International Specialised Skills Institute

Advanced design techniques and tools for the development of assistive technology devices

Ganesh R Naik
Higher Education and Skills Group (formerly Skills Victoria)
International TAFE Fellowship

Fellowship funded by the Higher Education and Skills Group, Department of Education and Early Childhood Development, Victorian Government

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The Place To Be

ISS Institute Inc
AUGUST 2012

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Published by International Specialised Skills Institute, Melbourne

Extract published on www.issinstitute.org.au

Executive Summary

The aim of the fellowship was to enable Ganesh R Naik to study and gain knowledge of current trends and research used in Assistive technology devices. The knowledge gained during this study will be applied in Australia, within both the healthcare industry and the Tertiary education sector; especially it will be used to recommend short courses and program modules for Australian Education sectors.

Assistive technology (AT) is a term used for any device or system that allows an individual to perform a task that they would otherwise be unable to do, or increase the comfort and well-being with which a task can be accomplished. AT devices helps both disabled and the elderly. Some of the applications include: Prosthetic devices, communication aids, communication control and daily activities. AT devices are mainly designed and manufactured in USA and EUROPE. Although, Australia has research expertise and capabilities, AT devices are not manufactured here. There is a great demand and need for AT devices in Australia. Hence, there is encouragement and government funding needed for both AT and Neuro-prosthetics manufacturing in Australia.

In order to address some of the issues related to the problem outlined above, the Australian context was analysed and the key areas of skill deficiency in AT devices were identified. The overseas AT devices industry was prudently studied and the contacts were established. In order to gain a complete understanding of the ongoing research and developments in this area, Ganesh Naik chose to split the fellowship travel into two parts. First, visiting Biomedical centres at University of California, San Diego (UCSD), USA, and later visiting the Biomedical and signal processing institute at Ryerson University, Toronto, Canada.

The fellow's finding and details conclusions are detailed in the report. Although, the report does not cover the technical aspects of AT device design, but it emphasis is the key areas of expertise needed and the skill shortage of AT device research in Australia. The potential benefits and need for AT device research in Australia has enabled the fellow to undertake this fellowship with great passion and enthusiasm. As a result of this fellowship, he experienced a very successful study tour to investigate a number of issues establishing AT research and education in Australia.

The fellow is currently working on novel source separation and identification technique to for the AT devices. Based on his travel experiences with the global leaders in AT devices, the fellow is convinced that it is the right time for Australia to be more competent in the global market of AT devices and neuroprosthetics.

Table of Contents

Abbreviations/Acronyms

BCI	Brain Computer Interface
EEG	Electroencephalography
EMG	Electromyography
EMBC	International Conference on Engineering in Medicine and Biology
HESG	Higher Education and Skills Group (formerly Skills Victoria)
HCI	Human Computer Interface
ICT	Information and Communications Technology
IEM	Institute of Engineering in Medicine
INC	Institute for Neural Computation
IEEE	Institute of Electronic and Electrical Engineers
ISS Institute	International Specialised Skills Institute
SAR Lab	Signal Analysis and Research Lab
SNR	Signal to Noise Ratio
TAFE	Technical and Further Education
UCSD	University of California, San Diego
USA	United States of America
VLSI	Very Large Scale Integration technology
ARC	Australian Research Council
NHMRC	National Health and Medical Research Council

Definitions

Assistive technology

Assistive technology includes procedures, tools, hardware and software that allow people with a disability to carry out functions that might otherwise be difficult or impossible. Developments in assistive technology have extensively improved opportunities for access to information and education for people with a disability.

Design

Design is problem setting to meet human needs and wants. Design is a fundamental economic and business tool. It is embedded in every aspect of commerce and industry and adds high value to any service or product – in business, government, education and training and the community in general. [1]

Electromyography (EMG)

Electromyography (EMG) is a method for evaluating and recording the electrical activity produced by skeletal muscles. EMG may assist with the diagnosis of nerve compression or injury and with other issues of the muscles or nerves.

EEG

Electroencephalography (EEG) is a method of gathering signals from the brain. It is a non-invasive method that records activity through the scalp by monitoring and recording electrical impulses.

