Institute for Intelligent Systems Research and Innovation

Annual Report **2017**

IISRI
INSTITUTE FOR
INTELLIGENT SYSTEMS
RESEARCH AND INNOVATION

RESEARCH - DEVELOPMENT - COMMERCIAL READY

DEAKIN
UNIVERSITY

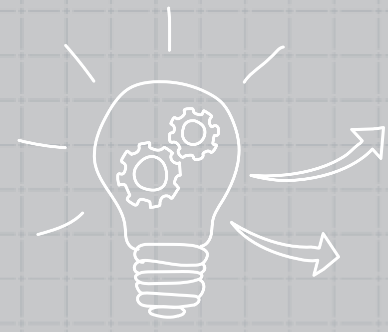
Contents

IISRI
INSTITUTE FOR INTELLIGENT SYSTEMS RESEARCH AND INNOVATION
RESEARCH - DEVELOPMENT - COMMERCIAL READY

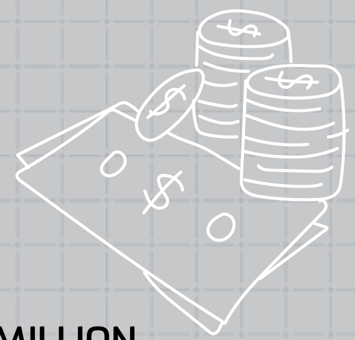
DEAKIN UNIVERSITY

Year at a glance

30 PHD STUDENTS



2 COMMERCIAL SPIN-OFFS



$7 MILLION FUNDING AWARDED

94 PEER REVIEWED PUBLICATIONS

Vision and Mission

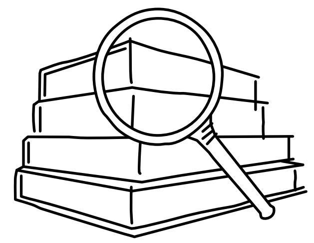
Vision

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

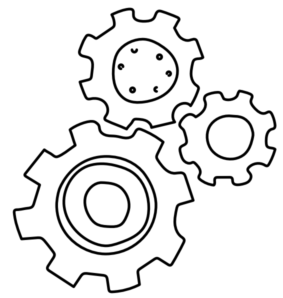
Mission

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

3 Key Pillars

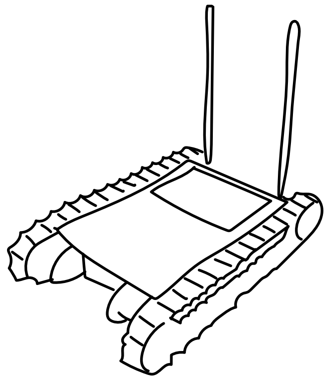


Research



Development

Commercial-ready



Chairperson's Report

IISRI is committed to its goals through research in autonomous systems and robotics, simulation training and haptics, systems modelling, and human performance and cognition.

Professor Peter Hodgson

Deputy Vice-Chancellor Research
Chairperson IISRI Board

IISRI's first full year as an institute was a very successful one, with exceptional achievements in its three key pillars of Research, Development, and Commercial Ready.

The University's mission is to deliver and translate high quality research and research training outcomes that are relevant and meaningful to improving the future of our communities. This will be achieved through high quality research; industry, business and government partnerships; commercialisation; international connections and career-ready research training programs.

IISRI contributes to these goals through its research in autonomous systems and robotics; simulation training and haptics; systems modelling; and human performance and cognition.

It is great to see IISRI's team of commercially connected research scientists, engineers and innovators delivering high quality solutions to industry and government. IISRI researchers offer innovation and creativity beyond traditional academia, complemented by an ethos and work practices that are an exemplar within Deakin, and which have enabled the team to exceed their KPIs in 2017.

Having a heart for dissemination of knowledge, IISRI embraces young minds in a highly nurturing environment to grow our future research leaders.

It is fantastic to experience such a buzzing environment, not due to caffeine consumption, but arising from brainwaves and the collaborative approach to research.

An area that I am deeply committed to is to grow cross-disciplinary research programs that address global challenges. IISRI is contributing to this goal by working with researchers from faculties and strategic research centres across the University on a number of initiatives, including projects in health and infrastructure.

The success of IISRI in translational R&D initiatives has resulted in the establishment of two start-ups by Deakin. These start-ups aim to bring state-of-the-art technologies created by IISRI to the local and global markets. They serve as examples to inculcate entrepreneurship in university environments and move towards translating knowledge and research findings into economic value.

On behalf of Deakin University, I would like to thank IISRI Board Members for their continuous support and wise counsel toward the growth of IISRI over the past 12 months. The unreserved commitment of IISRI Board Members and the team of proactive and energetic researchers will propel us in the coming years towards the next level of excellence in realising IISRI's vision and mission.

Director's Report

Institute for Intelligent Systems Research and Innovation saw its most successful year in 2017. The journey brought together IISRI's three pillars of Research, Development and Commercial ready in a synergistic manner combining science, engineering and technical expertise to solve complex problems for our clients putting effective, practical solutions into action.

Through close collaboration with the Australian Army IISRI delivered a unique solution for Army battle tank driver simulator for field trials and user conformance test and evaluation. This in turn has created new business opportunities for Deakin University.

During the same period IISRI delivered three autonomous mobile robots as target systems to the Army.

A series of trials were carried out to measure the suitability and also the effectiveness of such autonomous vehicle in harsh and unforgiving environment by the Army.

We secured over $3.7M of external research income to support various activities with the institute. Industry partners included Army, Navy, Air Force, Ford motor company, Lockheed Martin, DSTG, Queensland Police, Australian Electoral Commission, Carbon Rev., HPS, AIS.

IISRI was awarded a major contract by the Federal Government's Defence Innovation Hub, Deakin's first Innovation Hub award.

The project will deliver a next-generation, virtual reality, hot fire training system for Royal Australian Navy personnel and marks a significant achievement for IISRI in this competitive arena.

Another major project during the year, which illustrates the diversity of application of IISRI research, was a contract with the Australian Electoral Commission to explore the use of modelling and simulation technologies for operations analysis.

A number of key research leaders and their areas of research have been selected to provide an insight into the type of R&D carried out and their impact and application areas.

Alfred Deakin Professor
Saeid Nahavandi

Director IISRI

Over the past 12 months IISRI has secured over $3.7 million of funding from industry and government organisations.

Board Members 2017

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 2017

Professor Saeid Nahavandi
Director

Professor Doug Creighton
Deputy Director

Associate Professor Chee Peng Lim
Associate Director Research

Associate Professor James Mullins
Industry Commercial

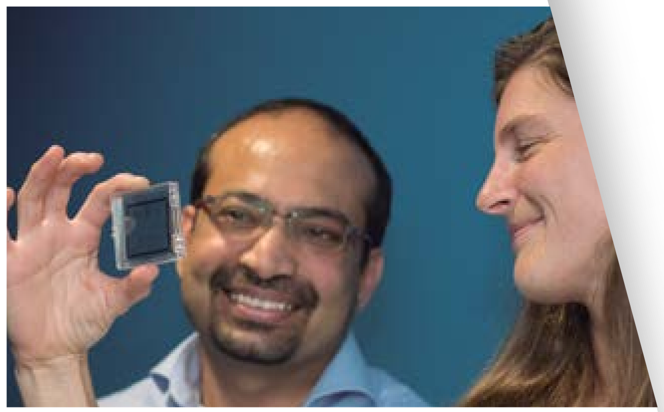
Dr Mick Fielding
Defence Commercial

Dr Michael Johnstone
Industry Simulation

Dr Kyle Nelson
Defence Simulation

Dr Samer Hanoun
DSI Liaison

Ms Virginie Hoareau
General Manager



Research, development and commercialisation

Highlights

PAGE

Opposite: Prof Saeid Nahavandi (Director of IISRI) and Dr Imali Hettiarachchi (Research Fellow) examine the EEG (electroencephalography) signals from a driver on IISRI's Universal Motion Simulator.

Above: A/Prof. Asim Bhatti and Ms Julie Gaburro inspect neuronal cells on a micro-electrode array.

Above: (from left) Dr Michael Johnstone, Professor Doug Creighton, Mr Burhan Khan, and Dr Vu Le.

Intelligent risk analytics and decision support for complex industrial systems

Professor CP Lim
Associate Director Research

With the advent of new challenges in Industry 4.0, risk analysis is essential to help identify and manage potential problems that could occur in complex industrial systems and/or processes.

