Institute for Intelligent Systems Research and Innovation

ANNUAL REPORT **2016**

IISRI
INSTITUTE FOR INTELLIGENT SYSTEMS RESEARCH AND INNOVATION

RESEARCH - DEVELOPMENT - COMMERCIAL READY

DEAKIN UNIVERSITY

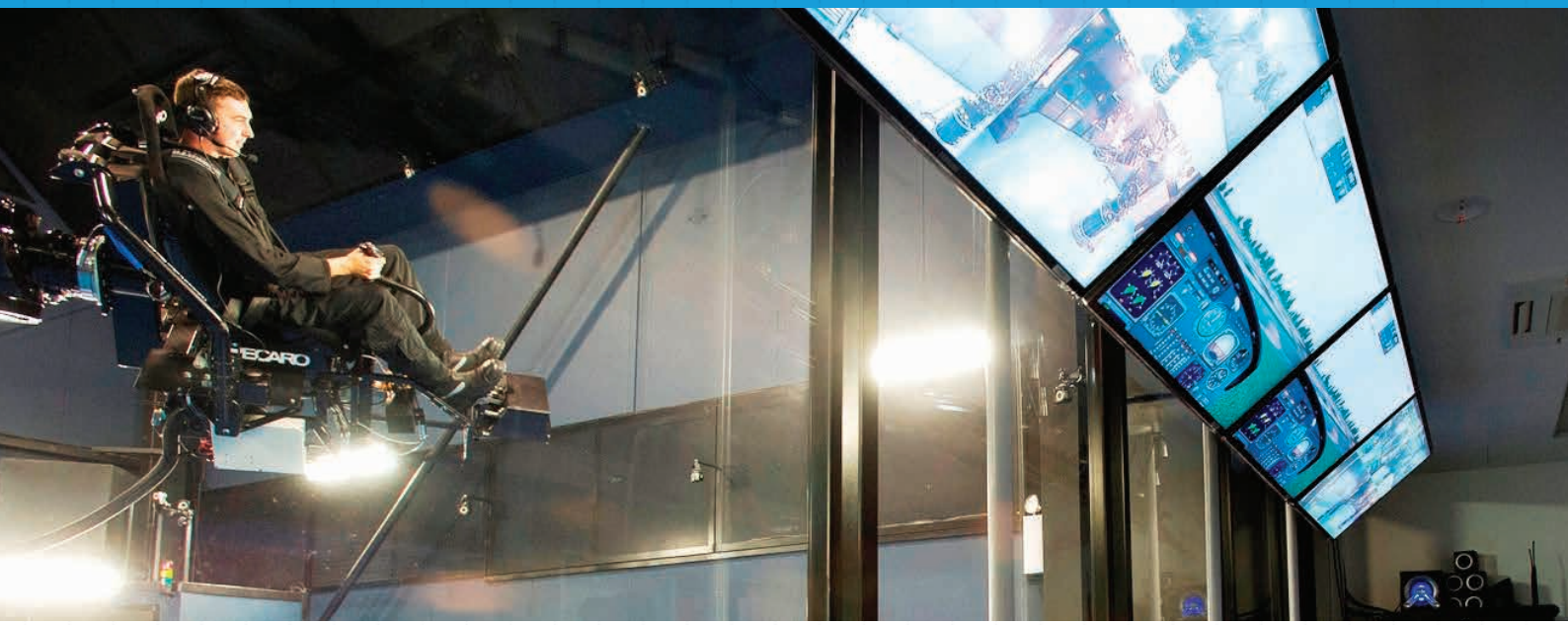
YEAR AT A GLANCE

31 PHD
STUDENTS

9 PHD
COMPLETIONS

>$2 MILLION
FUNDING AWARDED

81 PEER REVIEWED
PUBLICATIONS



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DEAKIN
UNIVERSITY

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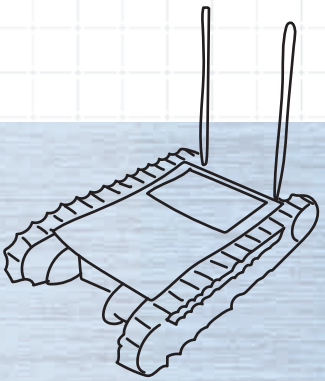


CHAIRPERSON'S REPORT

IISRI has demonstrated **impressive achievements** in motion simulation, robotics and haptics, defence systems, and modelling and simulation.

In March 2016, Deakin University Council approved the re-designation of the Centre for Intelligent Systems Research to become the Institute for Intelligent Systems Research and Innovation (IISRI). This move reflects Deakin's continuous progress and commitment to growing its global research footprint.

The Institute status is accorded to facilitate research and scholarly activities that help realise the mandate and mission of the University. As one of four Institutes at Deakin, IISRI will extend our critical mass of world-class researchers in intelligent systems, and will strengthen our research leadership in the international arena in this important field.

IISRI has demonstrated impressive research and development (R&D) achievements in the fields of motion simulation, robotics and haptics, defence systems, and modelling and simulation. As an institute, IISRI can act swiftly and strategically in key research and related activities, including improved retention of high performing researchers and attractiveness to other high-calibre staff, enhanced capacity to attract and train high-quality research students, and enriched relationships with industry and government organisations in Australia and overseas through smart partnerships.

IISRI has established extensive partnerships with numerous external stakeholders, in line with the Australian government's National Innovation Science Agenda. The innovative R&D outcomes from IISRI researchers have been recognised by awards and accolades from industry and government organisations, both nationally and internationally. The achievements of IISRI further drive the realisation of Deakin's *Research Plan 2016-2020* and *Deakin's LIVE the future: Agenda 2020* strategic plan.

Over the past 12 months, IISRI researchers have continued to work closely with industrial partners, putting greater emphasis on taking their R&D effort to the next level – turning research prototypes into commercial-ready products and services. Indeed, commercial-ready is one of IISRI's core values, which differentiates it from other research institutes and centres. The focus is bringing cross-disciplinary research from the laboratories to the real-world, where IISRI will play an important role to help solve complex real-life problems.

IISRI's Advisory Board is comprised of key strategic thinkers from industry and other academic institutions, as well as from within Deakin. They include Major General Michael Fairweather, Mr Vahid Haydari, Mr Jamie Baensch, Professor Peng Shi, Professor Jane den Hollander AO, Professor Brenda Cherednichenko, Professor Brendan Crotty, and Dr Ben Spincer.

I would like to thank our IISRI Board Members for their commitment and important contribution toward ensuring IISRI's vigour and connectivity and realising IISRI's vision and mission.