Innovation

Creating and meeting new needs with new technical and design styles [New realities of lifestyle]. [2]

Neuroprosthetics

An authority related to neuroscience and biomedical engineering concerned with developing neuralprostheses devices that can substitute a motor, sensory or cognitive modality that might have been damaged as a result of an injury or a disease.

Skills deficiency

Skill deficiency is where a demand for labour has not been recognised and where accredited courses are not available through Australian higher education institutions. This demand is met where skills and knowledge are acquired on-the-job, gleaned from published material, or from working and/or study overseas. [3]

There may be individuals or individual firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the IP to themselves; and over time they retire and pass way. Firms likewise come and go.

Sustainability

The ISS Institute follows the United Nations NGO on sustainability, *"Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* [4]

Acknowledgements

Ganesh Naik would like to thank the following individuals and organisations who gave generously of their time and their expertise to assist, advise and guide him throughout the Fellowship program.

Awarding Body – International Specialised Skills Institute (ISS Institute)

The International Specialised Skills Institute Inc is an independent, national organisation that for over two decades has worked with Australian governments, industry and education institutions to enable individuals to gain enhanced skills and experience in traditional trades, professions and leading-edge technologies.

At the heart of the ISS Institute are our Fellows. Under the **Overseas Applied Research Fellowship Program** the Fellows travel overseas. Upon their return, they are required to pass on what they have learnt by:

1. Preparing a detailed report for distribution to government departments, industry and educational institutions.
2. Recommending improvements to accredited educational courses.
3. Delivering training activities including workshops, conferences and forums.

Over 200 Australians have received Fellowships, across many industry sectors. In addition, recognised experts from overseas conduct training activities and events. To date, 22 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010':

> Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change.
>
> International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills, but also multiple and higher level skills and qualifications. Deepening skills across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills across a range of industries and occupations.[5]

In this context, the ISS Institute works with Fellows, industry and government to identify specific skills in Australia that require enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional practice, which they then share with their peers, industry and government upon their return. This is the focus of the ISS Institute's work.

For further information on our Fellows and our work see http://www.issinstitute.org.au.

Fellowship Sponsor

The Victorian Government, Higher Education and Skills Group (HESG) formerly Skills Victoria, is responsible for the administration and the coordination of programs for the provision of training and further education, adult community education and employment services in Victoria, and is a valued sponsor of the ISS Institute. The Fellow would like to thank them for providing funding support for this Fellowship.

Supporters

Australia

RMIT University

- Professor Dinesh K Kumar, School of Electrical and Computer Engineering
- Dr. Arvind Sharma, Divisional Manager, School of Engineering TAFE

Melbourne University

- Professor Marimuthu Palaniswami, School of Electrical Engineering, The University of Melbourne

Yooralla

- Cath Williams, Manager, Yooralla - Independent Living Centre, Melbourne

Germany

- Professor Hans Weghorn, Baden-Wuerttemberg Cooperative State University Stuttgart

USA

- Professor Tzyy-Ping Jung, University of California, San Diego (UCSD)

Canada

- Professor Sri Krishnan, Ryerson University, Toronto

Employer Support

The Fellow especially acknowledges the support of Head of the School, Divisional Manager, Program Manager and other staff at the School of Engineering (TAFE), RMIT University during the entire Fellowship candidature.

Organisations Impacted by the Fellowship

The following list of organisations/companies will benefit from the findings of this Fellowship:

Government

- State Government of Victoria , Department of Health
- State Government of Victoria, Department of Human Services
- State Government of Victoria , Centre for Developmental Disability Health (CDDHV)

Industry

- Yooralla - Independent Living Centre, Melbourne

Professional Associations

- Society for Medical and Biological Engineering (SMBE), Australia
- IEEE Victoria
- Motor Neurone Disease Association, Victoria
- Independent Living Centers (ILC), Australia

Education and Training

- School of Engineering (TAFE), RMIT University
- Department of Education and Early Childhood Development Assistive Technology Learning, Yooralla

Community

- Aged care community
- Disabled

About the Fellow

Name

Ganesh R Naik

Employment

TAFE Teacher (Electronics and Electrical), School of Engineering (TAFE), RMIT University, Melbourne.

