Faculty of Computing Health and Science

Research Group, Research Centre or Research Institute Report

RESEARCH UNIT NAME: CENTRE FOR COMMUNCATIONS ENGINEERING RESEARCH (CCER)

RESEARCH UNIT LEVEL (tick):

Level I Research Group:	☐	Level II Research Centre:	☒
Level III Research Institute:	☐	Centre of Excellence:	☐

REPORT TYPE: ANNUAL REPORT

YEAR: 2008

BRIEF OVERVIEW (1 – 2 paragraphs):

The Centre for Communications Engineering Research (CCER) was established in October 2007 with a goal to conduct applied engineering research that has high impact on the community. Motivations, interests and experience achieved while working with research groups, previously known as the communications research group (CRG) and the level-I visual information processing research (VIP), have been the major strengths of the members of CCER. Research strengths of CCER include quality of service in optical and wireless networks, design of survivable networks, wireless sensor networks, signal and image processing, and multimedia communications.

The aims of the research centre in the reporting period were:

To provide a stimulating environment for the pursuit of research in the field of communications, including acquisition, processing, transmission and networking of information;

To conduct collaborative research projects with the industry and interdisciplinary partners;

To disseminate research outcomes through international journal and conference publications, workshops, community focused seminars and University's teaching programs.

MEMBERSHIP (Full Title of Researchers, including staff, research students, adjuncts):

Academic Staff:

Prof Daryoush Habibi (Leader)

Dr Douglas Chai

Dr Stefan Lachowicz

Dr Alex Rassau

Dr Iftekhar Ahmad

Dr Wlodek Gornisiewicz

Dr Ganesh Kothapalli

Dr Alfred Tan

Dr Steven Hinckley

Postgraduate Students:

Mr Justin Wyatt (PhD candidate)

Mr Viet Quoc Phung (PhD candidate)

Mr Hoang Nghie Nguyen (PhD candidate)

Mr Kung-meng Lo (PhD candidate)

Mr Mahir Meghji (PhD candidate)

Mr Hushairi Zen (PhD candidate)

Ms Kartinah Zen (PhD candidate)

Ms Hiroko Kato (PhD candidate)

Mr Siong Khai Ong (PhD candidate)

Ms Kelly Eng (PhD candidate)

Mr Graham Wild (PhD candidate)

Mr Paul Jansz (PhD candidate)

NEW GRANTS (Identify Funding Body, Value of grant, Years Funded, Chief Investigator, collaborators, title):

D. Chai and A. Tan, "Prototype development for commercialisation of ECU invention: the MMCC barcode," ECU Strategic Initiative Funding Program, $295,000 (2009 – 2011).

A. Tan, "Fetal Heart Rate Monitoring via Smart Phone Project," Microsoft Research, USD 150,000, 2008-2010.

I. Ahmad and D. Habibi, "WiMAX/WiFi Framework Framework for Broadband Services in Rural, Regional and Remote Areas in Australia," ECU ECR funding, $25,000, 2008-2009.

D. Habibi and I. Ahmad, "Video Networking for Central Monitoring of Security Cameras on Public Trains," Public Transport Authority, $150,000, 2009-2011.

PUBLICATIONS, REFEREED BOOKS, CHAPTERS, JOURNAL ARTICLES, CONFERENCE PAPERS, REPORTS:

JOURNAL:

I. Ahmad, J. Kamruzzaman and D. Habibi, "Rerouting in advance for preempted IR calls in QoS-enabled networks," Computer Communications, vol. 31, issue. 17, pp. 3922-3928, November 2008.

G. Wild, S. Hinckley, "Acousto-Ultrasonic Optical Fiber Sensors: Overview and State-of-the-Art," IEEE Sensors Journal, vol. 8, issue. 7, pp.1184-1193, 2008.

G. Kothapalli and M. Y. Hassan, "Design of a Neural Network Based Intelligent PI Controller for a Pneumatic System," IAENG International Journal of Computer Science, vol. 35, issue 2, May, 2008.

PATENT:

D. Habibi, J. Wyatt, A. Rassau and I. Ahmad, "A network access control mechanism", US provisional patent (60/991,842), 2008.

A. Tan and D. Chai, "Mobile Multi-Colour Composite (MMCC(tm)) 2D-barcode", AU provisional patent, 2008.

CONFERENCE:

I. Ahmad and D. Habibi, "A Novel Mobile WiMAX Solution for Higher Throughput," Proc. 16th IEEE International Conference on Networks (ICON), pp. 1-5, December 2008.