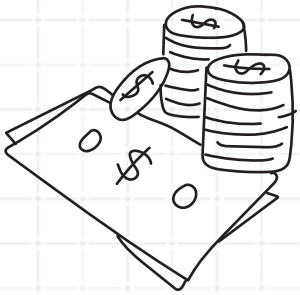
Professor Peter Hodgson

Deputy Vice-Chancellor Research
Chairperson IISRI Board

DIRECTOR'S REPORT

As highlighted in the Government's "Boosting the Commercial Returns from Research" initiative, Deakin has recognised the need for improvement in the proportion of businesses that collaborate with research institutions and innovation, and has initiated *LIVE the future: Agenda 2020* as the University's guiding strategic plan.

A key promise of Deakin's strategic plan is to advance ideas that make a difference through world-class research and innovation. As part of the plan, Deakin proactively supports a step change in key research areas that are well-positioned to work closely with industry and produce commercialisation outcomes. The establishment of the Institute for Intelligent Systems Research and Innovation (IISRI) is one such initiative.



Over the past 12 months IISRI has secured more than **$2 million of funding** from industry and government organisations.

Transforming from a Strategic Research Centre to one of four Deakin University Institutes in March 2016, IISRI embraces three key pillars: research, development, and commercial-ready. Armed with cutting-edge research and strong industry partnerships, IISRI has energetically embarked on its journey to become a catalyst and an innovation resource for Australian industry, and to fast-track the translation of intelligent systems research into commercial-ready products and processes.

IISRI had a very successful first year in 2016, as highlighted in this report. An executive team was established to support the Director in strategic planning, execution of key research, development and commercial (R&D&C) activities, governance and risk management.

We achieved a number of major successes over the past 12 months, including the delivery of key project milestones and development of commercial-ready opportunities. We secured more than $2 million of funding from various industry and government organisations, including Category 1 ARC, industry and CRC funding. In particular, IISRI has a strong commitment to provide innovative research technologies and capability to Australian Defence Force and national security agencies. This research area started back in 2004 through a series of collaborations with the Defence Science and Technology Organisation and Victoria Police. Building on its track record, IISRI won another major research grant in 2016 through the Department of Defence, as part of a Capability and Technology Demonstrator with the Australian Air Force as the end user.

In terms of awards and recognitions, IISRI has also had a fruitful year. Our research project on an innovative ingress/egress assessment tool for automotive designs was awarded the 2016 Society of Automotive Engineers (Australasia) Mobility Engineering Excellence Gold Award. While increasing our focus on R&D&C and industry engagement, we have continued to advance our core translational research, generating high-quality publications and providing research training to higher degree research students.

IISRI's student paper on ergonomic analyses with realistic biomechanical models received the Best Student Paper Finalist Award during the 2016 IEEE Systems Man and Cybernetic (SMC) International Conference, one of five such awards from a submission of 1500 papers. Internally, an IISRI student's PhD thesis on novel washout filtering designs for motion simulation was awarded the 2016 Alfred Deakin Medal for Doctoral Thesis.

We have had an active and successful first year, and I am extremely proud of the diligence and achievements of IISRI staff and students, as shared in this report.

Alfred Deakin Professor Saeid Nahavandi
Director IISRI

BOARD MEMBERS 2016

Alfred Deakin Professor Peter Hodgson
Deputy Vice Chancellor Research, Chairperson

Professor Jane den Hollander AO
Vice Chancellor

Alfred Deakin Professor Saeid Nahavandi
Director, IISRI

Professor Doug Creighton
Deputy Director, IISRI

Professor Brendon Crotty
Executive Dean,
Faculty of Health

Professor Brenda Cherednichenko
Executive Dean,
Faculty of Arts and Education

Dr Ben Spincer
Director,
Deakin Research Commercial

Professor Peng Shi
External Independent Director

Major General Michael Fairweather
External Independent Director

Mr Vahid Haydari
External Independent Director

Mr Jamie Baensch
External Independent Director

EXECUTIVE TEAM 2016

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Director

Professor Doug Creighton
Deputy Director

Associate Professor Chee Peng Lim
Associate Director Research

Associate Professor James Mullins
Industry Commercial

Dr Mick Fielding
Defence Commercial

Dr Michael Johnstone
Industry Simulation

Dr Kyle Nelson
Defence Simulation

Dr Samer Hanoun
DSI Liaison

Ms Virginie Hoareau
General Manager

BECOMING AN INSTITUTE

Research in the area of intelligent systems was established at Deakin in 2000. The initial research priority area within the School of Engineering led to the Intelligent Systems Research Lab, which was then followed by the establishment of the Centre for Intelligent Systems Research (CISR) as a Deakin Strategic Research Centre (SRC) in 2009.

CISR started with a number of key facilities, namely the Universal Motion Simulator (UMS), robotics, defence and haptics laboratories and a modelling, simulation and immersion laboratory. CISR became well known for its strong industry partnerships. It demonstrated its capabilities in designing and engineering innovative systems, including the world-first haptically-enabled UMS, which served as a high-fidelity flying or driving simulator. CISR established a track record of commercial adoption of their research outcomes, such as the OzBot family of mobile robots. These remotely controlled robots have been in-service within a number of Victorian and Queensland police units, such as the Special Operations Group, Bomb Response Unit and Police Negotiator.

As highlighted in the Australian Government's 'Boosting the Commercial Returns from Research' initiative, better translation of research into commercial outcomes is key to help drive innovation and grow Australian businesses, productivity, and exports. In view of CISR's clear evidence of success in innovative research and commercialisation, Deakin University Council took a proactive step in March 2016 to re-position CISR from an SRC to an Institute, with a goal of addressing identified gaps in translation of research outcomes into commercial-ready products and services.

The establishment of the Institute of Intelligent Systems Research and Innovation (IISRI) with its pioneering status as Deakin's first research, development, and commercial (R&D&C) entity sends a clear message to Australian industry and the community that Deakin is continuing to make industry engagement and commercialisation "core business", in line with its strategic plan of *LIVE the Future: 2020 Agenda*. This approach aligns well with Commonwealth and State reviews that recommend improving the interactions and economic benefits of building commercial research between universities and industries and businesses in Australia.

IISRI'S THREE PILLARS ARE RESEARCH, DEVELOPMENT AND COMMERCIAL READY

1. **Research:** Focusing on cross-disciplinary research to undertake complex problems and formulate solutions with potential for impact and commercial value.
2. **Development:** Focusing on the translation of research solutions into practical prototypes that are useful and usable in the real-world.
2. **Commercial ready:** Focusing on innovative technologies to further improve and up-scale practical prototypes into commercial-ready products and services.