Qualifications

- PhD in Bio-medical and Electronics Engineering, RMIT University, Melbourne, Australia, 2009
- Master of Communication and Information Engineering, Griffith University, Brisbane, Australia, 2002
- Bachelor of Engineering in Electronics & Communication, Mysore University, India, 1997.

Membership/s

- Member IEEE
- Member Australian Research Council Human Communication Science (ARC HCSNet) Australia.

Short Biography

Dr Ganesh R Naik has been employed as a teacher at the school of Engineering (TAFE), RMIT University since 2008.

His research interests include design and development of smart assistive technology devices, pattern recognition, blind source separation techniques, biosignal processing and human-computer interface.

Dr. Naik was the Chair for the IEEE Computer Society CIT08 Conference, Sydney. He was a recipient of the Baden–W'urttemberg Scholarship from the University of Berufsakademie, Stuttgart, Germany (2006–2007). Dr. Naik has edited two books and published more than 60 articles in refereed high impact journals and conferences.

Aims of the Fellowship Program

The ISS Fellowship provided the opportunity to learn the techniques in smart assistive technologies, in particular:

- To acquire skills in the design and integration of techniques used for the development of latest assistive technology devices
- To gain knowledge and skills of numerous signal processing methods involved in design and development of smart assistive technology devices
- To investigate current trend of research in BCI and smart assistive technology devices in Australia
- To understand the hardware architecture for the design of smart assistive devices
- To assess the software requirements for controlling the assistive devices using the bio-signals such as electromyography (EMG)
- To establish a better understanding and knowledge of integrating hardware with signal processing software for a wide range of smart assistive technology devices currently available in the market
- To enhance an understanding of the various control algorithm techniques used for assistive technology devices such as the robotic hand and smart robotic wheel chair
- To design and develop prototype boards for acquiring EMG from both elderly people and amputees to incorporate it in smart assistive technology devices
- To create teaching platforms in Australian universities and TAFE institutes with a view to train interested staff and students in the revolutionary technology in information technology (IT) areas.

The Australian Context

Australia, along with many parts of the world, has an ageing population. There is an urgent need in Australia to make the benefits of technology available to the ageing population. The appropriate application of technology supports the community, enhances quality of life and delivers economic benefits. Ageing is a life-long process, with no sudden or artificial transition to old age. While the majority of ageing Australians are relatively healthy, advanced age carries with it increased vulnerability and risk of impairment, with consequential loss of functional capacity. A single disabling event, such as a fall, can lead to a loss of independence, reduced quality of life and increased costs to the community. Smart technologies can assist older Australians to live safely and live well at home and in the community. [6, 7.]

Our modern computers have sufficient computational speeds and memory. Technologies have used the power of computers to make it fast and more efficient. Now is the time for using technology for the true purpose of helping humanity. Medicine has overcome a number of health issues and in most societies, we now live longer and healthier lives. There are a number of researchers around the world who are working on the different aspects of applying modern discoveries towards helping the disabled and assisting people in special circumstances, for entertainment and similar pursuits. There are also a number of multidisciplinary biomedical groups around the world, where the technologies are being developed for rehabilitation and health applications.

Assistive Technology

Assistive technology (AT) is a term used for any device or system that allows an individual to perform a task that they would otherwise be unable to do, or increase the comfort and well being with which a task can be accomplished. There currently exists several AT devices and some of the major ones related to ICT include:

- Aids for daily activities – These are the devices which help in day-to-day activities. Some of the examples include modified utensils, personal hygiene devices and dressing aids
- Communication devices – AT devices which help disabled people in formal communication include, speech synthesizers, text to voice converters, smart typewriter and hearing aids
- Mobility AT devices – AT devices which assist elderly and disabled people to move from one place to another include electric or manual wheelchairs, electric scooters, crutches, canes and walkers
- Prosthetics and orthotics – AT devices include artificial limbs and legs
- Environmental controls – Electronic systems that help people control various appliances include switches for telephones, TV and other related devices.