I. Ahmad and D. Habibi, "An Improved FEC Scheme for Mobile Wireless Communication at Vehicular Speeds," Proc. Australian Telecommunication Networks and Applications Conference (ATNAC), pp. 312-316, December 2008.

I. Ahmad, J. Kamruzzaman, D. Habibi and F. Islam, "An Intelligent Model to Control Preemption Rate of Instantaneous Request Calls in Networks with Book-Ahead Reservation," Proc. Australian Telecommunication Networks and Applications Conference (ATNAC), pp. 312-316, December 2008.

Z. Rahman, D. Habibi and I. Ahmad, "Source Localisation in Wireless Sensor Networks Based on Optimised Maximum Likelihood," Proc. Australian Telecommunication Networks and Applications Conference (ATNAC), pp. 235-239, December 2008.

K. Zen, D. Habibi and I. Ahmad, "Improving Mobile Sensor Connectivity Time in the 801.15.4 Networks", Proc. Australian Telecommunication Networks and Applications Conference (ATNAC), pp. 317-320, December 2008.

H. Zen, D. Habibi and I. Ahmad, "Self-restraint Admission Control for Adhoc WLANs," Proc. Australian Telecommunication Networks and Applications Conference (ATNAC), pp. 186-191, December 2008.

S. K. Ong, D. Chai and K. T. Tan, "The use of border in colour 2D barcode," International Symposium on Parallel and Distributed Processing with Applications (ISPA'2008), Sydney, Australia, pp. 999-1005, 10-12 December 2008.

H. Kato, K. T. Tan and D. Chai, "Development of a novel finder pattern for effective color 2D-barcode detection" International Symposium on Parallel and Distributed Processing with Applications (ISPA'2008), Sydney, Australia, pp. 1006-1013, 10-12 December 2008.

I. Ahmad and D. Habibi, "A Proactive Forward Error Control Scheme for Mobile WiMAX Communication," Proc. 9th IEEE International Conference on Communication Systems (ICCS), pp. 1647-1651, November 2008.

K. Zen and D. Habibi, "Improving the IEEE802.15.4 Re-Association Process in Mobile Sensor Networks," IASTED International Conferences on Communication Systems and Network, pp. 119-124, 2008.

H. Zen, D. Habibi, A. Rassau and I. Ahmad, "Optimized WLAN MAC Protocol for Multimedia Applications," Proc. 5th IEEE International Conference on Wireless and Optical Communications Networks (WOCN 2008), pp. 1-5, May 2008.

H. Zen, D. Habibi, J. Wyatt and I. Ahmad, "Converging Voice, Video and Data in WLAN with QoS Support," Proc. 5th IEEE International Conference on Wireless and Optical Communications Networks (WOCN 2008), pp. 1-5, May 2008.

K. Zen, D. Habibi, A. Rassau and I. Ahmad, "Performance Evaluation of IEEE 802.15.4 for Mobile Sensor Network," Proc. 5th IEEE International Conference on Wireless and Optical Communications Networks (WOCN), 2008.

P. V. Jansz, G. Wild, S. Hinckley, "A Proposed Fibre Optic Time Domain Optical Coherence Tomography System Using a Micro-Photonic Stationary Optical Delay Line," 19th International Conference on Optical Fibre Sensors, 2008.

G. Wild, S. Hinckley, "An Intensiometric Detection System for Fibre Bragg Grating Sensors," ACOFT, 2008.

P. V. Jansz, G. Wild, S. Hinckley, "A Micro-Photonic Stationary Optical Delay Line for Fibre Optic Time Domain OCT," ACOFT, 2008.

G. Wild, S. Hinckley, "A Transmit Reflect Detection System for Fibre Bragg Grating Acoustic Emission and Transmission Sensors," In: Lecture Notes in Electrical Engineering - Smart Sensors and Sensing Technology, 183-197, 2008.

G. Wild, S. Hinckley, "Fibre Bragg Grating Acoustic Emissions and Transmission Sensor in Carbon Fibre Composites," Proc SPIE, 7268, 2008.

G. Wild, S. Hinckley, "Wireless Acoustic Communications for In-Vivo Biomedical Device Monitoring," Proc SPIE, 7270, 2008.

P. V. Jansz, G. Wild, S. Hinckley, "Optical Switching of a proposed stationary optical delay line for OCT," Proc SPIE, 7268, 2008.

P. V. Jansz, G. Wild, S. Hinckley, "A comparison of wet and dry etching to fabricate a microphotonic structure for use in OCT," Proc SPIE, 7270, 2008.