Rather than distinct research teams for R&D&C activities, IISRI embraces a continuum structure. This model is preferred to allow expertise across IISRI to be effectively leveraged to address the multidisciplinary nature of problems and also to provide cross training and experience to IISRI staff and HDR students.

STRATEGIC GOALS

IISRI has begun its journey with four strategic goals:

GOAL 1 (Research): Leading translational research in intelligent systems

IISRI focuses on translational research in intelligent systems through understanding fundamental principles, formulating new principles, and enhancing existing principles to facilitate real-world application. The key domains of intelligent systems where IISRI has a competitive edge include motion simulation technologies, haptically-enabled systems, and complex systems modelling, simulation, and visualisation.

IISRI's translational research aims to "bridge the valley of death", as there is a gap between theoretical investigations in intelligent systems and their practical use. Therefore, it is imperative to create a pathway from discovery to application, and IISRI's research effort aptly serves to realise this pathway in the aforementioned domains of intelligent systems.

GOAL 2 (Development): Creating and developing differentiating intelligent solutions

IISRI adopts a holistic systems engineering lifecycle to design creative intelligent solutions. Compared with other R&D centres in the same field, IISRI's key differentiator is the capability to serve as a one-stop hub to create and develop both hardware devices and software solutions.

Based on the systems engineering lifecycle, IISRI performs feasibility study, conceptual design, specification development, analysis and/or synthesis, and rapid prototyping. Our competencies in mechatronics engineering, software engineering, computer science, and information and communication technologies allow IISRI to improvise (in the case of non-existence) or improve (in the case of sub-optimality) the intelligent hardware and software systems. Therefore, IISRI's development effort serves to undertake real-world problems in collaboration with stakeholders across different sectors covering industrial, government, and community organisations.

GOAL 3 (Commercial-Ready): Delivering commercial-ready intelligent products and services

IISRI strives to innovate and produce a series of commercial-ready products and services for immediate uptake by commercial partners. Unlike other R&D centres that focus on proof-of-concept prototypes or demonstrators, IISRI takes the R&D endeavours a step further in the technology development chain.

IISRI's commercial-ready effort aims to bring our intelligent products and services to a high technology readiness level. In collaboration with Deakin Research Commercial, IISRI is able to make a strong proposition to commercial partners to take over these products and services for commercialisation with minimal investment in terms of time and cost.

GOAL 4 (Innovation): Spearheading a cross-disciplinary innovation ecosystem across Deakin

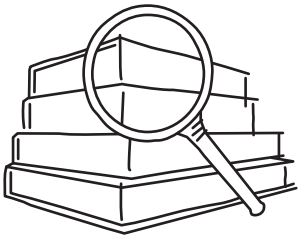
In view of IISRI's track record in technopreneurship, an innovation ecosystem is formulated to work with academics and researchers across different Faculties, Institutes, and Strategic Research Centres at Deakin. The ecosystem provides a robust cyclic framework to innovation, ranging from capturing ideas, nurturing the generation of intellectual property, assessing opportunities, planning pathways, determining milestones, and executing projects, to evaluating impact.

The innovation ecosystem aligns with a number of goals in Deakin's Research Plan 2016-2020. It serves as a resource to encourage cross-disciplinary interaction and generate novel research ideas. It also serves as one of the conduits in Deakin's research innovation and commercialisation pathway. The successful implementation of a systematic innovation ecosystem is pivotal to developing creative solutions that increase research funding, especially in Category 2 to 4. Indeed, innovation is a core tool in Deakin's strategy to achieve new heights in research in the international arena, and IISRI's innovation ecosystem aims to play such a role in this challenging journey.

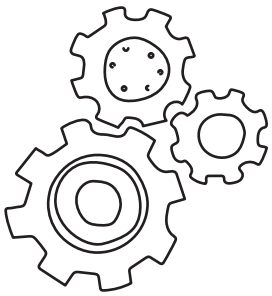
VISION AND MISSION

VISION › By 2020 IISRI is recognised as a global leader in research, innovation and development of intelligent systems.

3 KEY PILLARS ›



RESEARCH



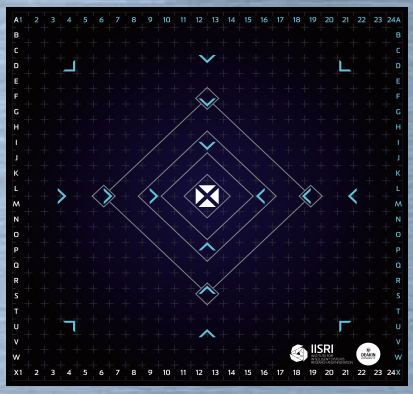
DEVELOPMENT

COMMERCIAL-READY

MISSION › To conduct innovative intelligent systems research and development to benefit society through the creation of knowledge and solutions for real world problems.

RESEARCH, DEVELOPMENT AND COMMERCIALISATION HIGHLIGHTS

- OzBot Raider to improve defence training
- Motion like no other
- 'Hero' robots step up for surgery
- Ultrasound robots go the distance
- 'FLAIM Trainer' – a realistic firefighting experience
- Digital mannequins win engineering gold
- STICKE to improve health and wellbeing
- Intelligent monitoring reduces defence maintenance costs
- Tracking swimmers' performance remotely
- Taking a Quickstep approach to workflow changes
- IEEE SMC Seminar Series



OZBOT RAIDER TO IMPROVE DEFENCE TRAINING

A robotic mobile target system is set to achieve improved accuracy in armed force training.

IISRI researchers have designed and developed a world-first autonomously-driven target system for training armed forces. The unmanned tug-operated unit was displayed at the Australia's Land Forces 2016 defence exhibition show in Adelaide.

IISRI Director Professor Nahavandi said the OzBot Raider was the latest innovation from Deakin's long-term cutting-edge research program that designs systems to improve Australian Defence capabilities and technologies.

"The OzBot Raider will enable armed forces to undertake validation and compliance testing of weapon systems without risk to personnel or any compromise in scenario realism," Prof Nahavandi explained.

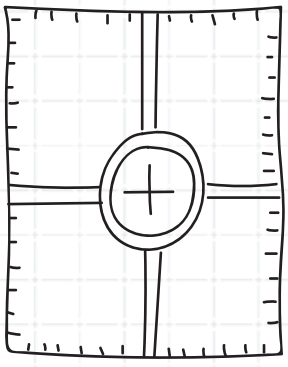
"This is a unique system that has potential to improve weapon accuracy through realistic training, which will translate to increased effectiveness."

