

ECONNECT

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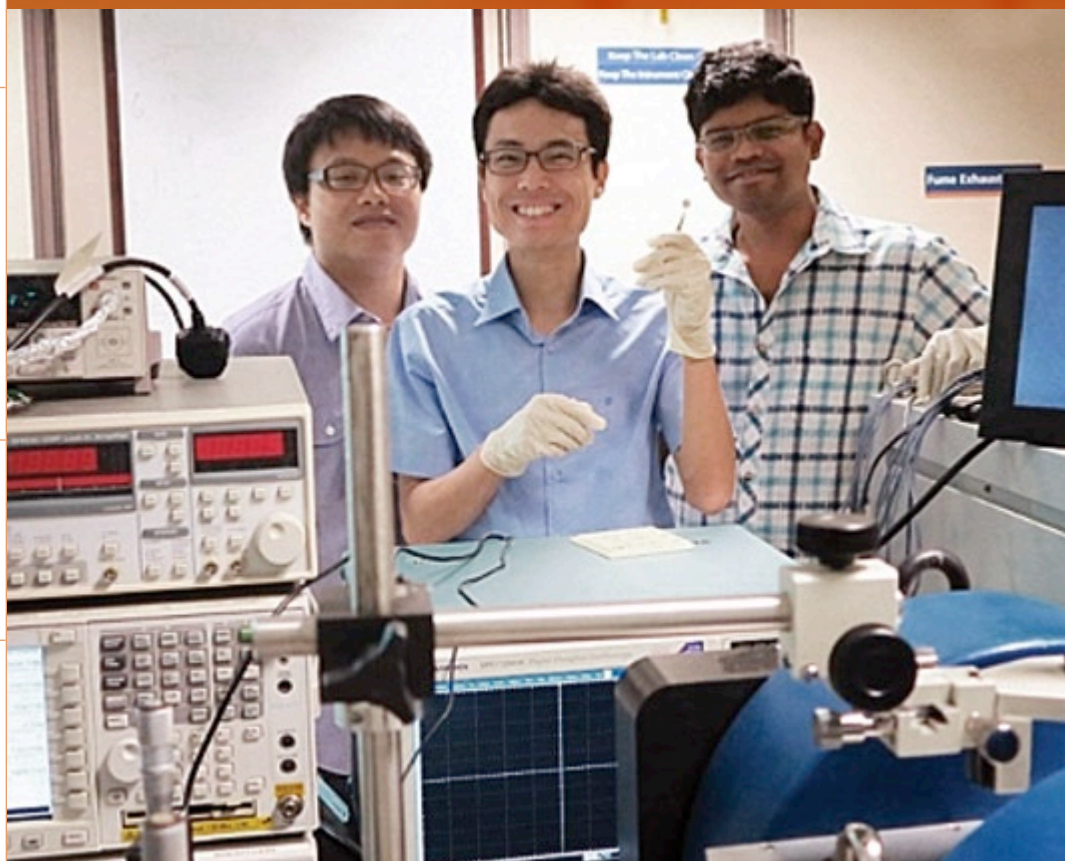
EXHIBITION **PAGE**
SHOWCASING NUS' **13**
CONTRIBUTION TO
NATION-BUILDING THROUGH
GROUND-BREAKING
RESEARCH LAUNCHED AT
THE UNIVERSITY CULTURAL
CENTRE ON 9 APRIL 2015.

**NUS ECE RANKED 6TH IN THE QS WORLD
UNIVERSITY RANKINGS BY SUBJECT 2015 FOR
ELECTRICAL & ELECTRONIC ENGINEERING**



**A NEW SPIN ON
MAGNETIC MULTILAYERS
FOR MRAM**

WE ARE PROUD TO **PAGE**
FEATURE ONE OF **15**
OUR DISTINGUISHED
ALUMNI, DR HU JUNHAO,
FOUNDER AND CEO OF DARMA.
LOCATED IN THE SILICON
VALLEY, DARMA DEVELOPED
THE WORLD'S FIRST SMART
CUSHION THAT MONITORS
SITTING HABITS.