HIGHER DEGREE BY RESEARCH LOAD (List name of candidate and degree type)

Mr Justin Wyatt (PhD candidate)

Mr Viet Quoc Phung (PhD candidate)

Mr Hoang Nghie Nguyen (PhD candidate)

Mr Kung-meng Lo (PhD candidate)

Mr Mahir Meghji (PhD candidate)

Mr Hushairi Zen (PhD candidate)

Ms Kartinah Zen (PhD candidate)

Ms Hiroko Kato (PhD candidate)

Mr Siong Khai Ong (PhD candidate)

Ms Kelly Eng (PhD candidate)

Mr Graham Wild (PhD candidate)

Mr Paul Jansz (PhD candidate).

HIGHER DEGREE BY RESEARCH COMPLETIONS (List name, degree, title of thesis)

Dr Kung-meng Lo, Doctor of Philosophy, Routing & Protection Issues in Optical WDM Mesh Networks.

VISITORS AND COLLABORATIONS (List the organisation's name and short summary of the nature of the collaboration. Separate into local, national and international)

The centere has established links with a number of research organisations in Australia and overseas.

Links at national level include:

Public Transport Authority, WA.

(currently conducting a collaborative project on video surveillance on public trains)

Monash University, Australia.

(working with the communication network research group at Gippsland School of IT,

Monash University).

University of Sydney, Australia.

(collaborating with Dr Guoqiang Mao at the School of Electrical and Information Engineering)

University of Wollongong, Australia.

(Initiated collaboration with Professor Farzad Safaie, ICT Institute).

The University of Western Australia, Australia.

(collaborating with Professor Brendan Griffin and Associate Professor Martin Saunders, Centre for Microsocpy, Characterisation and Analysis, CMCA).

Links at international level include:

Gwangju Institute of Science and Technology (GIST), Korea

(collaborating with Associate Professor Saeed Nooshabadi, Department of Information and Communications).

Ulm University (Germany).

(collaborating with Professor Hans-Jörg Pfleiderer from the Institute of Microelectronics of Ulm University, Germany for a project on optimization of Direct Digital Frequency Synthesis algorithms for FPGA (Field Programmable Gate Array) implementation).

COMMUNITY ENGAGEMENT ACTIVITIES AND LINKAGES (Provide an overview)

PARTICIPATION IN COMPETITIONS AT NATIONAL LEVEL

Wireless Token Network, Finalist in the Innovation Category at 18th WA Information Technology and Telecommunications Awards (WAITTA), Australia 2008.

Researchers at the Centre for Communications Engineering Research (CCER) at ECU have developed a firmware application for wireless local area networks (WLAN), referred to as Wireless Token Network (WTN). WTN has been designed with quality of service (QoS) guarantees in mind and it provides superior QoS for bidirectional streams such as VoIP. Performance results are generated by benchmarking WTN against IEEE 802.11 DCF, IEEE 802.11e EDCA and SpectraLink SVP MAC protocols. WTN is able to support more than twice the number of clients at acceptable quality levels before reaching 100% saturation, as compared to IEEE 802.11 DCF, IEEE 802.11e EDCA and SpectraLink SVP MAC and as such, more users can be serviced at a given bandwidth, which means lower installation cost for providers and lower service cost for end users. The overall throughput of WTN is about 50% higher than other protocols. For applications like VoIP that require bi-directional traffic, the improvement achieved by WTN is around 100%.

Investigators:
Prof. Daryoush Habibi, Dr Iftekhar Ahmad, Mr Justin Wyatt.

Mobile Multi-Colour Composite 2D Barcode Finalist in the Innovation Category at 18th WA Information Technology and Telecommunications Awards (WAITTA), Australia 2008.

Researchers at the ECU Centre for Communications Engineering Research are designing a new barcode that can hold high capacity data and is tailor made for use by mobile phones. They named this innovative technology the Mobile Multi-Colour Composite 2D Barcode, or the MMCC™ in short. Using the MMCC™, digital contents such as multimedia can be stored as a barcode and printed on paper or mediums such as magazines and notice board. The digital contents can then be retrieved into an electronic form by taking a snapshot of the barcode with a mobile phone camera. With the help from the Office of Research and Innovation, the research team has successfully filed a provisional patent that protects this intellectual property for ECU.

Investigators:
Dr Douglas Chai, Dr Alfred Tan, Ms Hiroko Kato and Mr Siong Khai Ong.

CONFERENCE PARTICIPATION

Australian Telecommunication Networks and Applications Conference (ATNAC), Adelaide 2008.
International Conference on Wireless and Optical Communications Networks (WOCN 2008).
16th IEEE International Conference on Networks (ICON), India 2008.
International Symposium on Parallel and Distributed Processing with Applications (ISPA'2008), Sydney, Australia 2008.
9th IEEE International Conference on Communication Systems (ICCS), China 2008.
IASTED International Conferences on Communication Systems and Network, USA 2008.
19th International Conference on Optical Fibre Sensors, Perth, Australia 2008.