IISRI's focus is to lead projects which bring together the Australian Defence Force, defence industry representatives and academics for sustainable contributions in the defence and security domains.

Deakin is renowned for driving transformation and investment in advanced manufacturing and this latest system signals the University's understanding of the innovation challenges facing the nation and its allies in defence.

Deakin was the first university to receive funding under the Capability and Technology Demonstrator program to design and develop a haptically-enabled mobile robot, which is currently in use by a number of law enforcement agencies.

IISRI has also been successful in winning a Capability and Technology Demonstrator contract in the field of Low-Cost High-G Centrifuge for pilot training.



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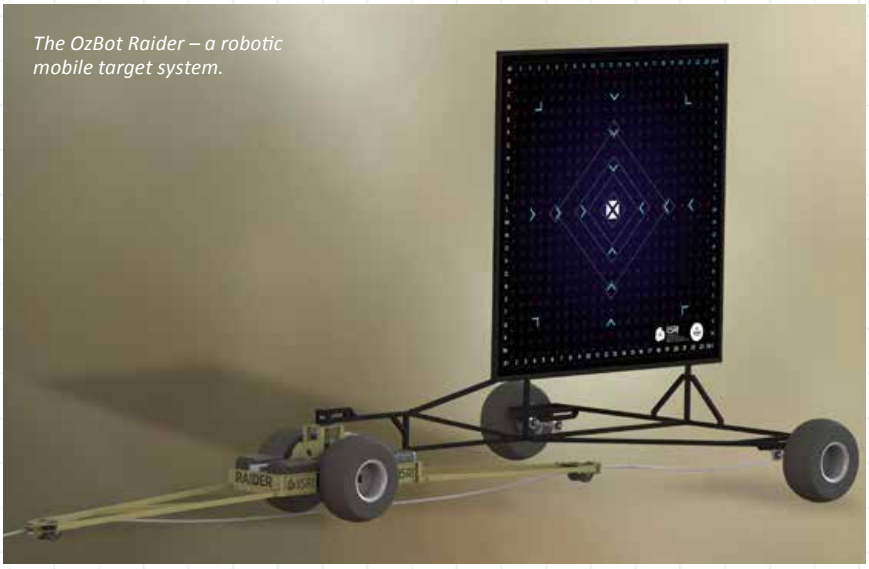
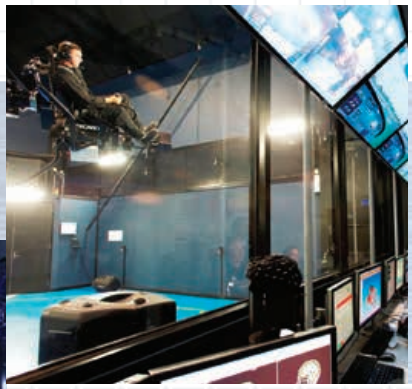
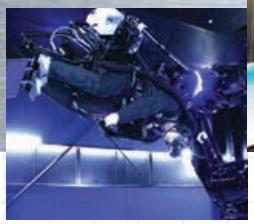


The OzBot Raider – a robotic mobile target system.





MOTION LIKE NO OTHER

IISRI's Universal Motion Simulator (UMS) takes 'virtual motion' to a whole new level.

Unlike stationary virtual systems where the user does not actually move, the gigantic robotic arm of the UMS delivers realistic accelerations and manoeuvres at high speeds in any direction.

But the UMS is no fairground ride. It is the latest in high-tech sophistication that is saving aircraft, defence and automotive industries serious capital. Designers and engineers are increasingly using the UMS to test new vehicle designs – long before they hit the production line.

Whether it be changes in suspension, centre of gravity, or ergonomics, the UMS can test virtual vehicle or aircraft prototypes under any conditions, from stormy weather, to rough terrain, to engine failure – with specific scenarios programmed into its software system.

The accuracy is formidable – enabling simulation of even the most unusual vehicle motions, like the large tilt angles found in rugged terrain, or the slipping or rollover scenarios of a tank in the desert – all in a controlled, safe and low-cost environment. This game-changing technology is being developed in conjunction with automotive manufacturers by a team of highly talented researchers and engineers from IISRI including Dr Kyle Nelson, Dr Shady Mohamed and Dr Houshyar Asadi.

Apart from design modifications, the UMS is also being used to train aircraft pilots through either fixed wing or helicopter aircraft simulations.

IISRI UMS research engineer, Dr Kyle Nelson, said the highly-customised industrial robot that forms the basis of the UMS system offers a far greater range of motion, flexibility and degree of realism than the previous generation of 'Stewart platform'-based simulators.

"The UMS brings together technologies, such as haptics (touch), robotics motion control and virtual prototyping to create the ultimate simulation," Dr Nelson said.

"The haptic vehicle controls, including cyclics, collectives, pedals and steering wheels, provide realistic sensations, while the high-resolution 3D head-mounted display and 36-camera motion capture and tracking system help to give a sense of complete immersion within the simulated environment."

"We can also monitor all the major physical responses of the user, such as heart rate and EEG (brain) activity, which is particularly useful in pilot training and defence research," said Dr Nelson.

IISRI researchers are using the UMS to simulate military vehicles, such as tanks and armoured personnel carriers. They are presently designing replica vehicle cabins that can be fixed to the end of the simulator for both improving armoured vehicle design and training military drivers.

The UMS is the first system of its kind in Australia and the first haptically-enabled robot-based motion simulator in the world. It has been developed with the support of the Australian Research Council.

The **HeroSurg** will enable surgeons to retain the sense of touch, **improving their ability** to diagnose and treat many conditions.

'HERO' ROBOTS STEP UP FOR SURGERY

A world-first, haptically-enabled, minimally invasive robotic surgical system can overcome many of the limitations of existing robotic laparoscopic systems.

The Haptically-Enabled Robotic Assisted Minimally Invasive Surgical System (HeroSurg), which includes features such as collision avoidance, modular instruments and automatic patient/bed adjustment, was developed by IISRI researchers in collaboration with Harvard University.

Haptic feedback (sense of touch) is the missing link that will provide natural hand-eye co-ordination and dexterity currently missing in existing systems.

In particular, the haptic feedback will enable surgeons to retain the sense of touch, improving their ability to diagnose and treat many conditions, especially those requiring surgeons to palpate and diagnose soft tissue damage.

Professor Suren Krishnan, a surgeon from Royal Adelaide Hospital and Honorary Professor at IISRI, who collaborated on the project, said HeroSurg was a "significant development in the ongoing efficacy of robotic surgical systems in operating theatres."