WE SEE THIS OFTEN **PAGE**
ENOUGH ON TV AND **17**
THE MOVIES -- WHERE
WITNESSES HELP POLICE COME
UP WITH SKETCHES OR IMAGES
OF SUSPECTS.



PAGE
03 MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) IS
EMERGING AS THE NEXT BIG THING IN NON-VOLATILE DATA
STORAGE WITH ITS PROMISE OF HIGH-BIT DENSITY AND
LOW POWER CONSUMPTION.

CONTENTS

DEPARTMENT

- 01 IEEE Fellow: Professor Charanjit Bhatia Singh
New IEEE Vice President
Member & Geographic Activities:
Professor Lawrence Wong
New Appointments
- 02 NUS Woman Engineer Awarded National Fellowship
- 03 A New Spin On Magnetic Multilayers For MRAM
- 04 GlobalFoundries Professorship Engineering Educator Awards
- 05 Engineering Researcher Award 2014
- 06 ECE Hawaiian Gala Night 2015
- 08 Making A Difference Indeed

RESEARCH

- 09 Thinking Underwater Robots That Mimic Nature
- 10 Sensing with Noise
- 11 Singapore Spintronics Consortium
- 12 Research Update: Wearable Device
- 13 Building our Nation through Science and Technology

ALUMNI

- 15 Doing NUS Proud – Smart Cushion

STUDENT

- 16 MSRA Award for Mr Canyi Lu
- 17 Mobile App On Police “Wanted” List
- 18 NUS Teams Soar At The SAFMC 2015

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HoD SPEAKS...



Prof John **Thong**
Head, Department of Electrical & Computer Engineering, NUS

“...there is increasing recognition of the importance of research outcomes that ultimately make a positive impact on human life...”

I am pleased to report that ECE has maintained its global position at number 6 in the 2015 edition of the QS World University Ranking by Subject for Electrical & Electronic Engineering. While university rankings are subject to the choice and interpretation of metrics, this achievement nonetheless provides an indication of the high regard the international academic community and employers accord the Department and its research and education programs, and is a tribute to our community of staff, students and alumni.

While bibliometrics still feature significantly as an objective measure of research productivity, there is increasing recognition of the importance of research outcomes that ultimately make a positive impact on human life, as befits the engineering discipline. We congratulate A/Prof **Ho Ghim Wei**, on being conferred the L'Oreal Singapore For Women in Science National Fellowship for her achievements in education and research in nanostructured materials for applications in energy generation and pollutant degradation. A/Prof **Yang Hyunsoo**'s research has the potential to significantly improve the performance of non-volatile magnetoresistive random access memories, and he is engaging industry to translate his scientific discoveries into manufacturable technology. This issue also features articles on research led by faculty members on biomimetic robots to carry out underwater tasks that would otherwise be difficult or dangerous for humans, acoustic imaging in the oceans using ambient noise that can be applied to surveying coastal waters, and wearable devices for health monitoring. Our ECE alumnus, Dr **Hu Junhao**, shares with us his venture into starting up a company whose first product is a smart cushion that was inspired by his Ph.D. research on optical fiber sensors.

We are also delighted to share with you the honours and awards bestowed on ECE colleagues. Prof Charanjit Bhatia **Singh** was elevated to IEEE Fellow, while Prof Lawrence **Wong** was elected IEEE Vice President, Member and Geographic Activities. At the 2014 Engineering Awards, A/Prof Aaron **Danner** and A/Prof **Tan Kay Chen** won the Engineering Educator Award. Prof Adeyeye **Adekunle** was conferred the Engineering Researcher Award for his work on nanomagnetism.