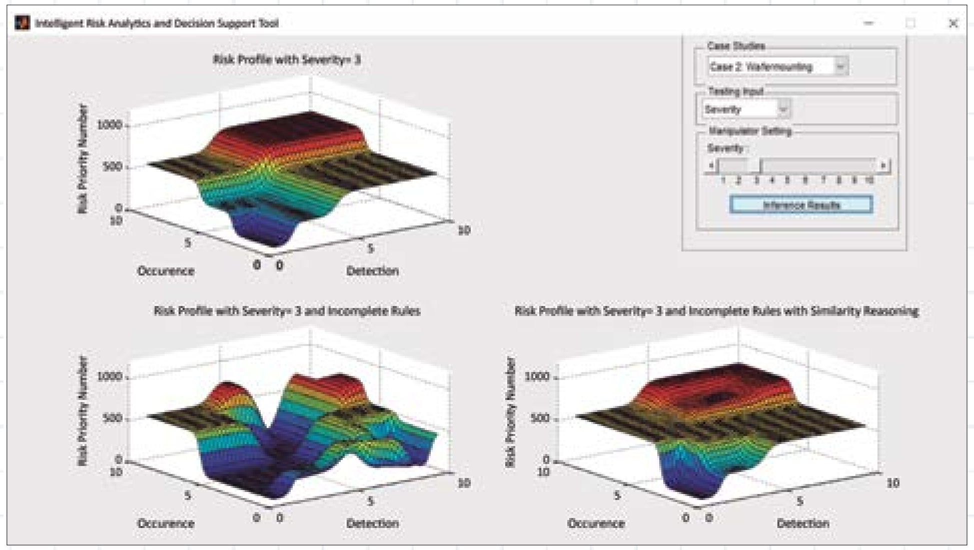
To perform risk analysis, we need to first identify the possible threats, and then estimate the likelihood of these threats propagating to other sub-systems or sub-processes.

IISRI researchers develop intelligent risk analytics and decision support methodologies using computational intelligence (CI) to help industrial practitioners scrutinise and manage risks related to complex systems or processes in their workplace.

Based on the Failure Mode and Effect Analysis (FMEA) method, we have designed and developed an intelligent decision support tool to visualise the entire risk profile of a particular system or process.

The fuzzy-based tool customises the traditional risk computation in FMEA using experts' knowledge provided in the form of human linguistic "if-then" rules. The tool allows FMEA users to make informed decisions about how to detect incipient faults, prescribe corrective actions, and mitigate potential risks that could affect their systems or processes.

Below: Visualising the system/process risk profile with IISRI's intelligent decision support tool.



IISRI works to improve the voting experience

Dr. Michael Johnstone
Senior Research Fellow

IISRI researchers are developing technologies that will enable voters to engage in a more pleasurable voting experience.

The Australian Electoral Commission (AEC) engaged IISRI to help test and record aspects of polling place activities to better understand and reduce the likelihood of queuing issues.

Now in the fifth phase of the project, IISRI's research has assisted the AEC to more accurately predict resource requirements for materials and personnel at polling places in the future.

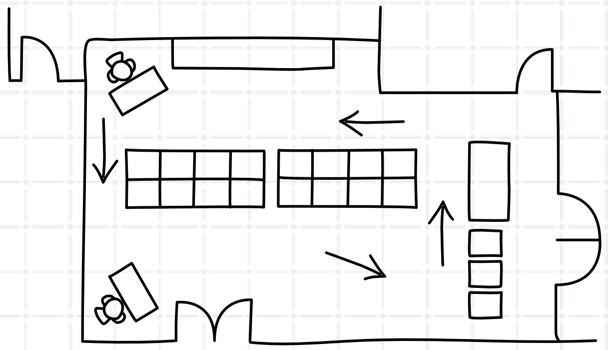
Project leader, Dr Michael Johnstone said the use of modelling and simulation technology developed by IISRI will affect the millions of voting Australians.

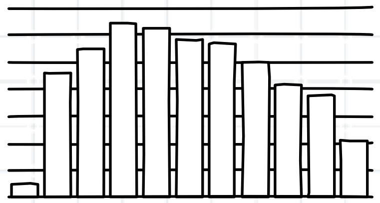
"The design of trials to collect data in order to build predictive models will help to explain the impact of decisions on election day resourcing," said Dr Johnstone.

To date, the study has generated several important general outcomes. These include the generation of real world datasets through simulated trials and live data collection; and the delivery of a suite of models for decision support. The models can be used to rapidly evaluate the impact of planning decisions, operational changes, policy changes and new technologies without the expense and logistical challenges of live trials.

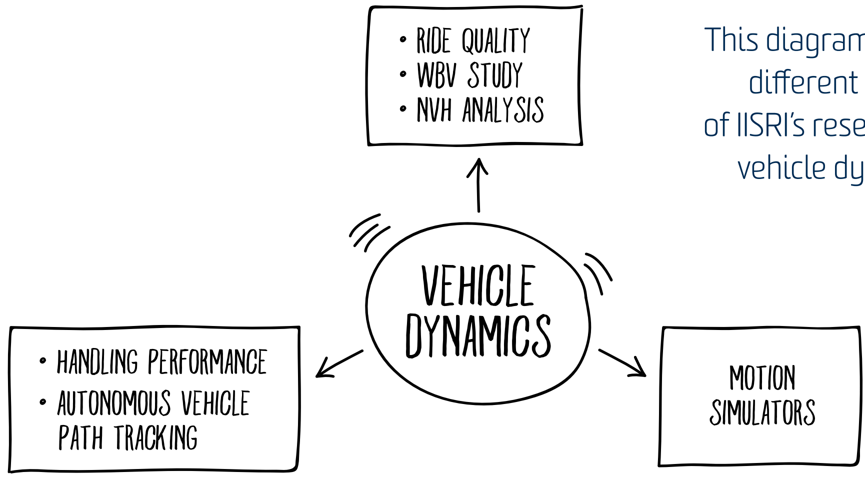
The research is being used for planning estimation and projection algorithms in the AEC systems.

IISRI uses advanced modelling and simulation technologies to improve people's voting experience.





Vehicle dynamics modelling



This diagram shows different aspects of IISRI's research on vehicle dynamics.

Dr Navid Mohajer
Research Fellow

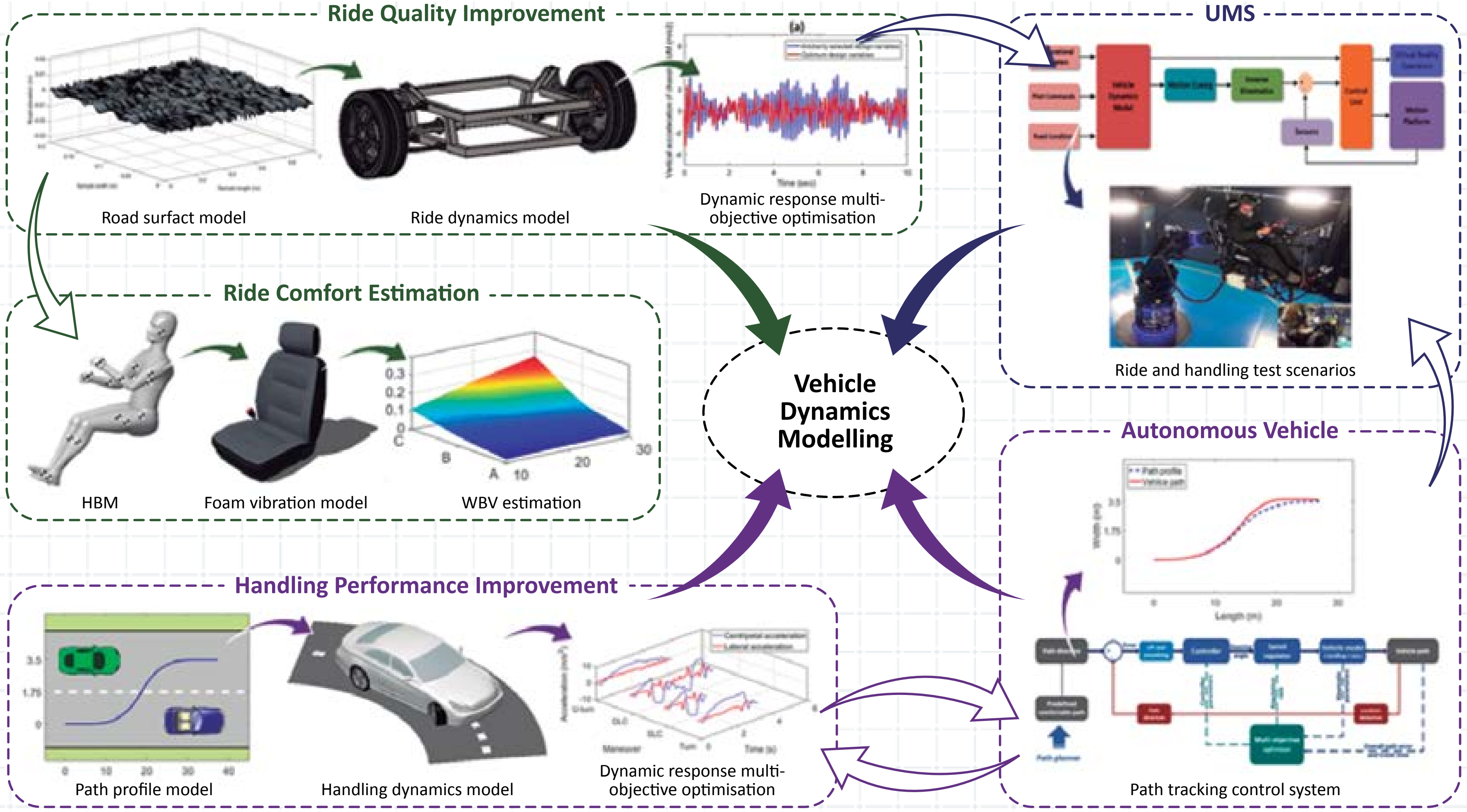
In the current automotive market, customers expect a sense of pleasure and comfort from their ride experience. This sensation is critical for users who routinely spend long hours in their cars.