***Top right:** The key feature of haptic feedback will enable improved diagnosis and treatment. **Above:** Extra views of the surgical site will help surgeons see the instruments and laparoscope in 3D space.*

"Haptics will add a greater ability to distinguish diseased tissues involved with cancer from normal tissues," Professor Krishnan said.

"It will also allow surgeons to feel more delicate tissues weakened by infection or inflammation and dissect them more carefully – and allow us to use finer and more delicate materials such as finer sutures in microsurgery."

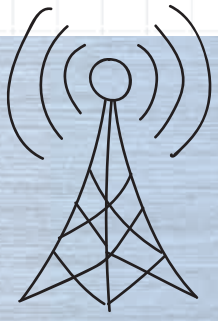
The project was led by Dr Mohsen Moradi Dalvand, a Deakin research fellow in Robotics and Haptics, who recently spent two years at Harvard University as a visiting scholar working on several collaborative projects with Professor Robert Howe, the Director of the BioRobotics laboratory, School of Engineering and Applied Science.

The key features of HeroSurg, including haptics, modularity, and collision avoidance, will enable surgeons to perform delicate procedures where palpation of soft tissues plays an important role in the outcome of the procedure.

The extra views of the surgical scene will help the surgeon identify the relationship of the instruments and laparoscope in 3D space.

The IISRI team collaborated with experts from Deakin's School of Medicine and will work with hospitals, medical centres and potential manufacturers to bring the technology into the health system over the next few years.

The **new technology** is now portable and expandable enough to cover more than **97 per cent** of Australia's population.



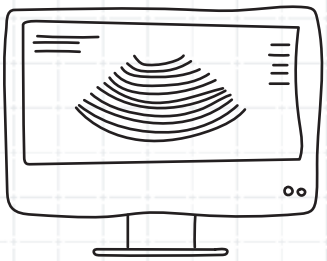
ULTRASOUND ROBOTS GO THE DISTANCE

Australians may soon be able to undergo ultrasound diagnostics from remote locations, thanks to a world-first robotics technology developed by IISRI in partnership with Telstra.

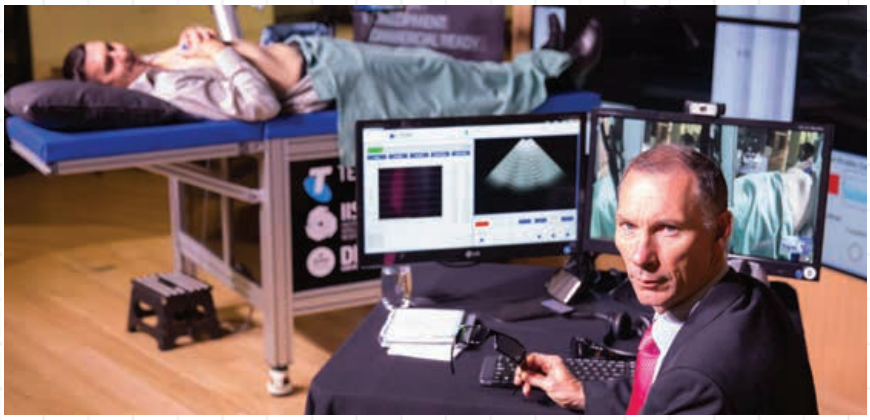
The haptics-enabled technology means a patient will no longer need to be in the same room as the sonographer. In fact, the medical professional could be as far as 1,000km away from the ultrasound unit.

The new technology has the potential to dramatically improve access to diagnostics tools for Australians living in regional and remote parts of the country, either not serviced by, or with limited access to, medical resources.

The HER (Haptically-Enabled Robotics) remote ultrasound technology was developed by IISRI, with funding and technical support from Telstra as part of its Research Partner Program.



Developed by **IISRI** with funding and support from **Telstra**, the haptics-enabled techonology means a patient can be 1,000km away from the ultrasound unit for diagnosis.



The system can be applied to abdominal ultrasound imaging to evaluate a patient's kidneys, liver, gallbladder, pancreas, spleen, the abdominal aorta and other blood vessels of the abdomen. It can also be used for the diagnosis of abdominal pain, abnormal liver function and an enlarged abdominal organ.

With the addition of patient feedback technology, the sonographer can remotely monitor patient discomfort in relation to the applied probe force. This information can be used to assess the tenderness of the examined area, and compared with historical data on the patient. The technology has been successfully tested in a trial using data links between Melbourne and several regional and rural cities. The aim is to develop advanced haptic, or force feedback, and stereovision capability for remote ultrasound procedures.

Director of Technology, Technology Strategy at Telstra, Kannan Alagappan, said that Telstra was the perfect partner for the project, bringing network expertise and capabilities, along with commercial experience.

"Early stage testing has extended the trial beyond initial expectations by proving the technology on Telstra's 4G wireless network," Mr Alagappan said. "It's now portable and expandable enough to cover more than 97 per cent of Australia's population."

Deakin University clinician and Epworth Geelong Chair in Surgery, Professor Glenn Guest, said the ability to perform a remote ultrasound procedure using robotic technology would enable skilled surgeons, doctors and radiologists to make diagnoses from their preferred location.

"In the future, a number of remote communities could be supplied with an ultrasound 'robot' for medical diagnosis requirements," Professor Guest said.

Telstra and Deakin are actively seeking partners and exploring a number of paths to bring the technology to market, through global health technology companies, and health networks across Australia. Once in market, this high technology system would be a driver in creating jobs in high technology manufacturing, diagnosis, maintenance and research and development.

***Top:** Deakin University clinician and Epworth Geelong Chair in Surgery, Professor Glenn Guest, demonstrates a remote ultrasound procedure.*

‘FLAIM TRAINER’ – A REALISTIC FIREFIGHTING EXPERIENCE

A haptically-enabled virtual and augmented reality simulator for training fire-fighters known as ‘FLAIM Trainer’ provides realistic training scenarios in a safe synthetic environment.

The FLAIM Trainer has been designed and developed by IISRI researchers. It can accurately represent heat, jet reaction and step-up forces, along with sound and visuals, to immerse a trainee in a real house, car, boat or aircraft fire.

It improves preparation of trainees before live fire training is undertaken. IISRI researchers particularly worked on the haptic (force feedback) aspect of the technology, which represents the ‘kick back’ of water pressure, and the augmented reality software, which allows trainees to use the program in any location.