In the past six months, a number of new colleagues joined ECE. Drs **Chen Silu** and **Teo Chek Sing**, both from SIMTech, joined as Adjunct Assistant Professors, having already played important roles in collaborative research and teaching with the Department. We also welcome Dr Abhra Roy **Chowdhury**, who joined as a Teaching Assistant, and Mr Muhammad Rufianul Hakim **Bin Razali** who is a Specialist Associate and Emergency Response Team member.

IEEE FELLOW: PROFESSOR CHARANJIT BHATIA SINGH



The IEEE (Institute of Electrical and Electronics Engineers, Inc.) is a global professional association with over 400,000 members.



Every year, following a rigorous evaluation procedure, the IEEE Fellow Committee recommends a selected group of recipients to be elevated to IEEE Fellows. To be part of this elite fellowship is an honour for any member of the IEEE community. The attainment of this milestone is in recognition of the outstanding and unusual professional achievement of the awardee.

The IEEE Board of Directors conferred this prestigious IEEE Fellow on Professor Charanjit Bhatia **Singh**, effective from 1 Jan 2015. Prof Singh is honoured in recognition of his contributions to the study of magnetic head-media interfaces and tribology. Congratulations to Prof Singh!

NEW IEEE VICE PRESIDENT



Prof Lawrence **Wong** has been elected IEEE Vice President, Member and Geographic Activities (VP-MGA).

Elected by the IEEE Assembly, Prof Wong will serve as the Chair of the MGA Board and also as a member of the IEEE Board of Directors. This position involves coordinating and providing advice and guidance to all MGA-related operations and activities.

Prof Wong is the first IEEE Vice President to come from outside of North America. Our best wishes to Prof Wong!

NEW APPOINTMENTS

FACULTY / ACADEMIC

- DR **CHEN** SILU joined ECE Department as Adjunct Assistant Professor on 2 February 2015. He is currently a Research Scientist with the Mechatronics Group at the Singapore Institute of Manufacturing Technology (SIMTech), A*STAR. Dr Chen obtained his Ph.D. degree in Electrical and Computer Engineering from NUS in 2010. His research interests are in the areas of precision motion control and vibration suppression of light-weight flexible systems.
- DR **TEO** CHEK SING joined ECE Department as Adjunct Assistant Professor on 9 March 2015. He is currently a Research Scientist at the Singapore Institute of Manufacturing Technology (SIMTech), A*STAR in which he is a Team Lead of the Precision Mechatronics Group. Dr Teo holds a Ph.D. degree (2008) from NUS and his research interests are in the application of advanced control techniques to precision mechatronic systems and instrumentations that result in enhanced performance of motion control and measurement.