The lack of this positive experience not only affects the ride experience, but may also cause adverse health impacts on the occupants. In technical terms, riders' sensation is directly related to the kinematic and dynamic responses of a vehicle – vehicle dynamics.

Indeed, vehicle dynamics is of increasing interest to the automotive development industry and vehicle research community. In the context of vehicle dynamics, simulation-based methods benefit from a minimum hardware requirement, hence they are cost and time effective.

In this regard, a vehicle dynamics model is the key for simulation-based analysis, evaluation and improvement.

Below: The overall structure of IISRI's research on vehicle dynamics modelling and simulation.



IISRI research has focused on the main modules of ride quality and performance handling in vehicle dynamics. For these behaviours, comprehensive vehicle dynamics models have been developed to address simulation, evaluation and improvement of vehicle responses. The models are developed using the computational multi-body system methodology. The simulation results are used to analyse the effects of noise-vibration and harshness, path tracking of autonomous vehicles, and whole-body vibration on a seated human subject.

For these effects, a human biomechanical model integrated into a seat foam model has contributed to the evaluation of ride quality and performance handling. For the purpose of simulation-based improvement of vehicle dynamics, multi-objective optimisation is used to enhance these behaviours with respect to different road surfaces or path profiles.

The research uses IISRI's unique Universal Motion Simulator (UMS) to evaluate vehicle dynamics. The main subsystems of the UMS are analysed in detail and the technical characteristics of each subsystem are scrutinised.

We have also investigated to determine the degree, and under what conditions the UMS could be used to evaluate ride quality and performance handling of traditional vehicles, as well as autonomous vehicles. The existing vehicle dynamics test scenarios related to these behaviours are simulated. Three main outcomes are: (1) the UMS can improve the current practice of on-road tests, i.e. save time, reduce cost and ensure safety; (2) an accurate and reliable vehicle dynamics model, which involves ride and handling dynamics is to be adopted in the UMS; (3) the performance handling aspect of road vehicles has the lowest practical limitations to be evaluated using the UMS.

Opposite (top) and below: IISRI develops advanced vehicle dynamic models for evaluating ride quality and handling performance of military vehicles.

Vision and learning techniques driving UAV intelligence and autonomy

Unmanned aerial vehicles (UAVs), commonly known as drones, are not limited to the military world for reconnaissance, monitoring, tracking, search or rescue purposes.

They also serve a large part of the economy with advanced mechanisms and impressive capabilities for civilian and commercial industries. With their continuous technical advances, the market for UAVs is expected to grow rapidly in transportation, agriculture, mining, energy, and construction fields. In these areas, the major tasks involve inspection, monitoring, surveillance, shipping and delivery, where the most important advances required are UAV intelligence and autonomy.

IISRI has conducted in-depth research into UAVs and relevant technologies. The developed image processing, computer vision, and deep learning techniques dramatically improve the sensing, detection, and perception capabilities of UAVs; potentially driving their intelligence and autonomy to the next level.

We have developed a novel vehicle detection method to automatically search cars in aerial images. Many challenging situations, such as variations in illumination, weather, image quality, occlusion and complicated background are successfully managed with over 92.9% accuracy.

Learning methods are used to train a strong classifier over thousands of UAV images so that the detection method can recognise cars with a large intra-class variation. The method is generic and can be extended to other targets, such as planes or ships. This technology will bring benefits, e.g. to military or transport authorities to efficiently and accurately gather vehicle statistics for better decision making.

Another success that IISRI has achieved is a novel road detection and tracking technique to automatically localise roads in aerial images and track them in an efficient and effective way.

A precision rate of 98.4% with a speed of 34 frames per second has been achieved over thousands of images and videos with the resolution of 1046 × 595. The method is not limited to road detection and tracking. It is also applicable to tracking along rivers, pipelines or coastlines.

Dr Hailing Zhou
Research Fellow

With this software on board, autonomous navigation of UAVs to follow a specified road, river, or pipeline is realisable in real environments.

Applications such as inspection, traffic monitoring, shipping and delivery, search and rescue will benefit from this technology, as it can quickly and accurately provide the regions of interest to a flying UAV.

Left: Detecting vehicles in arbitrary orientation in aerial images.

Dr Shady Mohamed
Senior Research Fellow

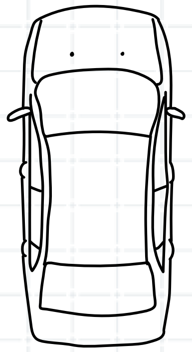
Robust target tracking

In real-time object tracking, occlusions are the most challenging problems that significantly undermine the accuracy of tracking algorithms.

Occlusions happen due to geometric objects such as tunnels or bridges, or due to poor visibility as a result of environmental and/or weather conditions. The traditional object tracking techniques, such as point tracking, kernel tracking, and silhouette tracking are sensitive to occlusions, since they depend mainly on visible features of the object of interest.

In this research, we develop a novel technique for object tracking, which is based on the estimation of the object state (such as speed, acceleration, and maneuverability) regardless of its visibility. The algorithm represents the tracking system as a state-space model where the object visibility is treated as measurement of uncertainties.

The tracking algorithm can overcome the challenges of poor visibility, weather conditions, faulty cameras, as well as complete occlusion. The algorithm also estimates different path likelihoods for objects under occlusion. This in turn helps the algorithm to adapt to the object's motion behaviours, therefore improving the tracking precision over time.



IISRI's new tracking algorithm can overcome the challenges of poor visibility, weather conditions, faulty cameras, as well as complete occlusion.

Below: The tracking algorithms can operate in very poor visibility conditions.

Producing realistic vehicle motions with computational intelligence-based motion cueing algorithms

Dr Houshyar Asadi
Research Fellow

Driving simulators are increasingly used for research and development as well as commercial and industrial applications. They are generally safe and cost-effective tools to evaluate new vehicle designs and increase road safety in a virtual environment.

The Universal Motion Simulator (UMS) at IISRI is a new generation of motion simulator with a larger translational and rotational motion range and higher dexterity and accelerations compared with other simulators.

The motion cueing algorithm (MCA) is the main technique used to transform acceleration and angular velocity of a simulated vehicle into the movements in a driving simulator such that high fidelity motions can be generated for the simulator user.

Simulator sickness is a common problem experienced by users, which occurs because of a mismatch between visual inputs and motion cues (perceived by the user's vestibular system).

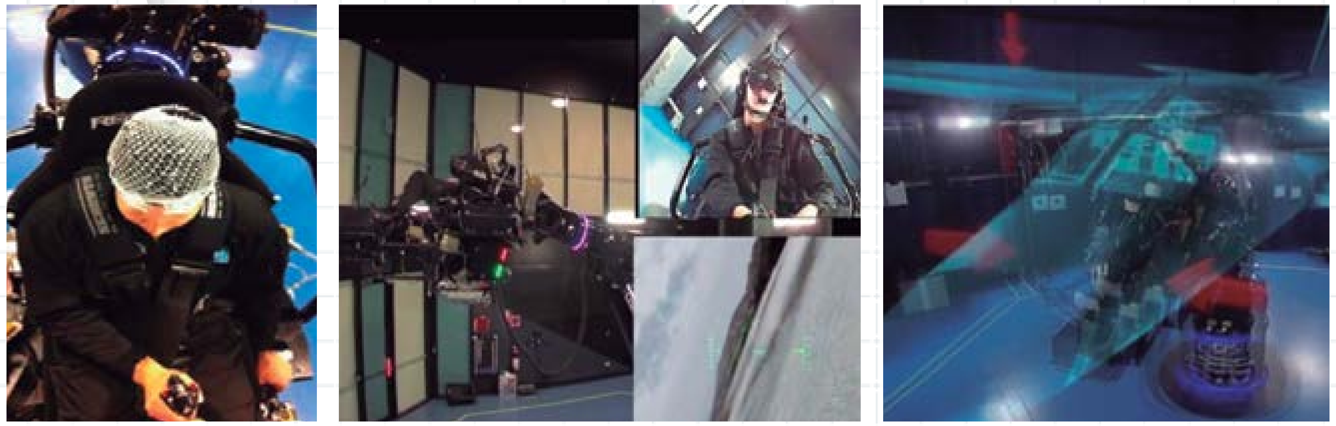
Despite using existing MCAs, the performance of a motion simulator is still majorly constrained by its limited physical movement envelope and generation of inaccurate motion cues. Accordingly, advanced MCAs are required to design and build the next generation of realistic motion simulators without causing any simulator sickness.

IISRI researchers have designed and developed a number of advanced MCAs using computational intelligence (CI) techniques and optimal control theory to enhance the motion fidelity of the UMS and eliminate simulator sickness.

These address the critical drawbacks of the existing motion-based driving simulators, which include inflexibility, sub-optimal tuning, inefficient use of platform workspace, lack of consideration for human sensation-related factors, real vehicle driver sensation shape tracking, unrealistic motions and simulator sickness.