PRESENTATION OF RESEARCH OUTCOMES

All conference papers listed earlier in this report have been presented at those conference by members of the Centre.

FUTURE PLANS AND DIRECTION (Provide an overview)

One of the important objectives of the centre is to work with ORI towards commercialisation of the products that have been developed at the centre. Two products on which the centre has provisional patents have good potential to either form the basis for the formation of a company, or, be licensed to existing vendors and product developers.

In the coming years, the centre aims to establish more linkages with industry towards research collaboration and funding , and with various national and international research groups and organisations. The centre will put more emphasis on interdisciplinary projects, particularly in collaboration with health, and/or environmental science. Sensor network and its applications have been very attractive in these interdisciplinary fields and the centre aims to utilise its strength in sensor networks to attract more national and international interest, and conduct collaborative research. The centre will continue its efforts to secure competitive grants at the national and international levels. The centre participated in the ARC grant application rounds (both discovery and linkage) in the past two years (please see Appendix A). Although the centre has not been successful to secure an ARC grant, members of the centre are confident that the experience from of the past rounds and the seminars arranged by ORI will highly assist the centre to apply for successful ARC grants in future.

The centre will maintain its strategy to attract more HDR students to further strengthen the research capabilities and outcomes of the Faculty and University. Members of the centre believe that successful completions of their on-going projects (please see Appendix A) will lead to more successes in terms of collaborative projects, community engagement and enrolment of HDR students.

DATE OF NEXT FORMAL REVIEW

MAY 2010

APPENDIX A

ARC RESEARCH GRANT APPLICATIONS LODGED IN 2008

I. Ahmad and D. Habibi, "WiMAX/WiFi Framework Framework for Broadband Services in Rural, Regional and Remote Areas in Australia," ARC Discovery Grant.

I. Ahmad and D. Habibi, "Video surveillance network for real-time central monitoring of passenger safety and security on public trains.," ARC Linkage Grant.

MAJOR ON-GOING RESEARCH PROJECTS

Video surveillance network for real-time central monitoring of passenger safety and security on public trains.

Public transportation has regained its popularity over the last few years mainly due to a sharp increase in fuel price and environmental awareness. This offers a new challenge for the public transport authority to introduce an improved safety and security management. As a measure to improve the safety and security management, most of the public transport stations are now equipped with CCTVs. The issue that still remains a major research challenge is to enable CCTV on public transports when they are on the move. The aim of this project is to develop new strategies to increase uploading video data rate from moving public transports so that a centrally monitored real-time video surveillance system can be facilitated on public transports.

New strategies to improve throughput in mobile WiMax communications.

The IEEE 802.16 standard, also known as WiMax, has emerged as an exciting technology for broadband wireless communications with potentials to offer high throughput and support high bandwidth demanding applications. WiMax however, has yet to prove its effectiveness when the end terminals are not fixed and have the capacity to move from one place to another at different speeds. Multipath fading that causes high bit error rate at the receiver end is a key reason for low throughput at high speed. In this project, we aim to propose new techniques to improve throughput in Mobile WiMax communication. This research will have significant impacts on diverse wireless applications starting from the Internet facilities on moving vehicles to video surveillance applications on public transports.

Capacity design for multiple quality of protections in shared risk link groups optical mesh networks.

The aim of this research is to study the capacity design problem in survivable optical mesh networks. The research question is to how to employ multiple appropriate protection schemes to protect different Multiple Quality of Protection (MQoP) service classes with minimum capacity requirements. In addition, due to economic issues, our research focuses on investigating real optical networks which usually comprise of many Shared Risk Link Group (SRLG) in which many fibre links are bundled in a conduit.

Medium access control protocol for guaranteed quality of service of (QoS) voice and video in wireless local area networks.

The media access control (MAC) layer is responsible for controlling which node of the wireless network is allowed to access the shared channel and how nodes communicate with each other, hence it is directly responsible for the throughput, delay and jitter characteristics observed at each node. Many different wireless MAC schemes have been developed to support a wide variety of services whilst trying to ensure that QoS is guaranteed. The existing MAC schemes however, are not efficient in terms of throughput and QoS guarantee. The aim of this project is to improve throughput and QoS of end applications in wireless communications.

Quality of services for multimedia applications in Wireless LAN.