TEACHING ASSISTANT

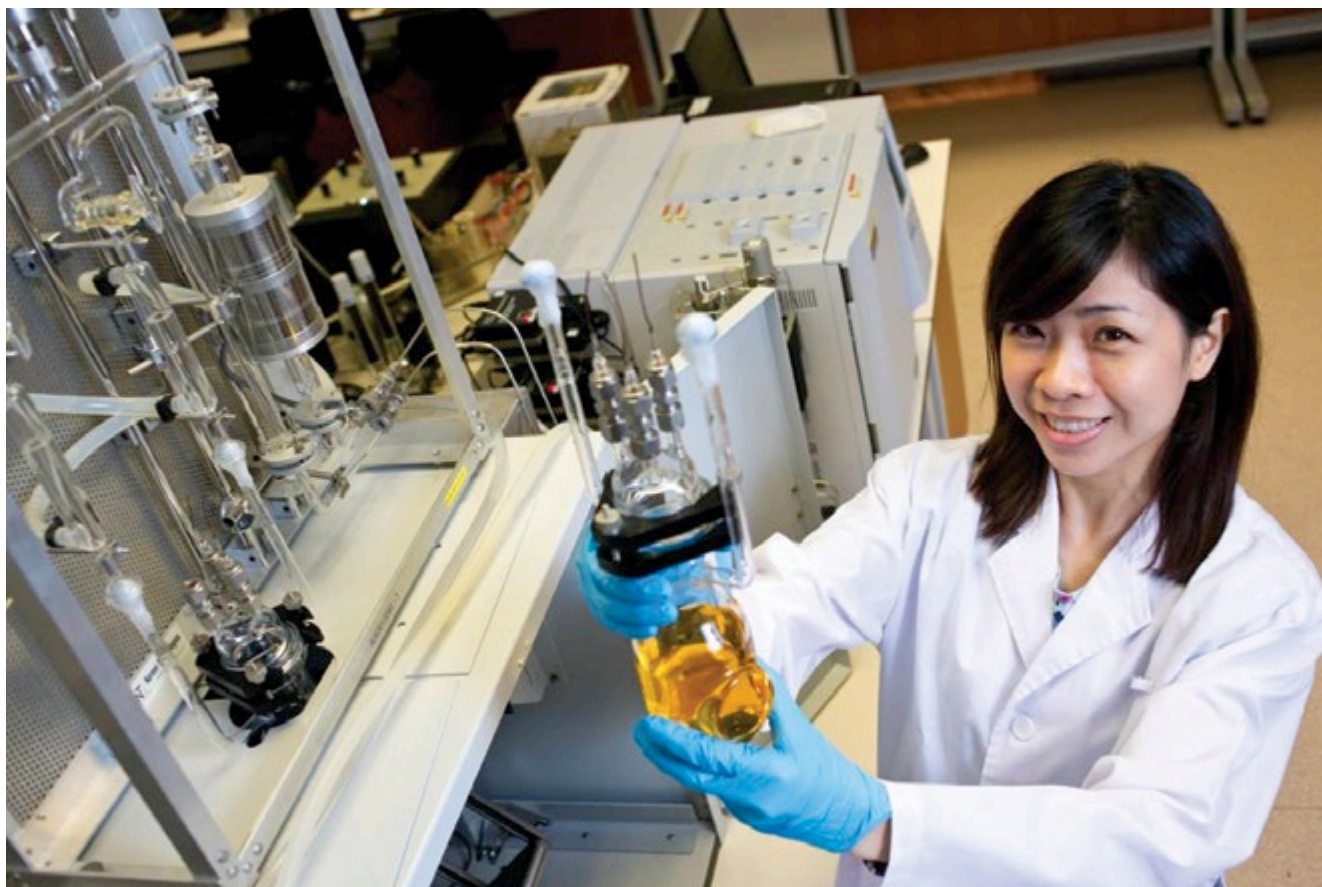
- DR ABHRA ROY **CHOWDHURY** joined ECE Department as Teaching Assistant on 6 March 2015.

EXECUTIVE AND NON-ACADEMIC

- MR MUHAMMAD RUFIANUL HAKIM **BIN RAZALI** joined ECE Department as Specialist Associate (Emergency Response Team) on 5 January 2015.

NUS WOMAN ENGINEER AWARDED NATIONAL FELLOWSHIP

Associate Professor **Ho** Ghim Wei, from the Electrical & Computer Engineering Department and Engineering Science Programme, was awarded a fellowship from L'Oréal Singapore in the Physical & Engineering Science field for her efforts in education and research in nanomaterial science and engineering.



Associate Professor **Ho** Ghim Wei's work in nanostructured materials for photocatalysis has won her recognition
Picture courtesy of L'Oréal Singapore

The L'Oréal-UNESCO For Women in Science Awards were established by the L'Oréal Foundation in 1998 as the first international awards dedicated to woman scientists around the world. A benchmark of international scientific excellence, the award programme has been an invaluable source of motivation, support, and inspiration for women in the scientific field. In Singapore, the award is supported by the Singapore National Commission for UNESCO and the Agency for Science, Technology and Research (A*STAR), and L'Oréal Singapore.

Assoc Prof Ho's research focuses on the development and design of nanostructured materials for advanced photocatalyst in the area of energy generation and pollutant degradation.