Leader of the IISRI team on the FLAIM Trainer project, Associate Professor James Mullins, who is himself a volunteer fire-fighter, says the team wants to take the technology a lot further.

“We have a big need, in Australia at least, to learn different techniques for fire-fighting. Some fire-fighters go their entire career and may experience a particular type of job only once or twice. FLAIM Trainer could help them prepare for those times. It could also be used to help educate people about fire safety,” he says.

The FLAIM Trainer can use augmented reality markers and advanced tracking systems to superimpose flames within any environment, such as from within the engine room of a ship.

“This means that users can gain firefighting experience in the location where they are most likely to be confronted with it – and it allows trainees to keep learning within different types of environments.”

The system includes a high-end computer, a HTC Vive virtual reality headset and a software game engine. It was developed for users such as the US and Australian Defence Departments, the nuclear industry and fire fighters.

www.flaimtrainer.com

DIGITAL MANNEQUINS WIN ENGINEERING GOLD

IISRI researchers, in collaboration with Excellerate Australia and GM Holden, have been recognised for high-tech innovation in automotive design.

A system that uses digital mannequins and computer-generated vehicles to assess the comfort of drivers has been awarded the 2016 Society of Automotive Engineers (Australasia) Mobility Engineering Excellence Gold Award.

It was one of four Gold Awards for Engineering Excellence, covering Automotive; Rail; Caravan and Camper; and Manufacturing/Non-OE categories. Holden is now using the award-winning Ingress/Egress Assessment Tool for automotive design to evaluate automotive designs prior to production.

The team worked on the tool for over 12 months, bringing together skills in motion capture, advanced modelling, software development and signal processing. Using motion capture obtained from sensors on the arms and shoulders of people and analysed by signal processing techniques, to form the original baseline data, the system allows automotive designers to assess the degree of discomfort drivers experience getting into and out of a vehicle without the need to build any actual mock-ups.

The initial 12-month project has recently been extended to develop a system to analyse the comfort of front and back seat passengers moving in and out of vehicles. The initial project focussed on four different vehicle types: a small hatch-back, two types of Sports Utility Vehicles (SUVs) and a luxury sedan.

"The project accelerates the design-testing loop for producing beautiful vehicles, while maintaining the highest standards of comfortable vehicle access," said leading researcher Dr Mohammed Hossny. Dr Hossny explained that there is often a trade-off to be considered between the aesthetic requirements of automotive design and ergonomics. The conventional process for assessing the comfort of drivers getting into and out of different cars is to develop a design, build a large mock-up, seek many opinions and then report this feedback to the design team," Dr Hossny said.

"Our system allows the entire process to be completed through a computer model with digital mannequins. It can pinpoint the 'sweet spot' between creative design and ergonomics."

The technology has many other potential applications, such as in the design of trains, aircraft, buses and ambulances, or industries such as construction or infrastructure.

***L-R:** Dr Asim Bhatti, Mr Gary Carroll (Project Champion - GM Holden), Dr Mohammed Hossny, Dr Shady Mohamed, Dr Imali Hettiarachchi, Mr Gary White (Excellerate Australia), Professor Saeid Nahavandi, Professor Doug Creighton, Dr Lei Wei receiving their award.*

The project will enable **new technologies** to be developed to understand the complex drivers of an **unhealthy diet**.

STICKE TO IMPROVE HEALTH AND WELLBEING

A cutting edge project from IISRI researchers has been awarded a VicHealth grant for new innovative research.

The funding will support a pioneering health research project on investigating a new software approach for scale mapping the complexities behind unhealthy diets.

The Systems Thinking in Community Knowledge Exchange (STICKE) Healthy Eating project includes IISRI researchers, Dr Michael Johnstone and Professor Doug Creighton, and the World Health Organisation Collaborating Centre (WHO CC) for Obesity Prevention.

STICKE enables communities to approach complex problems in new ways, developing capacity within the local community for collaboration and driving change.

IISRI Deputy Director, Prof Doug Creighton said systems thinking was a proven method for addressing complex problems but it hasn't previously been fully applied in health promotion or the prevention of chronic disease.

Dr Michael Johnstone noted that without systems maps it is difficult to adequately design, implement and evaluate interventions for these complex problems and this has limited community obesity prevention efforts to date.

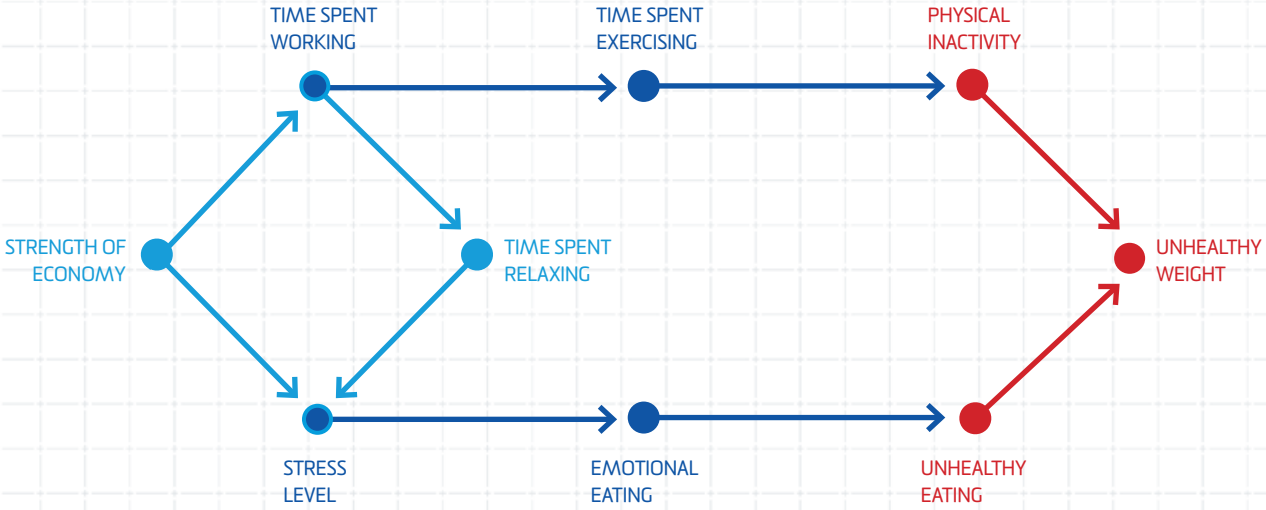
"STICKE presents an opportunity to provide an efficient automated approach to collect systems maps from larger numbers of people and to support community engagement and intervention planning," said Dr Johnstone.

