document revisitations. Numerous factors influence these predictions, including recency, frequency, clusterings and time of day. Simulations across a diverse set of real world data sets show that AccessRank is more likely to predict the next access than other algorithms both with and without hint patterns, and that it presents a relatively stable list of suggestions, which provides advantages to usability. Finally, we explore how AccessRank might lead to productivity improvements for everyday tasks.

Amali Weerasinghe: Evaluating a General Model of Adaptive Tutorial Dialogues.

Tutorial dialogues are considered as one of the critical factors contributing to the effectiveness of human one-on-one tutoring. We discuss how we evaluated the effectiveness of a general model of adaptive tutorial dialogues in both an ill-defined and a well-defined task. The first study involved dialogues in database design, an ill-defined task. The control group participants received non-adaptive dialogues regardless of their knowledge level and explanation skills. The experimental group participants received adaptive dialogues that were customised based on their student models. The performance on pre- and post-tests indicate that the experimental group participants learned significantly more than their peers. The second study involved dialogues in data normalization, a well-defined task. The performance of the experimental group increased significantly between pre- and post-test, while the improvement of the control group was not significant. The studies show that the model is

applicable to both ill- and well-defined tasks, and that they support learning effectively.

Ansar Ali: Natural Language Processing of Urdu for Information Retrieval.

On web, vast resources of information are in reach of common people, but still it is difficult to extract meaningful and required information without the help of a search engine. Search engines index, rank or manage clusters of similar documents to increase precision and retrieval of a query. Expanding a query is another method to increase precision and retrieval of the query. The nature of a language of the documents and a query has a direct impact on efficiency of the search engine. Languages similar to Urdu have many words, which are ambiguous if they are taken out of their phrases or clause. If these words are not handled properly, they can reduce the precision of results generated by a search engine. In this research work, it is proposed that phrase-based search is more efficient for retrieving documents for such languages. Moreover, we can expand a search query to improve retrieval and precision. To test this hypothesis, I will use chunking to identify and analyse phrases within queries. Once the phrases and their components are identified, pre-defined grammar rules will be applied to re-arrange these components to construct new semantically similar phrases. During my initial investigation on the topic, I used bagging and adaboost algorithms combined with J48 (java implementation of C4.5). The results found were, 95%. However, this efficiency is greatly affected if there are any errors in the training data.

Joey Scarr: Why the Ribbon Sucks.

Expert interface use is typically characterised by automaticity - the ability to perform familiar commands and tasks without spending mental effort on the interaction itself. In point-and-click interfaces, this automaticity can only be developed if controls are in predictable locations. Furthermore, since experts spend no time on visual search, the speed at which experts can interact is limited by mechanical factors - the time taken to point, click and navigate through menu hierarchies. A theoretically optimal interface is therefore both flat (i.e., all controls are accessible with a single click) and spatially constant. However, screen real estate constraints mean that such interfaces are not used in real-world software such as Microsoft Word. Come to my talk to hear about we redesigned the Microsoft Office Ribbon to be both flat and spatially stable, and why the existing Ribbon sucks in comparison.

Saghar Izadpanah: Optimal energy-aware resource allocation in data intensive networking applications.

Power consumption and energy efficiency are becoming very important in the design and management of computer systems. The purpose of my research is to study the problems of allocating resources and managing the energy saving in large scale applications to improve the performance and quality of service.

Amir Shareghi Najari: Using Example-based strategy in Intelligent Tutoring System.

Intelligent Tutoring System (ITS) is a computer based tutor individualized for each student. The most common learning strategy being supported by ITSs is Problem-Solving. In this strategy the student is expected to solve problems and meanwhile the system supports with providing different levels of feedback. While problems only contain a description of the question along with a goal statement, worked examples also give students worked-out solution steps needed to achieve the goal. Research has indicated that for

novice learners, worked example based instruction is more effective for transfer and learning compared to problem solving. Moreover, it has also been shown that using worked examples leads to shorter learning time. In the cognitive Load Theory (CLT) the worked example effects has been explained. The main reason of faster learning is decreasing the cognitive load on working memory. In contrast, a number of studies showed that using fixed worked examples is not necessarily efficient for all levels of students. My research aims to investigate the benefits of using adaptive worked examples in ITS. For this purpose, a new version of SQL Tutor enriched with adaptive worked examples will be developed. Finally, the difference between the results of four conditions (Example only, Example-Problem pairs, Problem-Example pairs and Problem only) will be compared.