“ Through my innovation and impact in both education and research in nanomaterial science and engineering, I hope to contribute to advances in health and environmental benefits and bring about greater recognition of the under-represented women in this field. ”
said Assoc Prof Ho.

As part of the endowment, Assoc Prof Ho received a grant of \$30,000. In the past six years, 14 women have been awarded the fellowship. Her award was reported on 4 and 6 December 2014 in The Straits Times and Lianhe Zao Bao, respectively.

A NEW SPIN ON MAGNETIC MULTILAYERS FOR MRAM

Magnetoresistive random access memory (MRAM) is emerging as the next big thing in non-volatile data storage with its promise of high-bit density and low power consumption.

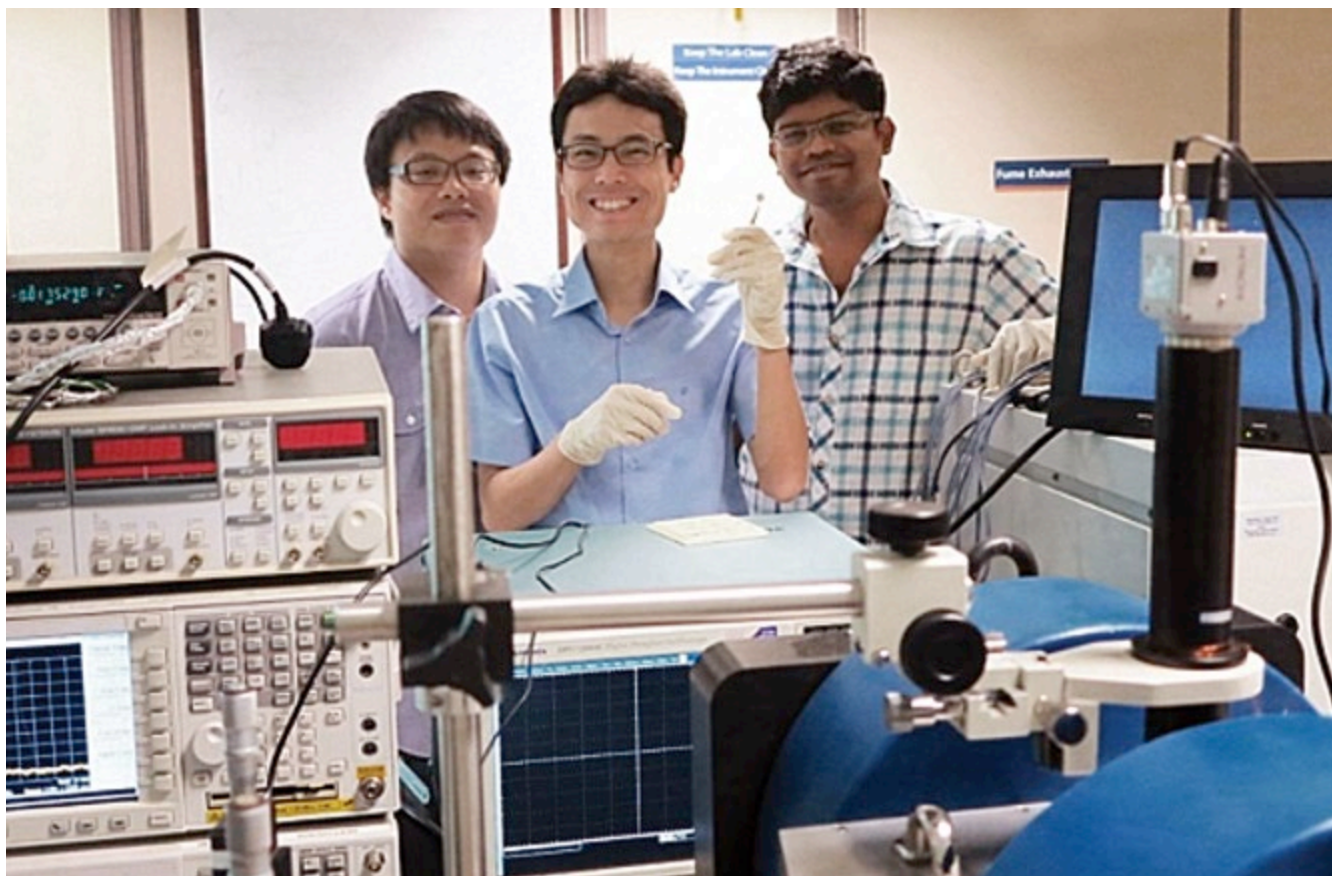
A hotly-pursued avenue in MRAM-related research is in-plane current-induced magnetisation switching combined with spin-orbit coupling which would provide a practical mechanism for writing data in future MRAM technology.