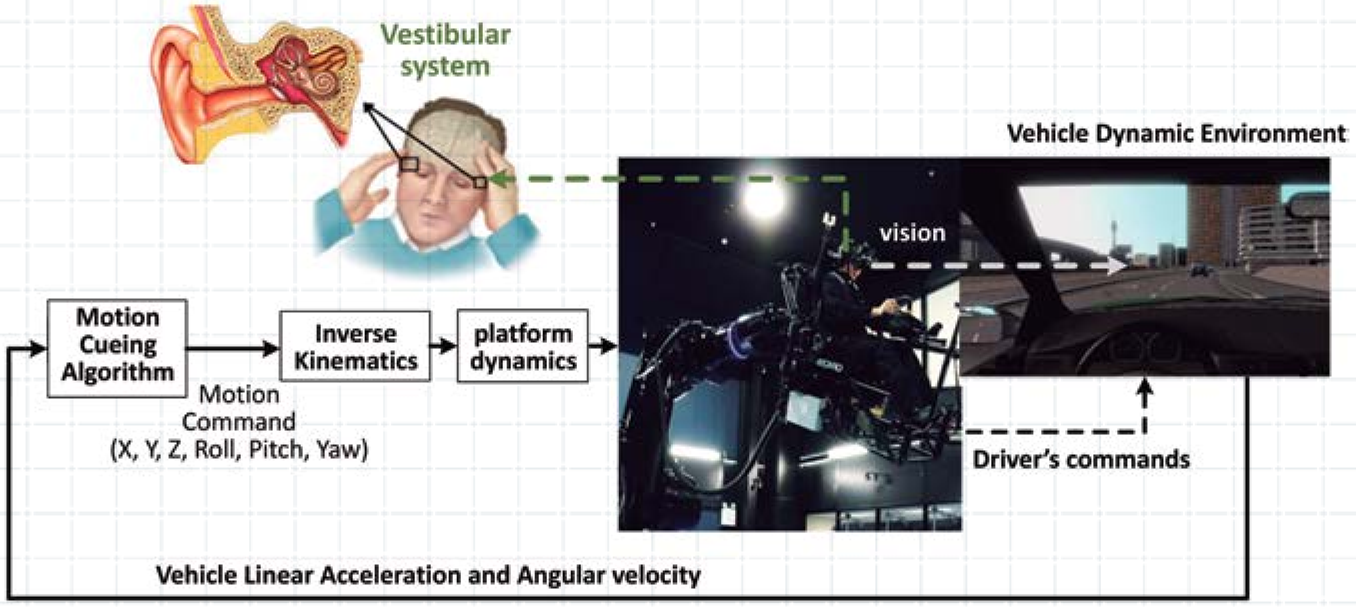
With these new MCAs, the UMS is able to realistically emulate a range of land, air and sea vehicles without eliciting simulator sickness in a virtual environment. This is achieved by taking a series of factors into account in developing the MCAs, including the vestibular motion sensation error between the real and simulator driver, the simulator's dynamic limitations, the human motion threshold limit, the real vehicle driver sensation shape-following factor and the human sensation error fluctuation.

The novel MCAs developed by IISRI prove to be effective for producing realistic vehicle motions and reducing simulator sickness for different applications such as driver training, user behaviour analysis, as well as for virtual prototyping and testing of new vehicle models.



Above: Analysing the user's behaviour, performance, perception and motion sickness using physiological signals.

Below: The design and structure of IISRI's motion cueing algorithms.



Fall detection using computational intelligence

Dr Mo Hossny
Senior Research Fellow

The use of technological advances to enhance medical services is a rapidly emerging field. A fall detection sensor is an essential component towards achieving smart healthcare solutions.

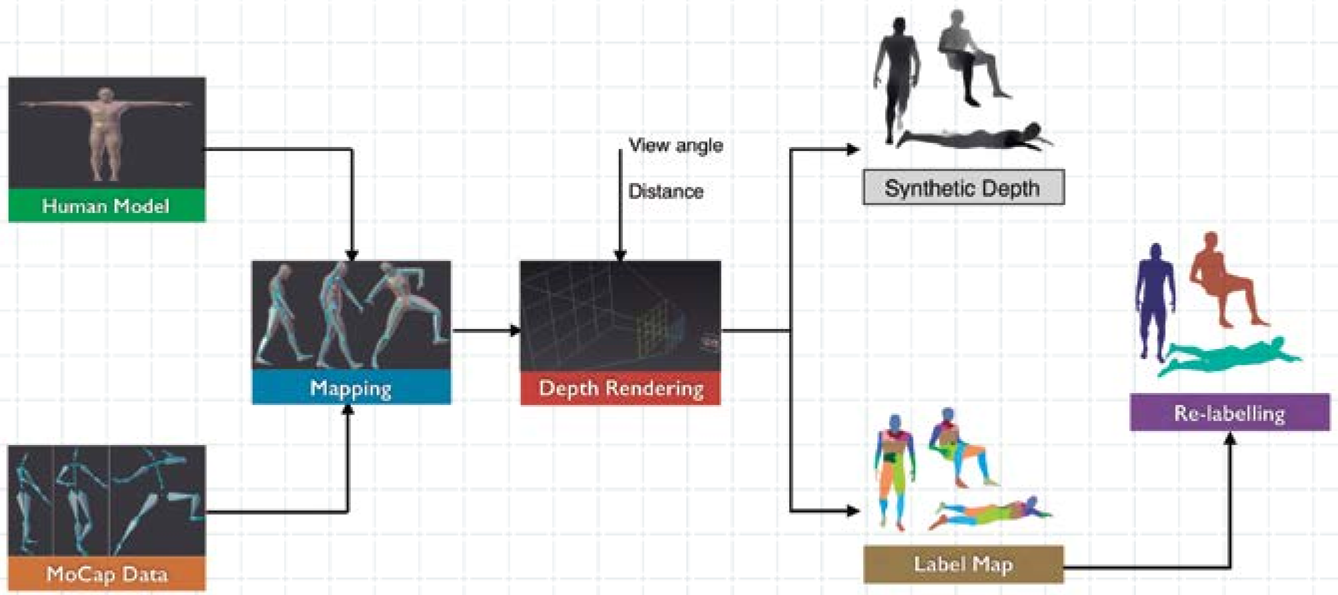
Traditional vision-based methods rely on tracking a skeleton and estimating the change in height of key body parts such as head, hips and shoulders. These methods are often challenged by occluded body parts and abrupt posture changes.

IISRI has developed a fall detection system consisting of a novel skeleton-free posture recognition method and an activity recognition stage. The posture recognition method analyses local variations in depth pixels to identify the adopted posture.

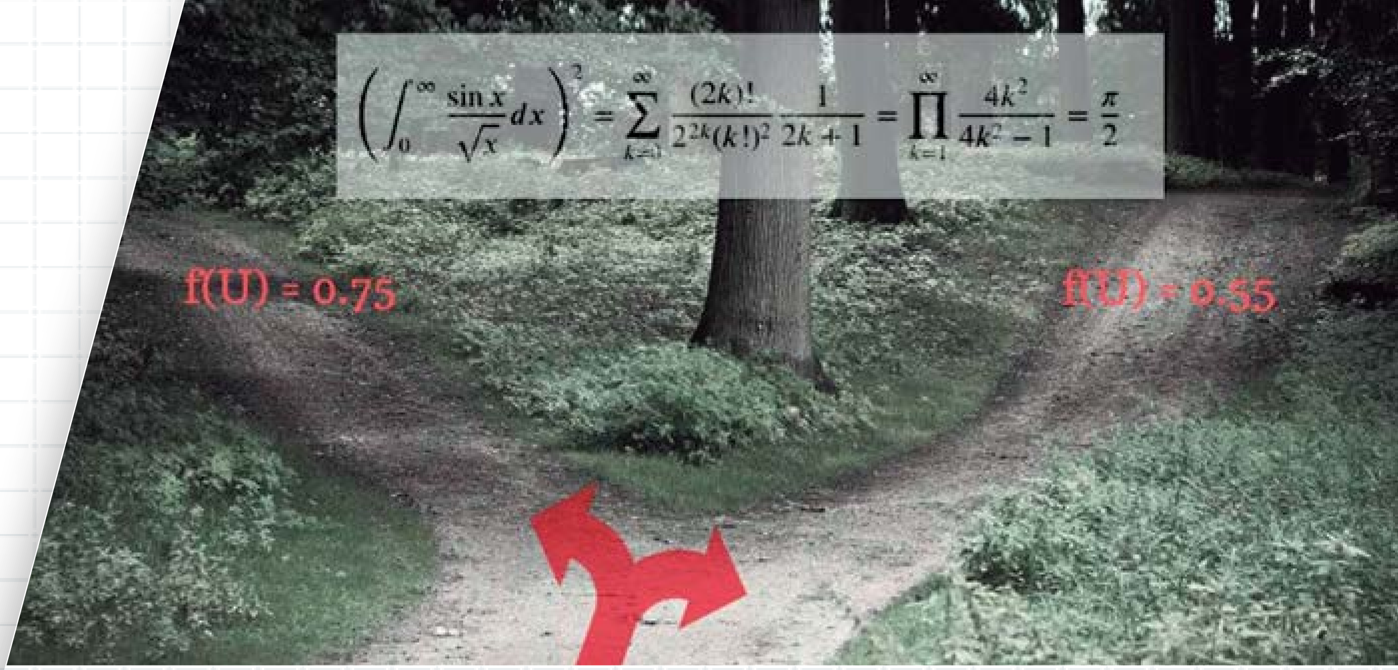
An input depth frame acquired using a Kinect-like sensor is densely represented using a depth comparison feature, and fed to a random decision forest model to discriminate between standing, sitting, and fallen postures.