Need for Smart Assistive Technology

In the recent past, several researchers conducted significant study in smart AT devices in Australia. Recently, researchers from the University of Melbourne conducted extensive research on the need for smart AT devices in Australia.[15] They have identified some of the gaps in implementation of smart AT devices and their recommendations and identified gaps are listed below:

- Smart AT devices are the most beneficial technology systems to optimise health, safety and wellbeing for older Australians
- There are significant health benefits from assistive technology
- The impact of assistive technologies in influencing the quality of life of elderly citizens in rural and regional Australia is significant
- The social impact of smart AT devices on older Australians is significant.

From the above, it is clear that a holistic, system wide approach to planning is essential if Australia is to make smart technologies accessible to older Australians. Hence some of the strengths, weaknesses, opportunities and threats of smart AT devices are reviewed below:

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

Strengths

The main advantages of smart assistive technologies are:

- Mobility aids - Locomotion and navigation which includes design and development of safe and reliable mobile robotic assistive devices, intelligent homes and buildings and communication with smart wheel chairs
- Manipulation aids - Interaction with the physical world and therapeutic aids (medical devices) which includes the development of smart prosthetic hands and robots.

Weaknesses

At present there exists a few challenges in assistive technology devices. Some of them include:

- Assistive technology devices which can understand human intention and adapting to it
- Safe and effective human-robot interaction for hands-off assistive robotics
- Development of combined therapeutic/assistive rehabilitation robotic systems that are lightweight enough to be worn while performing activities of daily living.

Opportunities

Following are the opportunities/benefits to Australia:

- It addresses the skill gap in a significant area in design, development of IT and assistive technology
- It integrates latest cutting edge technology in design and development of assistive technology devices with biomedical signals
- It will offer a platform for educating both staff and students and enhance skills using the revolutionary technology required by future industry standards in IT
- It will extend sustainable skill paradigms to meet our promising and potential marketplace demands such as in rehabilitation, assistive technology and in aged care industries
- It will endorse and expand interest in TAFE and secondary school students by introducing and incorporating interesting projects (e.g. racing cars, robotic arm) in the curriculum.

Threats

The fundamental threats to advancement in this area of technology include:

- No encouragement for the establishment of Australian owned local industries
- Less encouragement for research and development in IT and related areas
- Technology gaps with overseas competitors.

Identifying the Skills Deficiencies

The skill deficiencies that will be addressed by this Fellowship research detailed below:

1. Skills in Assistive Technology (AT) devices such as smart wheel chair and robotic hand.

Neuroprosthetic device control has a wide number of applications especially in rehabilitation, healthcare and defence. At present, due to availability of only a limited range of AT equipment and issues with costs particularly in rural and remote areas of Australia, accessibility of this equipment is difficult for the disabled and ageing population. Hence there is an urgent need of skills for design and development of AT techniques.

Learning and understanding the techniques and practical skills in assistive technology (AT) devices such as smart wheel chair and the robotic hand devices.

2. Development tools used for the AT devices such as robotic hand and smart wheel chair.

Modern devices that support finer controls of prosthetic and assistive devices would benefit users through the use of suitable electronics and signal processing techniques that can identify a wider range of user commands. In order to provide a latest cutting edge technology, in depth knowledge of both electronics and IT tools are essential.

Gaining in depth knowledge in using the development tools used for the AT devices for such things as robotic hand and smart wheel chair.

3. Technologies used for the integration of biomedical signals such as Electromyography (EMG).

Current advances in prosthetic and assistive technology have led to a set of amazing technologies around the world. Victorian Neurotrauma Institute (Traffic Accident Commission, Victoria)[8] and Engineers Australia (IEAUST)[9] have identified rehabilitation methods as one of the key research areas in the healthcare industry. Some of the renowned international agencies such as Defence Advanced Research Project Agency (DARPA)[10] and Ontario Neurotrauma Foundation[11], Canada have identified this as an important area that needs research and development. Hence research on new techniques for rehabilitation engineering has to be performed.

Researching technologies used for integration of biomedical signals such as Electromyography (EMG) with the smart wheel chair and robotic hand for ample applications, e.g. rehabilitation and health care technology.

4. Training and teaching platforms using the biomedical signal processing techniques with assistive devices available.

Incorporating hardware and software skills are essential in both TAFE and University courses. Some of the Australian universities and TAFEs have incorporated international collaborative teaching projects to enhance both teaching and research skills. In TAFE, students have more hands on experience in some recent technologies. Integrating both hardware and software skills in association with local health care industries would address the skill shortage in the IT area, especially in the design and development of smart AT devices. Gaining a doctoral degree in the electronics and biomedical signal processing area have enabled the Fellow to design, develop and deliver courses using the latest technology platform.