The project represents the next generation of chronic disease prevention, according to Professor Steve Allender, Professor of Population Health and Co-Director World WHO CC for Obesity Prevention.

"The funding will enable the WHO CC and IISRI teams to work with VicHealth and develop new technologies to understand and intervene in the complex drivers of unhealthy diet," he said.

Researchers will engage directly with a number of communities in western Victoria to conduct field trials of new software for mapping at scale the complex drivers of unhealthy diet and the consumption of water versus sugar sweetened beverages such as soft drinks and energy drinks and determine the best ways to make this information effective, efficient and engaging in driving change.

STICKE is also generating interest beyond the current VicHealth grant, with commercial income supporting ongoing research into this innovative platform.



INTELLIGENT MONITORING REDUCES DEFENCE MAINTENANCE COSTS

IISRI researchers and their collaborators have developed an intelligent decision support tool to monitor vehicle conditions through the engine lubrication oil.

The new tool was developed in collaboration with Defence Science and Technology Group (DSTG) and the Land Engineering Agency (LEA).

Efective use of the Vehicle Health and Usage Monitoring System (VHUMS) for implementing condition-based maintenance policies could deliver savings of 8 per cent of fleet maintenance costs to the ADF, and could revolutionise the way Army supports and runs its vehicles, according to a report by the Defence Material Organisation.

The tool avoids the time and cost burdens associated with laboratory-based oil testing for land vehicle fleets of the ADF. The research revealed the potentially useful correlations between VHUMS data from G-Wagons and laboratory test results for inferring engine oil conditions using machine learning models.

To maintain engine performance and prolong the lifespan of key engine components, one solution is to implement a short oil-change interval policy. This helps maintain the engine in an excellent condition and reduce the likelihood of a catastrophic engine failure. However, changing the engine lubrication oil periodically within a short interval unnecessarily increases the maintenance cost in the long run. Therefore, determining an optimal oil-change interval could reduce cost while maintaining engine reliability.

Associate Professor CP Lim, the lead investigator of the VHUMS project, said that applying intelligent condition monitoring methods in a predictive maintenance scheme could reduce excessive service maintenance as in the current preventive maintenance practice.

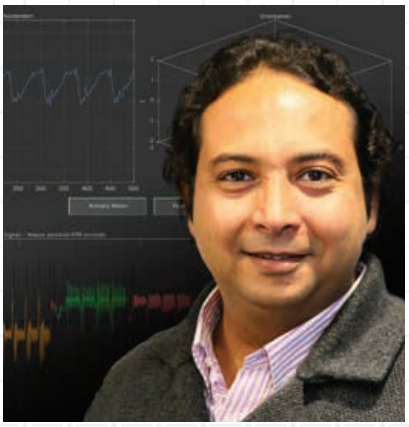
“The intelligent prognostic algorithms developed by IISRI are able to provide an earlier prediction of the remaining useful life of the engine lubrication oil, reducing the associated maintenance costs, and ensuring the “health status” of land vehicles of the ADF”, said Dr Vu Le, another key researcher on the VHUMS project.

Effective use of the new monitoring tool could revolutionise the way the army supports and runs its vehicles.

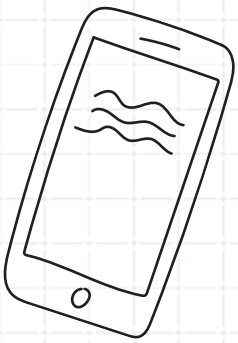
TRACKING SWIMMERS' PERFORMANCE REMOTELY

New IISRI technology is expanding the potential for remote coaching.

In the world of competitive swimming, where success is measured in fractions of a second, elite swimmers and their coaches work as a team to develop a winning edge.



Dr Shady Mohamed.



The Intelligent Swim Sensor will allow **more athletes** to **access coaching** resources without having to spend time travelling to the AIS.

However, this quest for success often requires swimmers to spend time away from home at the Australian Institute of Sport (AIS) in Canberra in order to access high-level coaching.

A collaboration between the AIS and IISRI has made it possible for swimmers to train in their local pools without missing out on the benefits of specialist coaching.

IISRI researchers worked closely with the AIS to develop the Intelligent Swim Sensor which allows coaches to remotely assess swimmers' performance during training using automatic analysis of swimming techniques as well as accurate measurement of lap timing.

It also reconstructs the swimmer's movements in 3D, eliminating the need for video filming and analysis.

"Traditionally, coaches use video analysis to monitor swimmers' strokes and swimming styles, but the process is very time consuming. It also limits the number of swimmers individual coaches can mentor," said IISRI project leader, Dr Shady Mohamed.

"This system can record the swimmer's performance and provide a detailed description of their stroke style and timing, enabling coaches to develop effective training strategies and lead a larger number of swimmers.

"It also allows more athletes to access coaching resources without having to spend time travelling to the AIS."

The Intelligent Swim Sensor consists of a lightweight, off-the-shelf sensor clipped to the athlete's swimwear at the lumbar spine and an iPhone app developed by Dr Mohamed, who also developed the algorithm and analytic software behind the Intelligent Swim Sensor.

"One of the advantages of the technology is that it works using different brands of sensors and doesn't require expensive, proprietary equipment. The system also works without needing to be calibrated to individual swimmers.

"All the swimmer needs is the sensor and an iPhone. The sensor records the data to the app, and the coach then uploads and analyses the file."

During testing at the AIS, the system achieved 100 per cent swimming style accuracy with elite swimmers and club-level swimmers and a lap timing accuracy of over 99.8 per cent, where the error in determining the start and end of swimming laps is less than 0.4 of a second.

The system has a number of unique features compared to existing swimming analysis technologies, including provision of swimming scores for each of the swimming styles to monitor a swimmer's progress, high accuracy in determining stroke counts and durations and the ability to adapt to different swimmers from different levels without the need for recalibration.

Dr Mohamed said the robust algorithm and analysis tools behind the software could be easily adapted for sporting domains other than swimming and had already attracted attention from cycling and skiing coaches.

Lighter weight seat systems offer **significant advantages** to manufacturers of luxury and performance vehicles, SUVs and electric vehicles.

TAKING A QUICKSTEP APPROACH TO WORKFLOW CHANGES

Quickstep Technologies is an Australian SME at the forefront of advanced composites manufacturing and technology development. Quickstep manufactures using both traditional autoclave and leading edge out-of-autoclave production technologies for aerospace and automotive.