The innovative method simplifies the posture recognition problem into a simple pixel labelling task, after-which determining the posture is as simple as counting votes from all labelled pixels. The falling event is recognised using a support vector machine.

The method achieves a sensitivity rate of 99% on synthetic and live data sets as well as a specificity rate of 99% on synthetic datasets and 96% on popular live data sets without invasive accelerometer support.



Above: Customised data generation pipeline for holistic posture recognition.



Dr Syed Salaken
Research Fellow

Defining uncertainty of the output for decision making tools

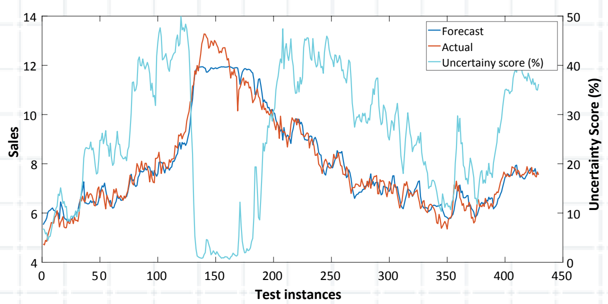
Many decision making tools are available to help executives in making critical decisions. However, almost none of these existing tools provide an estimate of the uncertainty in the output, apart from a mere confidence interval.

This confidence interval, coupled with a confidence level, only offers an estimate of the true value pertaining to the decision from randomised samples. It does not offer any information about the uncertainty associated with the produced output in a given scenario.

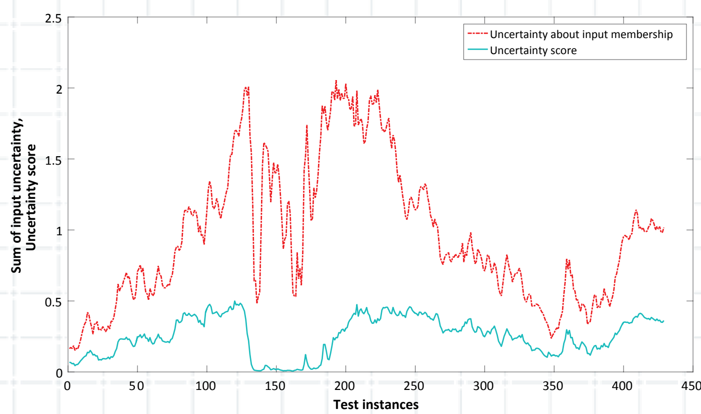
In this research, we develop a score for uncertainty associated with the output of a fuzzy decision support tool. This output uncertainty score is expressed in percentage for easy understanding, which preserves the flow of uncertainty throughout the system and does not depend on the prediction error.

Uncertainties associated with the inputs flow through the decision-making process, and are processed on the output side to provide a final uncertainty score. The user is able to understand how the uncertainty in the inputs affects the decision-making process by using the tool. It exploits the capabilities built into interval type-2 fuzzy systems and extends them to produce a more informative decision.

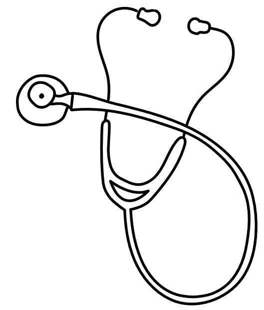
Uncertainty on a sales forecasting sample:



Relationship between output and input uncertainty:



Above and right: Analysing and quantifying uncertainty for a fuzzy decision support tool.



IISRI researchers have developed automated evaluation techniques to support trainers and instructors with AAR in simulation-based medical training.

Dr Samer Hanoun
Senior Research Fellow

After action review for simulation-based medical training

In simulation-based medical training, traditional methods used to evaluate trainee performance are based on subjective assessment, either through observing the training exercise or by reviewing it later on a videotape.

These methods are primarily manual, time-consuming, dependent on the assessment of expert trainers and overall cognitively demanding. Additionally, post-training After Action Review (AAR) may or may not be offered, which influences the trainee self-reflection, aiming to enhance their acquired skills and learning goals.

IISRI researchers have developed automated and rigorous evaluation techniques to support expert trainers and instructors with AAR in simulation-based medical training. Clinical training scenarios and domain knowledge are modelled via parametrised rules associated with logical and temporal constraints. This gives the trainers the ability to create different scenarios and tailor them to the trainees' learning levels.

The framework employs temporal pattern matching of trainees' actions against encoded domain knowledge in a rules engine to report on satisfied, violated and missed actions. These are used to identify strengths and limitations in the trainees' applied technical skills.

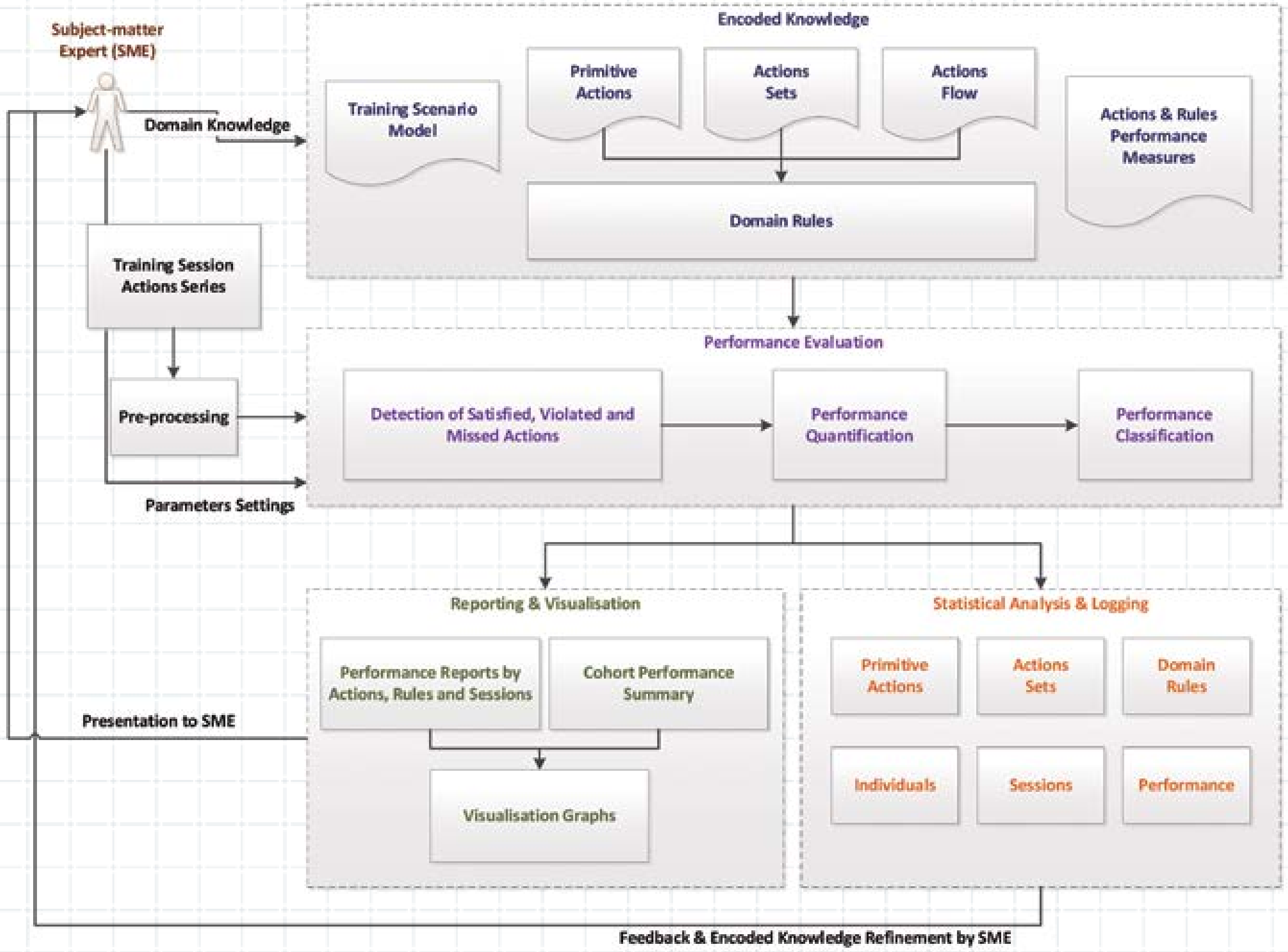
Dynamic Time Warping (DTW) is extended with optimal distance metrics to compare performance of different trainees, based on a complex combination of factors such as time, action and importance. Comparison results are clustered using Support Vector Machine (SVM) into cohorts' performance groups, which provides the ability to track the evolution in a trainee's performance from session to session, and from one level to the next.