Developing and providing an appropriate training and teaching platform using the biomedical signal processing techniques with assistive devices available.

5. Techniques for the integration of smart assistive technology devices using biomedical signal processing and electronic engineering devices.

During his PhD study, the Fellow developed biosignal algorithms to recognise different hand gestures. This technique has been tested with the robotic hand at RMIT's biosignal laboratories. Similar techniques can be used for smart assistive technology devices, where elderly and disabled people can control and run smart AT devices. The intent is to develop smart assistive technology devices at RMIT TAFE and test the interfacing at RMIT's biosignal laboratory. Assistance from local industries such as Yooralla[12] also can be sought to train and test the developed devices with the elderly and disabled.

Examining and developing techniques for the integration of smart assistive technology devices using biomedical signal processing and electronic engineering devices.

6. Identifying cheap and easy to use smart assistive technology devices.

At present there exists a few challenges in AT technology devices. Some of them include:

- AT devices which can understand human intention and adapting to it
- Safe and effective human-robot interaction for hands-off assistive robotics
- Development of combined therapeutic/assistive rehabilitation robotic systems that are lightweight enough to be worn while performing activities of daily living
- Inexpensive, safe, back-drivable robots.

Identifying and then exploring the possibility of developing cheap and easy to use smart assistive technology devices.

7. Identify and evaluate various next generation smart assistive technology devices.

A skill deficiency in the area of smart assistive technology devices currently exists in Australia. There is an urgent need in the research and development of smart assistive technology devices in Australia. The reason for this is the significant elderly population in Australia, which is in need of affordable smart devices. There exists a few BCI and assistive technology devices in Australia such as the pacemaker, cochlear implant and neuroprosthetic devices. However smart robot-controlled wheelchairs are expensive to buy in Australia as they are manufactured elsewhere in the world.

The International Experience

Destination 1: Center for Advanced Neurological Engineering Institute for Neural Computation (INC) and Institute of Engineering in Medicine (IEM) University of California, San Diego (UCSD)

Location

San Diego, USA

Contact

Professor Tzyy-Ping Jung

Objectives

The main objectives of visiting to UCSD were to conduct discussions and develop international contacts with experts working in the area of Assistive Technology devices and neuroprosthetics:

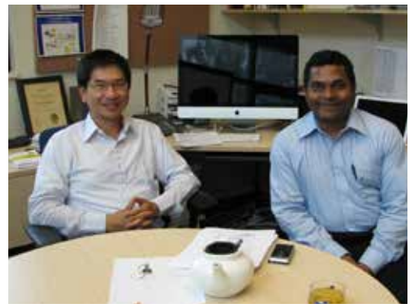
- Visit the Center for Advanced Neurological Engineering Institute for Neural Computation (INC) and Institute of Engineering in Medicine (IEM) UCSD to gain an understanding of the current state-of-the-art technology
- Visit Swartz Center for Computational Neuroscience, Institute for Neural Computation (INC), UCSD
- Visit the Department of Bioengineering, UCSD

Outcomes

UCSD is considered one of the top universities in the world (ranked 72nd in the world). UCSD has world renowned research labs in the field of Neuroscience and Assistive Technology devices. The Fellow visited two research institutes – INC and Swartz Center for Computational Neuroscience.

INC has been in existence on UCSD since 1990, and has its origins in the Institute for Cognitive Science as the oldest such unit worldwide. Over the years, INC has had a defining and pioneering role in computational studies of neural systems, both natural and manmade. The Institute aims to bring together the diverse research community in the basic sciences, medical and engineering disciplines at UCSD in advancing and promoting a new science of computation and learning. This is based on the multi-scale, parallel and highly adaptive architectures found in biological neural systems.

The Swartz Center for Computational Neuroscience is one of the top neuroscience institutes in the world. Its aim is to observe and model how functional activities in multiple brain areas interact dynamically to support human awareness, interaction and creativity.