The global seat structures market is a significant product segment in the automotive sector, currently valued at US$16 billion p.a., with 91 million seat frame sets forecast to be manufactured and supplied to vehicle producers globally in 2016. Lighter weight seat systems offer significant advantages to manufacturers of luxury and performance vehicles, SUVs and electric vehicles and represent an attractive target segment for Quickstep. In response, Quickstep has been trialling materials and innovative manufacturing processes.

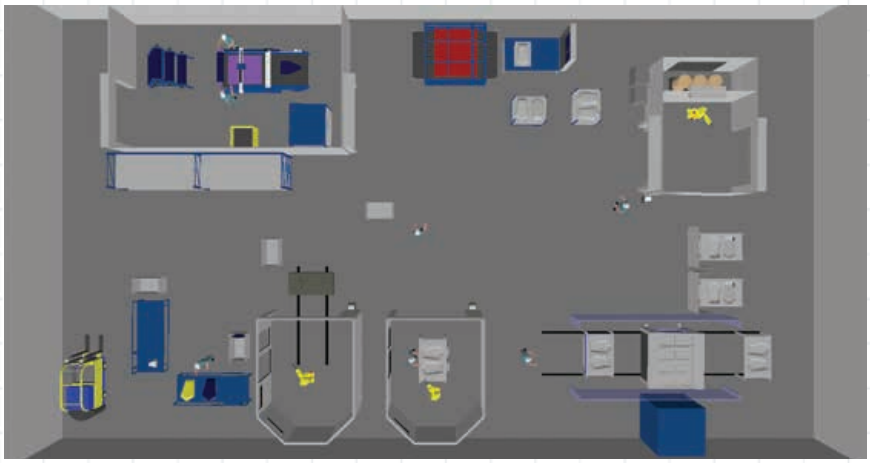
IISRI has supported Quickstep modelling the integration of the company's next generation processes into a production sequence.

Modelling and simulation capability was used to understand process bottlenecks and design a system with a demonstrated production rate of greater than 20,000 parts per annum for the automotive sector.

IISRI modelled a specific design scenario using the discrete event simulation package Quest, and provided the analysis and visualisation from the simulation of that scenario. Through the modelling process, IISRI supported changes to the original workflow and labour allocation, to better balance the production workflow.

The collaboration between Quickstep and IISRI is an outstanding example of how industry and universities can work together for the benefit of both. IISRI was able to respond quickly to meet commercial timelines and work with the project team as the shared understanding of processes evolved from preliminary simulation analytics.

www.youtube.com/watch?v=SNpbl9QWHW8



***Top:** Simulation model screenshot showing a top view of the facility. **Bottom:** Simulation model screenshot of a robotic workcell.*

IEEE SMC SEMINAR SERIES

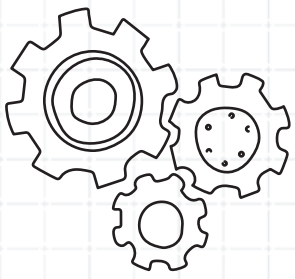
"On behalf of IEEE Victorian Section, I am pleased to acknowledge the valuable role played by Deakin University's Institute for Intelligent Systems Research and Innovation, through its ongoing sponsorship and support of our Systems, Man and Cybernetics Chapter.

"The SMC group was founded in 2014, and has since become one of the most active subunits of the Victorian Section. This has been largely due to the leadership provided by the current SMC Chapter Chair and IISRI Director, Prof. Saeid Nahavandi, and his very willing and able IISRI staff.

"IISRI is itself a unique research institute whose 'broadband' vision of the future, human-centric endeavours, and high professional standards, are all congruent with the corporate mission of the IEEE. We value our ongoing relationship with this organisation."

Anthony E. Gascoigne,
MIEEE MIEAust CPEng NER
Past Section Chair (2014/2015 and 1993/1994) IEEE Victorian Section

Date	Title	Presenters
22 Feb 16	Mutli-scale Robotics	Prof. Toshio Fukuda, Nagoya University, Meijo University, Beijing Institute of Technology
2 Mar 16	Resilience and Customisation in the Industrial Supply Chain: The Role of Information	Prof. Duncan McFarlane, University of Cambridge, United Kingdom
2 May 16	Liquid Metal Based Systems: Moving Towards Soft Actuators and Flexible Electronic Devices	Dr. Khashayar Khoshmanesh, School of Engineering, RMIT University
30 May 16	Simulation and Human Factor in Systems Design	Associate Prof. Marcus Watson PhD, The University of Queensland
16 Aug 16	Understanding how to shape technology so it doesn't shape us	Prof. Bernadette A. Murphy, Head of Kinesiology, Faculty of Health Sciences, University of Ontario Institute of Technology (UOIT), Canada
19 Sep 16	Big Internet Traffic Data Analytics for Cybersecurity	Dr. Jun Zhang, School of Information Technology, Deakin University
14 Nov 16	Towards Effective Interoperability of Flight and Mission Simulators	Mr. Jawahar Bhalla – Manager, Systems and Technologies, CAE Asia Pacific
2 Dec 16	Internet of Things: Research and Practice	Prof. Mengchu Zhou, Department of Electrical and Computer Engineering, New Jersey Institute of Technology, USA
5 Dec 16	Functional Tissue Modelling Asymmetry, Laterality, Neural Plasticity and Medical Imaging	Prof. Paul Yielder, Chair in Medical Imaging, School of Medicine, Deakin University



IISRI is itself a unique research institute whose 'broadband' vision of the future, human-centric endeavours, and **high professional** standards, are all congruent with the corporate mission of the IEEE.

FINANCIAL REPORTS AND PUBLICATIONS

FINANCIAL SUMMARY 2016

FINANCIAL SUMMARY - For Period Ended 31 December 2016	2016 Actual $
INCOME	
Research Income	2,391,250
Other Income	18,731
Research Allocation / University Contribution	3,436,885
Total Income	**5,846,866**
EMPLOYMENT COSTS	
Academic Salaries	(3,755,355)
General Salaries	(293,667)
Other Employment Costs	(19,179)
Total Employment Costs	**(4,068,201)**
NON SALARY EXPENSES	
Buildings and Grounds Infrastructure Costs	(39,993)
Communication / Advertising, Marketing and Promotions	(33,468)
Consumables	(284,699)
Depreciation and Amortisation	(223,198)
Equipment - Repairs, Maintenance and Other Costs	(367,523)
Other Costs	(338,494)
Professional, Legal and Consultants	
Staff Recruiting, Training and Other / Library Information Resource Expenses	(38,886)
Student Expenses	(314,355)
Travel, Catering and Entertainment	(138,049)
Total Non Salary Expenses	**(1,778,665)**
Surplus / (Deficit)	**0**

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