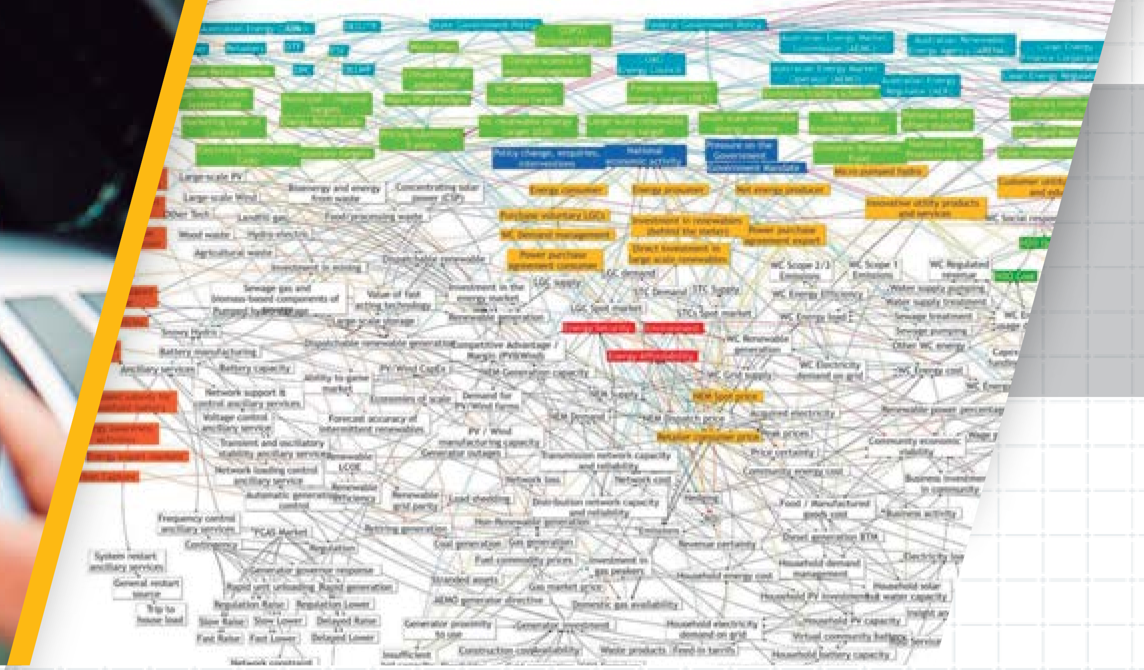
The developed research provides many benefits to trainers and trainees. Firstly, automated assessment of performance supports providing the trainee with immediate feedback after the training session. Secondly, the cognitive load on the trainer is reduced, allowing them to focus on observing non-technical skills such as communication, decision making and situational awareness of trainees. Thirdly, it is possible to compare trainees' current performances with previous performances to indicate changes in skills acquired from one year to another, or from one level to the next.

The developed framework is generic, and so it could be applied to different training levels, based on the ability to adapt the modelled scenarios to required complexities and learning objectives.

Right: Comparison of cohorts performance.

Below: The after action review (AAR) framework designed and developed by IISRI.





Dr Abbas Khosravi
Senior Research Fellow

Safer roads through advanced driver awareness monitoring systems

The use of social media and driver assistance systems have led to a significant increase in low awareness related motor vehicle accidents in recent years.

Advanced monitoring systems are required to monitor driver behaviour and generate warning alarms if lack of awareness is detected.

Research at IISRI evaluates data gathered from vehicles and drivers to determine the onset of distraction. Physiological signals, such as perinasal electrodermal activity, heart rate, breathing rate and palm electrodermal activity are measured during simulated driving sessions.

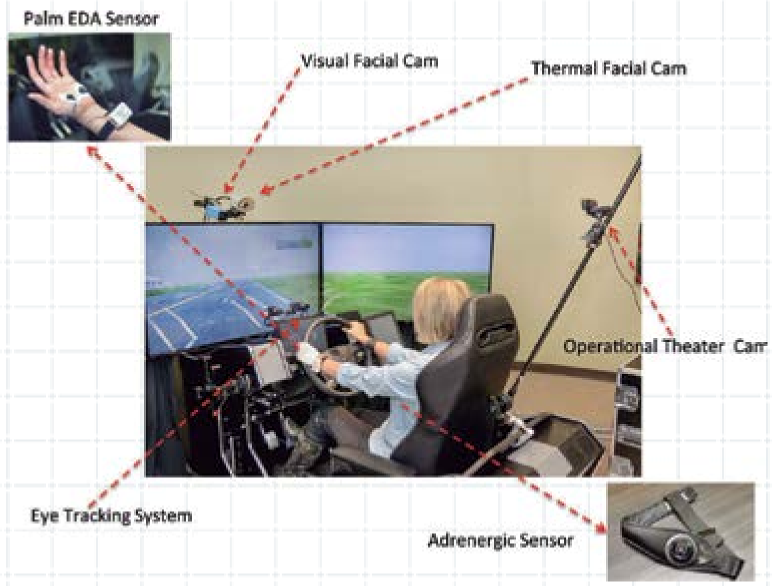
Lane deviation of the vehicle during simulation is treated as the response variable (awareness). Measured physiological signals are pre-processed to extract informative features for awareness evaluation. These features are then passed to multiple traditional and advanced machine learning models for the purpose of binary classification and detection of the onset of distraction.

The prediction results obtained indicate that machine learning algorithms are able to quickly and precisely determine whether the driver is distracted.

The area under the curve for the best performing model is 0.92, which is a sign of its excellent predictive capability. Furthermore, the research showed that physiological signals, such as palm and perinasal electrodermal activity, are the most important/informative signals for awareness evaluation.

This key finding sets the minimum hardware requirements for the design of future drivers' awareness monitoring systems which are accurate, cost effective, and computationally less demanding.

Below: Monitoring and evaluating drivers' awareness to detect the onset of distraction.



Professor Doug Creighton
Deputy Director, IISRI

Intended and unintended consequences

Professor Doug Creighton presented the culmination of the research outcomes from IISRI's collaboration with Vic Water at the 2017 Future State of Electricity Conference.

The research focused on understanding the roles that Victorian Water Corporations could take in Australia's changing energy market. A key outcome from the project were factors regional water authorities needed to consider in determining their strategy and business models during Australia's energy transition.

System mapping, modelling and visualisation methods allowed the audience to appreciate the broader impact of energy decision making to their business and the communities they serve, with particular focus on the intended and unintended consequences arising from actions taken within the system.

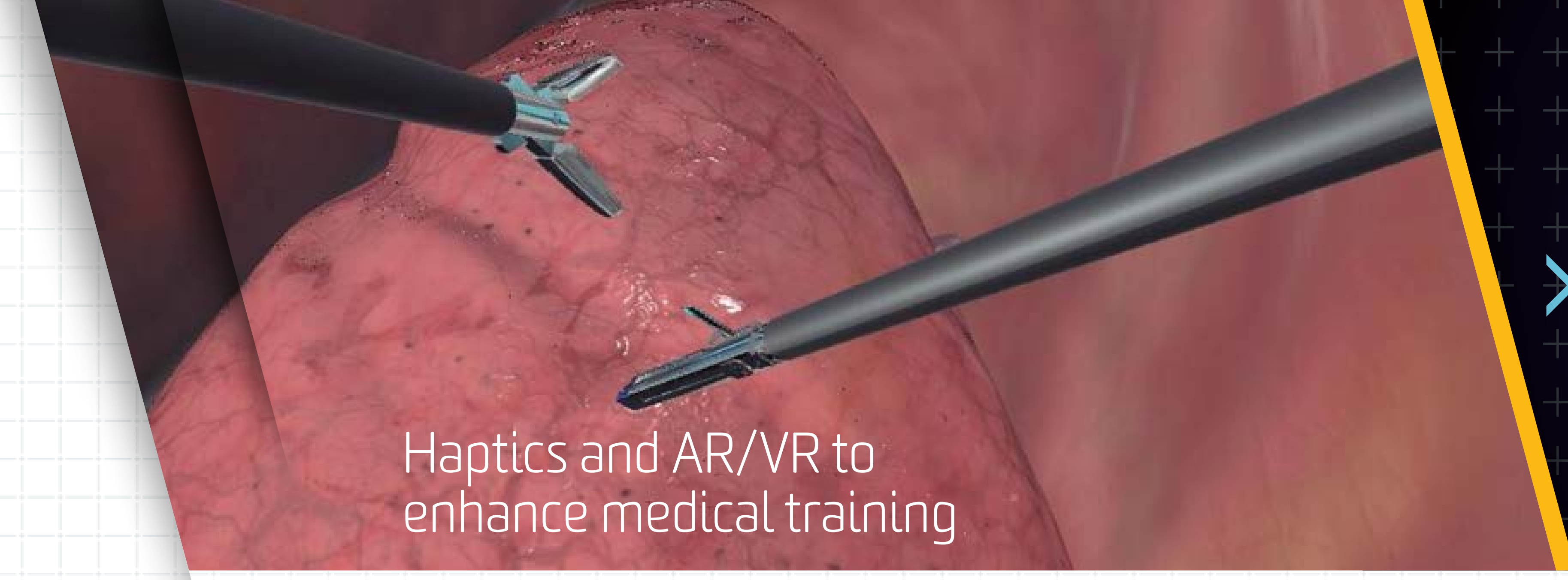
The research built on the Systems Thinking platform StickE, jointly created by Deakin researchers in IISRI and The World Health Organization Collaborating Centre for Obesity Prevention (Faculty of Health), and seeded further opportunities to apply Systems Thinking methodologies in sectors beyond water.

Addressing complex real world challenges requires an understanding of the behaviours, interconnections and interrelationships between systems. Understanding the connections not only within an organisation's own operating systems and assets, but also the integration and impact of community, government, economic, environmental and broader industry factors is complex.