The Fellow visited both the INC and the Swartz Center for Computational Neuroscience laboratories at UCSD and had the opportunity to discuss the recent development in AT devices with the expert research scientists and professors at the laboratories. The Fellow had discussions with some renowned researchers in the AT technology and BCI arena. The Fellow met the co-director of INC, Professor Tzyy-Ping Jung, and had an interesting discussion on BCI and smart assistive technology devices. Prof. Jung's expertise is briefly discussed below.

Left: Fellow (Naik) with Professor Tzyy-Ping at UCSD.

Professor Tzyy-Ping Jung

Professor Jung is Associate Director of Swartz Center for Computational Neuroscience INC and Co-Director of Center for Advanced Neurological Engineering INC and IEM, UCSD. He is the inventor of technology that links thoughts and commands from the brain to computers. In addition to neat neat gadgets like mind-dialed cell phones, devices to assist the severely disabled and a cap to alert nodding-off air traffic controllers, new technology could reshape medicine. His research on BCI technology could benefit the AT devices for the disabled and elderly.

Expertise related to AT devices

Listening in on the brain

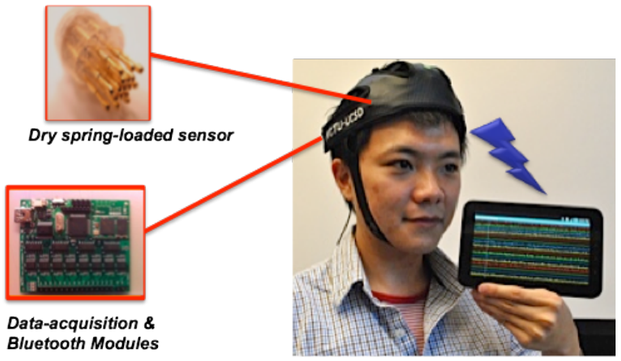
UC San Diego scientists are developing technology that links thoughts and commands from the brain to computers. In addition to neat gadgets like mind-dialed cell phones, devices to assist the severely disabled and a cap to alert nodding-off air traffic controllers, new technology could reshape medicine.[13]

Left: Tzyy-Ping (left) and a group at the National Chiao Tung University in Taiwan has developed headgear and software that monitors brainwaves, collects data and transfers a thought process to a mobile device (courtesy Prof. Tzzyy Jung Ping).[13]

Brain-monitoring technology makes media waves

Jung and collaborators Chin-Teng Lin, Jin-Chern Chiou and associates at National Chiao-Tung University in Hinschu, Taiwan have developed a mobile, wireless and wearable electroencephalographic headband system that contains dry scalp sensors that monitor the wearer's brain waves via signals transmitted through a Bluetooth link that can be read by many cell phones and other mobile devices.

The system can continuously monitor the wearer's level of alertness and cue appropriate feedback (i.e. audible warning signals or other system alerts) to assist a drowsy worker in maintaining system performance.[14]



Left: A student tests a new brain-wave cell phone application (courtesy Prof. Tzzyy Jung Ping).[14]

Destination 2: Institute for Neural Computation - University of California, San Diego

Location

San Diego, USA

Contact

Professor Gert Cauwenberghs

Objectives

The main objectives of visiting to Institute for Neural Computation at UCSD was to conduct discussions and develop international contacts with experts working in the area of Assistive Technology devices and neuroprosthetics:

- Visit the Institute for Neural Computation at UCSD to gain an understanding of the current state-of-the-art technology
- Visit the Department of Bioengineering.

Outcomes

The Computational Neuroscience specialisation is a new facet of the broader Neuroscience graduate program at UCSD. The goal of the specialisation is to train the next generation of neuroscientists with the broad range of computational and analytical skills that are essential to understand the organisation and function of complex neural systems. The Fellow had discussions with some renowned researchers in the AT technology and BCI arena. The Fellow also had an interesting discussion with the co-director of the Institute for Neural Computation, Professor Gert Cauwenberghs, and discussed key smart assistive technology devices and future trends in these technologies. Prof. Gert's research areas are briefly discussed below.