Thammathip Piumsomboon: Toward natural hand interaction for virtual objects manipulation

In three-dimensional AR/VR environments, the natural hand is a desirable mean for manipulating the virtually simulated objects as we commonly do with objects in the real-world. Traditionally, data gloves are worn for detecting hand inputs. Today, vision-based method using skin color segmentation for natural hand tracking is also widely adopted. However, this technique only allows limited number of poses to be recognized without ambiguity. Marker-based gloves are still required to achieve higher level of fidelity. Recently released, low-cost depth sensors, 'Microsoft's Kinect' and 'Asus's Xtion PRO', that permit full-body skeletal tracking and gestures recognition, have opened up new opportunities for high-fidelity natural hand tracking, potentially making intuitive interaction possible.

NOTES FOR SPEAKERS

1. Please keep your presentation to the allocated time of 15 minutes.
2. Five minutes is allowed for discussion after your talk.
3. Speakers with PowerPoint slides - It is your responsibility to load them into the computer before your session begins.
4. A computer and data projector will be available. Please load your presentations onto it before the start of your session.

Prizes will be awarded for the

- best PhD student talk
 - best Masters student talk
 - best Honours student talk
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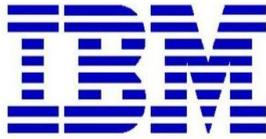
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i n v e n t

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Microsoft®

Microsoft New Zealand is heavily involved in supporting local student innovation. The Microsoft Imagine Cup is a technology competition that help to inspiring students to bring their ideas to life by supporting them with industry and Microsoft Mentors. The programme is available to all students each year. In addition to this Microsoft also provides access to all creative tools for free to students to help them develop their skills and take part in this competition. You can find out more information from [:www.imaginecup.co.nz](http://www.imaginecup.co.nz)



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Tait Electronics Ltd was formed in 1969 and is a leading provider of radio communications equipment to 160 countries. The company's global headquarters is in Christchurch, New Zealand, and its research and development operation is one of the largest in its sector in Australasia. Tait employs about 800 people in New Zealand and in its wholly-owned customer service operations in Australia, Singapore, Thailand, China, United Kingdom, France, Germany, Canada and the United States. Tait exports more than 90% of its products, with customers ranging from small private businesses to large multi-national corporations, government agencies, emergency services, network providers and specialist communications agencies. Tait's product offering has grown beyond its roots in conventional two-way mobile radio to encompass a wide range of products and services. From portable and mobile radios, through to wide area trunked radio network systems that provide integrated radio and telephone services for both voice and data communications. Tait is a founding partner of the New Zealand's national Wireless Research Centre based in Canterbury. www.taitworld.com



Telogis provides Location-Based-Services to enterprises in 60+ countries worldwide. Telogis' scalable, Software as a Service ("SaaS") platform helps enterprises, business owners and fleet managers optimise business operations by making their vehicles, fleets, workers and assets more efficient through GPS location technology. Telogis' solutions help enterprises to reduce: fuel, hours per job, kilometers per route and increase: communication, fleet visibility, accountability and profit margins. Telogis products include:

- **Telogis Fleet:** Provides real-time location and status for all assets on one dashboard, with full fleet metrics and reports to match.
- **Telogis Mobile:** Enables companies to stay connected to their workers through two-way messaging, forms, work orders, and navigation.
- **Telogis Route:** Allows fleets to reduce kilometres and travel times with optimised planned routes and instant reroutes, as well as actual vs planned reporting.
- **Telogis GeoBase:** Allows organisations to build powerful and differentiated mobile and Web-based location based services.

Telgis is rapidly growing and always on the lookout for bright individuals who are keen for challenging, yet rewarding career to join the team in our Christchurch R&D office. For the latest employment opportunities please visit www.telgis.co.nz



Trimble is a leading provider of advanced positioning solutions that maximize productivity and enhance profitability.

Though best known for GPS technology, Trimble integrates a wide range of positioning technologies including GPS, laser, optical and inertial technologies with application software, wireless communications, and services to provide complete commercial solutions. Its integrated solutions allow customers to collect, manage and analyze complex information faster and easier, making them more productive, efficient and profitable.

Trimble products are used in over 100 countries around the world. Employees in more than 21 countries, coupled with a highly capable network of dealers and distribution partners serve and support our customers.

For over 30 years, Trimble has created unique positioning products that help customers grow their business. Our portfolio includes over 900 patents and serves as the basis for the broadest positioning offerings in the industry. Trimble augments its organic product development with strategic acquisitions to bring the latest positioning technologies to a wider market. <http://www.trimble.com/>

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1.

2.

Top THREE PhD presentations (best, 2nd, 3rd):

1.

2.

3.