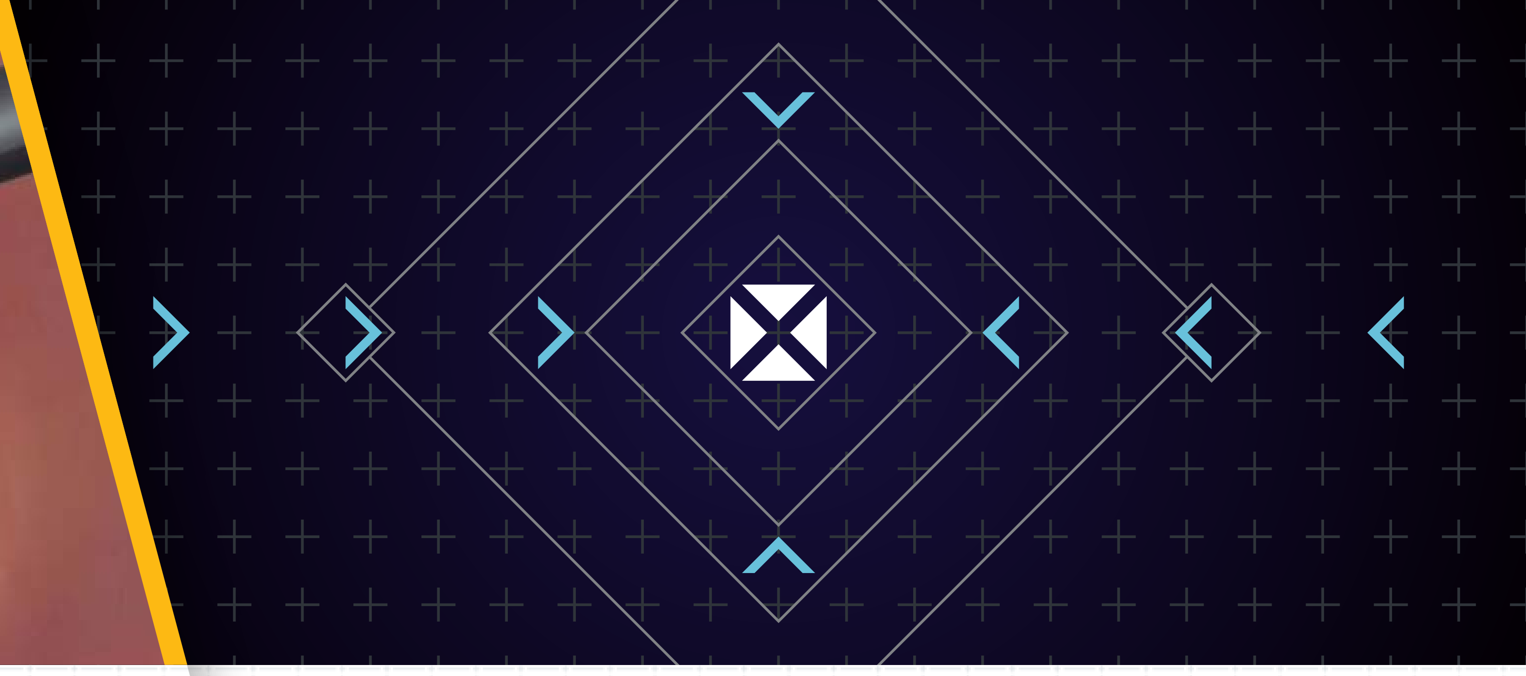
The time and effort spent coming to grips with a complex system and 'wicked' problems, identifying what needs to be done, and being able to track impact of decisions, policy changes and program initiatives is extensive.

Professor Creighton shared with the conference how applying system modelling, analysis and simulation techniques to today's systems and operations can provide a basis for insight into the impact of future policy, strategy, and operational decisions.

Top: Systems mapping, modelling, and visualisation with IISRI's Systems Thinking platform StickE.



Haptics and AR/VR to enhance medical training



Dr Lei Wei
Senior Research Fellow

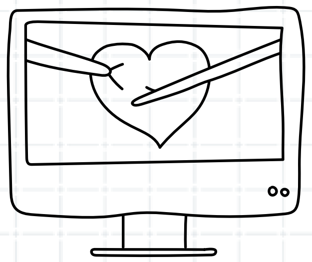
IISRI has designed and developed comprehensive and realistic systems for medical training, which include Video-Assisted Thoracoscopic Surgery (VATS) and Percutaneous Nephrolithotomy (PCNL).

Using haptics, AR/VR, and enhanced visual rendering technologies, these systems improve the immersion, effectiveness, and efficiency of medical training.

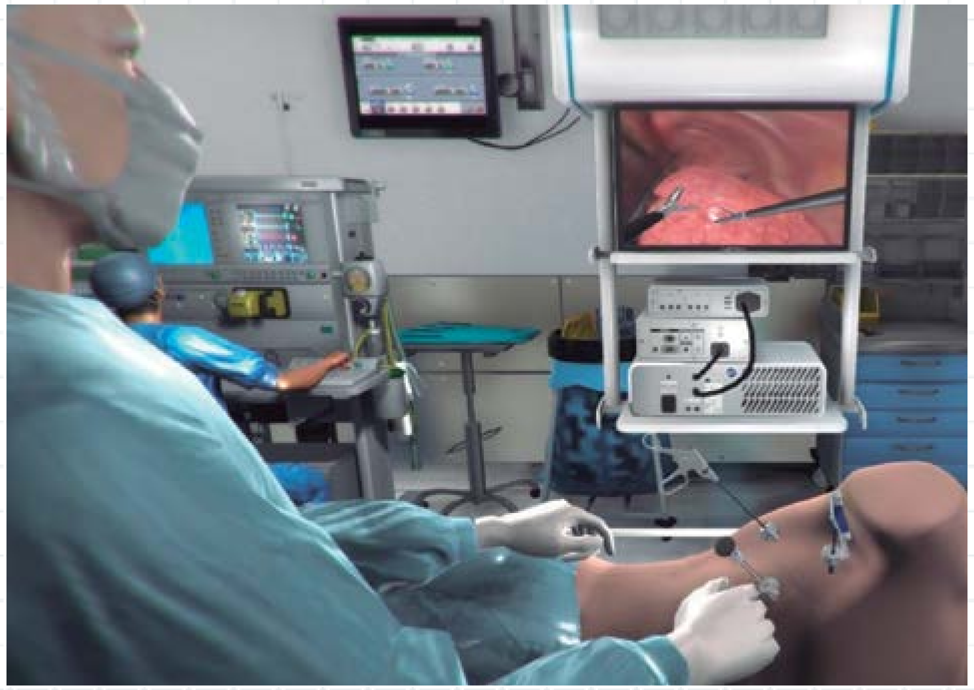
Haptic devices provide both accurate tracking and realistic force feedback to medical trainees, allowing them to feel exactly how various human tissues and organs deform and tear during surgical procedures. However, due to their extremely high computational cost, traditional haptically-enabled training simulators make significant compromises on visual quality.

IISRI researchers have developed a system based on a hybrid representation of bounding volume and space partitioning to solve the fundamental haptic collision detection problems in real-life application scenarios. It generates tighter, mutually exclusive bounding volumes at the pre-processing stage. It quickly culls irrelevant nearby objects at the broad phase to ensure that the developed haptic collision detection methods will not be overloaded with unnecessary narrow phase collision detection. An increment of up to 91% additional polygon counts in a complex scene have been observed. This provides greater potential to enhance visual immersion for medical training purposes.

The research findings have been published in IEEE Transaction on Haptics.



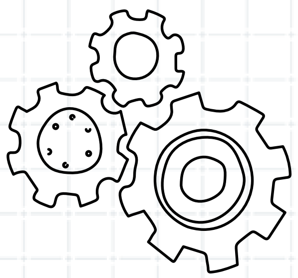
IISRI has developed improved systems for medical training using haptics, AR/VR, and enhanced visual rendering technologies.



Top and above: Haptics and AR/VR technologies developed at IISRI for medical training.

IEEE SMC Seminar Series

Date	Title	Presenters
2 Feb 17	Trusted Autonomy: Challenges and Opportunities for Computational Intelligence	Prof. Hussein Abbass, University of New South Wales
9 Feb 17	On the simulation of a complex power system	Prof. Tyrone Fernando, School of Electrical, Electronic & Computer Engineering, University of Western Australia
3 Apr 17	Triality: God Image for Multi-Scale Complex Systems and Unified Theory for Identifying Chaos and NP-Hardness	David Yang Gao, Alex Rubinov Professor of Mathematics, Federation University Australia
19 Jun 17	Unlocking the art of technical writing: From journal papers to competitive grants	Dr. Khashayar Khoshmanesh, School of Engineering, RMIT University, Melbourne, Australia
31 July 17	Aircraft Mishap Modelling as a Tool to Develop Material Solutions that Prevent Spatial Disorientation Accidents	Dr. Angus H. Rupert, M.D., Ph.D., Research Scientist, Flight Surgeon, Head, Warfighter Health and Performance Division, U.S. Army Aeromedical Research Laboratory
14 Aug 17	State-of-the-Art Neurodynamic Optimization: Past, Present, and Prospects	IEEE Distinguished Lecturer: Prof. Jun Wang, Department of Computer Science, City University of Hong Kong, Hong Kong
15 Aug 17	Symposium on Intelligent Technologies for Advancing and Safeguarding Australia	Prof. Wang Jun (Keynote); Prof. Jason Scholz; Prof. Abdollah Ebbie Homaifar; Prof. David Gao; Prof. Peng Shi; Prof. Adrian Pearce; Prof. John Grundy; Andrew Luca; Patrick Howlett; Prof. Mark Wallace
4 Sep 17	New Stability Tools for Stability Analysis of Switched Systems	Prof. Ti-Chung Lee, Minghsin University of Science and Technology, Taiwan
4 Dec 17	Autonomous Operations as Optimization - A Field Sensor Network Approach	Prof. Xiang Chen, University of Windsor, Windsor, Ontario, Canada
12 Dec 17	Cyber-Medical Systems: the digitalized healthcare approach and its trends	Prof. habil. Levente Kovacs, Physiological Controls Research Center, University Research and Innovation Center, Óbuda University, Hungary
18 Dec 17	Intelligent Facial and Bodily Expression Recognition for a Humanoid Robot	A/Prof. Li Zhang, Northumbria University at Newcastle, UK



The IEEE SMC seminars are a major source of information, inspiration and collaboration.