Professor Gert Cauwenberghs

Professor Cauwenberghs is Co-Director for the Institute for Neural Computation and also Professor of Biomedical Engineering, UCSD. Professor Cauwenberghs pioneered the design and implementation of highly energy efficient, parallel microchips that emulate function and structure of adaptive neural circuits in silicon. His research on Very Large Scale Integration (VLSI) technology for neuroscience could benefit the AT devices for the disabled and elderly.

Left: Students working on research project at Professor Gert Cauwenberghs' Lab.

Destination 3: Ryerson University

Location

Toronto, Canada

Contact

Professor Sri Krishnan

Objectives

The main objectives were to establish research collaboration on AT signal processing methods and to deliver a presentation on work to date as well as initiate contacts for future collaborations. In order to fulfill the above requirements, the Fellow visited the Signal and Analysis Research (SAR) lab at Ryerson University Toronto, Canada.

Outcomes

Professor Sri Krishnan is the Director of SAR lab at Ryerson University, Canada. He is also the Interim Associate Dean (Research & Development) in the Faculty of Engineering, Architecture & Science at Ryerson University. The Fellow met with signal processing and neuroscience experts at Ryerson and discussed the potential collaboration in advancement of AT devices. As well as this, the Fellow delivered a presentation to researchers from Ryerson and other experts from IEEE Toronto section, which also involved experts from University of Toronto. The Fellow's presentation included the usage of AT devices in Australia and its applications and challenges. The staff of Ryerson and also the experts from IEEE Toronto section appreciated the technology and the research findings in the Fellow's presentation.

Knowledge Transfer: Applying the Outcomes

The Fellow has shared and discussed the outcomes of the research and development on smart assistive technology devices (gained in the USA and Canada) with research staff at Biosignal Laboratory at RMIT University and will be presenting it to industry groups and also in workshops and seminars. The Fellow would also like to discuss the smart assistive technology aspects with Professor Hung Nguen of the University of Technology Sydney (UTS) who is a pioneer in the field of smart assistive technology devices. Professor Hung, an award-winning engineer, has dedicated the last decade to providing severely disabled people with greater independence and control with his revolutionary wheelchair, the 'Aviator'. As Project Leader for the Centre for Health Technologies at UTS, Hung and his team created a wheelchair that can 'read' the patient's mind by the installation of two electrodes inside a hat worn by the user. He is also investigating a similar system to the Aviator to control a car.

The Fellow is planning to present his work at different universities in Australia and also overseas. Future seminars/workshop will also be arranged at RMIT University where the Fellow would like to emphasise the importance and design/development of smart assistive technology devices in Australia. Some of the ideas of the smart assistive technology devices design are also introduced and discussed in RMIT AD005 (Associate Degree) courses such as MIET2137 'Industrial Studies' and EEET2281 'Digital System Design' subjects. The first course 'Industrial Studies' introduces the student to the basic facets of Industrial Studies including Occupational Health & Safety and an introduction to drafting, use of hand tools, power tools, machine processes and manufacture. Hence, some of the Assistive Technology device planning and implementation, such as printed circuit board (PCB) design, may be introduced in this course. The work that is finished in the first course may be easily extended in the second year/semester course 'Digital System Design', because this course provides an introduction to Embedded Systems, which includes logic circuits, hardware description, micro-controller, digital signal processor programming, interfacing techniques and simple project design, construction, testing and commissioning.

Recommendations

Australian and Victorian Government

Currently, the Australian Government has allocated a large amount of grants in the areas of assistive technology and neuroprosthetics in both Australian Research Council (ARC) and National Health and Medical Research Council (NHMRC) projects. The Government should allocate more funds to emerging researchers at universities and also encourage the development of more small to large assistive technology industries in Australia.

Apart from the funding for the research, there is also need for funding in Assistive Technology education. In Victoria few organisations such as Assistive Technology Learning (Yooralla), Centre for Developmental Disability Health and the Department of Human Services (State Government of Victoria) conduct this training. However, such training could be extended to wider communities through further Government funding.

Manufacturing Skills Australia (MSA)

Manufacturing Skills Australia (MSA) is the national Industry Skills Council that is recognised by the Australian Government and the manufacturing industry to ensure that the skills needs of enterprises are being met. MSA should take interest and provide industry intelligence and advice to Skills Australia in the area smart assistive technology. MSA should also actively support the development, implementation and continuous improvement of high quality training in smart assistive technology. Also, new project proposals could be submitted to MSA regarding the addressing of current limitations in the area of smart assistive technology.