The deployment of wireless local area networks (WLANs) has been on the rise over the last decade. Unfortunately, support to provide QoS for multimedia applications is not yet available. The existing protocol standard like the IEEE 802.11b does not support QoS while the IEEE 802.11e provides certain degree of QoS support, but further research is required to optimize the protocol. The objective of this research is to design a MAC protocol that provides QoS guarantee for real-time traffic in wireless communications.

A MAC protocol to provide efficient mobility in wireless sensor networks.

The aim of this research is to enhance the MAC protocol for mobile sensor networks based on the standard IEEE 802.15.4 so that it can overcome the synchronization, association and collisions problems due to the movement of the nodes. The current standard only supports static wireless sensor networks and the protocol is believed to degrade the network performance if it is applied in mobile sensor networks. The main objective of this research is to make sure that the enhanced protocol maintains the throughput and consumes minimum energy when operates in mobile sensor networks environment. The synchronization, re-association and association problems will be improved by making the node aware of its position whether it is moving away or towards to its original coordinator.

2D barcode design for mobile phone applications.

The project investigates the design of a novel color 2D barcode optimized for camera-enabled mobile phone platform. The integration of 2D barcode technology and camera phone technology provides general users with interesting and convenient applications. Examples of such applications include web link, online shopping and e-ticketing. Captured on a camera phone, the information encoded in the format of a 2D-barcode is decoded and used to perform certain applications. Considering that mobile phones have become a part of many daily lives and are always within reach, people can use such mobile applications according to their convenience. This research also aims to establish a standard 2D barcode, on which the third party software vendors and manufactures can develop new functions and applications. This will, in turn, provide general users with more available mobile applications.

Wireless acoustic communications for autonomous agents in structural health monitoring sensor networks.

In this project, we demonstrate wireless acoustic communications methods that include both electro-acoustic and acousto-optic communications. The communications methods are intended for use by autonomous robotic agents in the Non-Destructive Evaluation (NDE) of structures containing a distributed acoustic emission sensor network. The acoustic emission sensors can be based on either piezoelectric or optical fibre sensors. Distributed acoustic emission sensors are used in Structural Health Monitoring (SHM) for the detection of impacts and/or strain, in real time. Secondary damage may result from the initial impact or strain. This damage may include surface pitting, erosion, or cracking. These types of secondary damage may not be detectable, and hence may not be able to be monitored by the SHM system; specifically in optical fibre based sensing systems. The integration of NDE by robotic agents into a SHM sensor network enables the detection and monitoring of a wider variety of damage. Acoustic communication represents a wireless communication method that does not require any additional hardware, as piezoelectric transducers are commonly used in the NDE of materials. Various modulation methods are being iinvestigated for the communications channel. These include Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK). Successful communication was achieved using both the piezoelectric and optical fibre receivers. The optical fibre sensor isbased on a Fibre Bragg Grating (FBG).

A transmit reflect detection system for fibre Bragg grating photonic sensors.

Traditional Fibre Bragg Grating (FBG) sensing systems acquire data about the measurand via the spectral response of the FBG. Edge filter methods are also used in the acquisition of data from FBGs. In edge filter systems, the spectral shift in the FBG due to the measurand is converted into an optical power change. This optical power change can then be easily measured using conventional optoelectronic devices. In this research, we have developed a Transmit Reflect Detection System (TRDS) for Fibre Bragg Grating (FBG) sensors. The TRDS is in essence a dual edge filter detection method. In conventional edge filter detection schemes, the reflected portion of the incident spectrum is monitored to determine the change in the measurand. In the TRDS, both the transmitted and reflected portions of the input spectrum, from a narrow band light source, are utilised. The optical power of the transmitted and reflected signals are measured via two separate photoreceivers, where each generates a single edge filter signal. As the spectral response of the FBG shifts due to the measurand, the transmitted power will increase, and the reflected power will decrease, or vice versa. By differentially amplifying the transmitted and reflected components, the overall signal is increased. This results in improved sensitivity and efficiency of the photonic sensor.

A novel microphotonic structure for generating true time delays for application to optical coherence tomography.

Conventional time domain Optical Coherence Tomography relies on the detection of an interference pattern generated by the interference of backscattered light from the sample and a reference Optical Delay Line (ODL). By referencing the sample interference with the scan depth of the ODL, constructive interference indicates depth in the sample of a reflecting structure.

Conventional reference ODLs require some physical movement of a mirror to scan a given depth range. This movement results in instrument degradation. Also in some situations it is necessary to have no moving parts. Stationary ODL include two discrete step types: dual reflective Spatial Light Modulator (SLM) systems and single transmissive SLM with match-arrayed-waveguide systems. In this research, we are developing low cost stationary ODLs based on a novel Stepped Mirrored Structures (SMS) structres.