Financial Summary

FINANCIAL SUMMARY - For Period Ended 31 December 2017	2017 Actual $
INCOME	
Research Income	3,706,791
Other Income	25,145
Research Allocation/ University Contribution	3,317,629
Total Income	**7,049,565**
EMPLOYMENT COSTS	
Academic Salaries	4,071,685
General Salaries	448,282
Other Employment Costs	34,684
Total Employment costs	**4,554,651**
NON SALARY EXPENSES	
Buildings and Grounds Infrastructure Costs	10,414
Communication / Advertising, Marketing and Promotions	29,146
Consumables	307,304
Depreciation and Amortisation	1,029,780
Equipment- Repairs, Maintenance and Other Costs	529,095
Other Costs	117,874
Professional, Legal and Consultants	18
Staff Recruiting, Training and Other / Library Information Resource Expenses	29,600
Student Expenses	308,011
Travel, Catering and Entertainment	133,672
Total Non Salary Expenses	**2,494,914**
Surplus / (Deficit)	**0**

Publications 2017

BOOK

1. Bhatti, K. H. Lee, H. Garmestani, and C. P. Lim, *Emerging Trends in Neuroengineering and Neural Computation*. Springer, 2017.

BOOK SECTIONS

2. T. Babaei, C. P. Lim, H. Abdi, and S. Nahavandi, “A Modified Functional Link Neural Network for Data Classification,” in *Emerging Trends in Neuro Engineering and Neural Computation*, 2017, pp. 229-244.
3. M. A. U. Bari, J. Gaburro, A. Michalczyk, M. L. Ackland, C. Williams, and A. Bhatti, “Mechanism of Docosahexaenoic Acid in the Enhancement of Neuronal Signalling,” in *Emerging Trends in Neuroengineering and Neural Computation*, 2017, pp. 99-117.
4. J. Gaburro, S. Nahavandi, and A. Bhatti, “Insects Neural Model: Potential Alternate to Mammals for Electrophysiological Studies,” in *Emerging Trends in Neuro Engineering and Neural Computation:* Springer, 2017, pp. 119-130.
5. I. T. Hettiarachchi, L. Shanmugam, A. Bhatti, and S. Nahavandi, “Synchronization Criteria for Delay Coupled Izhikevich Neurons,” in *Emerging Trends in Neuro Engineering and Neural Computation:* Springer, 2017, pp. 131-144.
6. D. Khudhair, S. Nahavandi, H. Garmestani, and A. Bhatti, “Microelectrode arrays: architecture, challenges and engineering solutions,” in *Emerging Trends in Neuro Engineering and Neural Computation*, 2017, pp. 41-59.

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8. K. I. A.-l. Al-Abdullah, H. Abdi, C. P. Lim, and W. Yassin, “Force and temperature modelling of bone milling using artificial neural networks,” *Measurement*, vol. 116, pp. 25-37, 2017.
9. S. Al-Wais, S. Khoo, T. H. Lee, L. Shanmugam, and S. Nahavandi, “Robust H∞ cost guaranteed integral sliding mode control for the synchronization problem of nonlinear tele-operation system with variable time-delay,” *ISA Transactions*, vol. 72, pp. 25-36, 2017.
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11. H. Asadi, C. P. Lim, A. Mohammadi, S. Mohamed, and S. Nahavandi, “A Genetic Algorithm-based Nonlinear Scaling Method for Optimal Motion Cueing Algorithm in Driving Simulator,” *Journal of Systems and Control Engineering*, DOI: 10.1177/0959651818772940, 2017.
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15. M. Hossny, S. Nahavandi, D. Creighton, C. P. Lim, and A. Bhatti, “Enhanced decision fusion of semantically segmented images via local majority saliency map,” *Electronics Letters*, vol. 53, no. 15, pp. 1036-1038, 2017.
16. H. M. D. Kabir and S. M. Salahuddin, “A frequency multiplier using three ambipolar graphene transistors,” *Microelectronics Journal*, vol. 70, pp. 12-15, Dec 2017.
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21. F. Khozeimeh, R. Alizadehsani, M. Roshanzamir, A. Khosravi, P. Layegh, and S. Nahavandi, “An expert system for selecting wart treatment method,” *Computers in Biology and Medicine*, vol. 81, pp. 167-175, Feb 1 2017.
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47. W. Srisukkham, L. Zhang, S. C. Neoh, S. Todryk, and C. P. Lim, “Intelligent leukaemia diagnosis with bare-bones PSO based feature optimization,” *Applied Soft Computing*, vol. 56, pp. 405-419, Jul 2017.
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49. T. L. Tiang, D. Ishak, and C. P. Lim, “Fourier decomposition of segmented magnets with radial magnetization in surface-mounted PM machines,” *Journal of Electrical Engineering*, vol. 68, no. 6, pp. 470-475, 2017.
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53. H. Zhou, L. Wei, D. Creighton, and S. Nahavandi, “Orientation aware vehicle detection in aerial images,” *Electronics Letters*, vol. 53, no. 21, pp. 1406-1407, Oct 12 2017.

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54. A. Abobakr, D. Nahavandi, J. Iskander, M. Hossny, S. Nahavandi, and M. Smets, “RGB-D Human Posture Analysis for Ergonomic Studies using Deep Convolutional Neural Network,” presented at the IEEE International Conference on Systems, Man, and Cybernetics (SMC 2017), Banff, Canada, 2017.
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56. M. Attia, M. Hossny, S. Nahavandi, and A. Yazdabadi, “Skin melanoma segmentation using recurrent and convolutional neural networks,” presented at the International Symposium on Biomedical Imaging, 2017.
57. S. S. Choong, L.-P. Wong, and C. P. Lim, “An Artificial Bee Colony Algorithm with a Modified Choice Function for the Traveling Salesman Problem,” presented at the IEEE International Conference on Systems, Man, and Cybernetics (SMC 2017), Banff, Canada, 2017.

Publications 2017

58. N. de Boer, H. Abdi, M. Fielding, S. Nahavandi, and B. Laxmidhar, "Simulation of generic body weight support systems effects for assisted walking," presented at the The 4th Workshop on ICTs for improving Patients Rehabilitation Research Techniques, 2017.
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61. M. Hassan, M. Hossny, S. Nahavandi, and H. Asadi, "Surgical Tool Segmentation Using A Hybrid Deep CNN-RNN Auto Encoder-Decoder," presented at the IEEE International Conference on Systems, Man, and Cybernetics (SMC 2017), Banff, Canada, 2017.
62. S. Hassan, M. A. Khanesar, A. Hajizadeh, and A. Khosravi, "Hybrid Multi-objective Forecasting of Solar Photovoltaic Output Using Kalman Filter based Interval Type-2 Fuzzy Logic System," presented at the IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2017), Italy, 2017.
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64. I. Hossain, A. Khosravi, I. Hettiarachchi, and S. Nahavandi, "Informative instance transfer learning for motor imagery Brain Computer Interface," presented at the IEEE International Conference on Systems, Man, and Cybernetics (SMC 2017), Banff, Canada, 2017.
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77. D. Nahavandi and M. Hossny, "Skeleton-free task-specific rapid upper limb ergonomie assessment using depth imaging sensors," presented at the Proceedings of IEEE Sensors, 2017.
78. T. Nguyen, I. Hettiarachchi, A. Khosravi, S. M. Salaken, A. Bhatti, and S. Nahavandi, "Multiclass EEG data classification using fuzzy systems," presented at the IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2017), Italy, 2017.
79. S. Pedrammehr, Z. Najdovski, H. Abdi, and S. Nahavandi, "Design methodology for a hexarot-based centrifugal high-G simulator," presented at the IEEE International Conference on Systems, Man, and Cybernetics (SMC 2017), Banff, Canada, 2017.
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83. S. M. Salaken, A. Khosravi, A. Khatami, S. Nahavandi, and M. A. Hosen, "Lung Cancer Classification Using Deep Learned Features on Low Population Dataset," presented at the IEEE 30th Canadian Conference on Electrical and Computer Engineering (CCECE), Canada, 2017.
84. K. Saleh, M. Hossny, A. Hossny, and S. Nahavandi, "Cyclist Detection in LIDAR Scans Using Faster R-CNN and Synthetic Depth Images," presented at the Intelligent Transportation Systems Conference, Yokohama, Japan, 2017.
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