Education and Training

Smart assistive technology is an emerging research area. There exists Biomedical Engineering courses in RMIT, Monash University, Victoria University and the University of Melbourne in Victoria. However, specialised courses such as design and development of smart assistive technology and neuroprosthetics courses are not fully taught/covered in Australian universities. Recently, the University of Melbourne has taken some initiative to introduce programs in brain research. Similarly, this year RMIT has started a new Biomedical Engineering (BP275) program in which smart assistive technology topics could be incorporated in engineering biomechanics and biomaterials and medical engineering and instrumentation courses. Introducing smart assistive technology or similar engineering studies in secondary schools as an elective topic will also encourage the next generation of students to show more interest in technology. Also, both government and university funds should be available and utilised for development and commercialisation purposes. The funds should be targeted to enable small industry growth from the research carried out in the universities. This will in turn generate jobs due to growth in biomedical industries and also create a self-sustainable smart assistive technology market in Australia.

ISS Institute Involvement

ISS Institute is an independent, national organisation, which works in association with Australian governments, industry and education institutions to permit individuals to benefit enriched skills and knowledge in conventional trades, professions and cutting-edge technologies. ISS Institute can help to improve the development of smart assistive technology in Australia by conducting the seminars/ workshops with industry groups and experts in association with the Australian Government. Last year (2011) ISS Institute invited a leading professor from MIT to deliver a special talk, which demonstrates how expert knowledge could be shared with both researchers and industry groups. Similar invited talks could be arranged from special experts from Australia and overseas in the smart assistive technology area.

References

Endnotes

1 *Sustainable Policies for a Dynamic Future*, Carolynne Bourne AM, ISS Institute 2007.
Note: This is a reference to a manual report held on file by ISS Institute.

2 Ibid.

3 *Directory of Opportunities. Specialised Courses with Italy. Part 1: Veneto Region*, ISS Institute, 1991.
Note: This is a reference to a manual report held on file by ISS Institute.

4 "The United Nations Non Government Organisation (NGO) has worked for many years to create a global buy-in on sustainability. Starting with the definition developed in 1987 this organisation is now working on many fronts to ensure that sustainability is understood and adopted by all sectors of Government, Industry, Education and the Community".

The following web site link will enable connection to the activities of this UN NGO that are relevant to this report. http://unngosustainability.org/

5 Skills Australia's *Australian Workforce Futures: A National Workforce Development Strategy 2010*, pp. 1-2. http://www.issinstitute.org.au/pdfs/WWF_strategy.pdf

6 Australian Institute of Health and Welfare (AIHW) 2000, Disability and ageing: Australian population patterns and implications. AIHW cat. no. DIS 19. Canberra: AIHW (Disability Series).

7 Australian Institute of Health and Welfare (AIHW): Bricknell S 2003, Disability: the use of aids and the role of the environment. Disability Series. AIHW Cat. No. DIS 32. Canberra: AIHW.

8 Victorian Neurotrauma Institute, Victoria, Australia, viewed on 10 August 2010, http://www.vni.com.au/

9 Institute of Engineers (IE) Australia, Sydney, Australia, viewed on 15 August 2010, http://www.engineersaustralia.org.au/

10 Defence Advanced Research Project Agency (DARPA), USA, viewed on 16 August 2010, http://www.darpa.mil/

11 Ontario Neurotrauma Foundation, Canada, viewed on 20 August 2010, http://www.onf.org/

12 Yooralla Australia, Victoria, Australia, viewed on 18 August 2010, http://www.yooralla.com.au/

13 University of Southern California, Sandieogo, viewed on 25th August 2011, http://www.universityofcalifornia.edu/research/stories/2011/08/brain-computer-interface.html

14 University of Southern California, Sandieogo, viewed on 25th August 2011, http://health.universityofcalifornia.edu/2011/05/16/brain-monitoring-technology-makes-media-waves/

15 Morris, M. et al, Smart Technologies for older people, Institute for a Broadband–Enabled society, Report, The University of Melbourne.