To date, studies of in-plane current-induced torques have focused on the spin-Hall effect. NUS researchers and their collaborators have reported that the oxidation of spin-orbit torque devices triggers a new mechanism of spin-orbit torque which is about two times stronger than that based on the spin-Hall effect.

ECE's research team has introduced a way to engineer spin-orbit torques via oxygen manipulation. With electrical gating of the oxygen level, our findings may

pave the way towards reconfigurable logic devices. These groundbreaking results were published by Nature Nanotechnology (2015 April) in a paper titled "Spin-orbit-torque engineering via oxygen manipulation".

Assoc Prof **Yang** Hyunsoo is the lead-PI of a recent National Research Foundation Competitive Research Programme (NRF CRP) project entitled "Next generation spin torque memories: From fundamental physics to applications". The objective of this project is to investigate scientific issues by employing new physical phenomena, materials and device structures. The team is confident that its integration of new materials and device structures into a next-generation-spin transfer/orbit torque MRAM will produce even more exciting results.



Assoc Prof **Yang** Hyunsoo (centre) holding the spin orbit torque chip. With him are Research Fellows, Dr **Qiu** Xuepeng (left) and Dr Kulothungasagaran **Narayanapillai**

GLOBALFOUNDRIES PROFESSORSHIP



**Associate Professor
Yang Hyunsoo**

Associate Professor **Yang** Hyunsoo has been appointed to a GlobalFoundries Singapore (GFS) Pte Ltd Associate Professorship in Engineering with effect from 1 April 2015.

Assoc Prof Yang obtained his Ph.D. from Stanford University in 2006. He joined ECE Department in 2007 from the IBM Almaden Research Center, USA. Assoc Prof Yang is a leader in the area of spintronic research, which is the study and manipulation of the spin property of electrons.

Spintronics is different from the present conventional electronics which involves the manipulation and control of electron charge rather than electron spin. The area of spintronics has great potential and application, and is already attracting significant interest from the industry. Notably GFS Pte Ltd, a major semiconductor industry player, has embarked on R&D in embedded Magnetoresistive Random-Access Memory (MRAM).

Assoc Prof Yang's appointment as GFS Pte Ltd Associate Professor will help to build a closer and more collaborative relationship between the National University of Singapore (NUS) and GFS. The appointment is also in line with his interest in developing novel devices, building circuits and systems based on emerging (spintronics) technologies, and synthesising new materials for such devices.

ENGINEERING EDUCATOR AWARDS



**Associate Professor
Tan Kay Chen**

“Each moment with my students is an opportunity to share our knowledge and make that shared experience part of our lives forever.”

Associate Professor **Tan** Kay Chen effectively uses real-life examples to stimulate students' learning interest and motivates them to apply knowledge creatively. He often makes learning a positive and enjoyable experience by delivering lectures in a student-oriented and interactive manner. He also stays abreast of current research and developments to ensure relevance of knowledge imparted. Assoc Prof Tan was on the Honour Roll for his sustained high performance in teaching after receiving the University Annual Teaching Excellence Award five times and the Engineering Educator Award four times. He was also a recipient of the Outstanding Educator Award in 2004 for his outstanding efforts in teaching.



**Associate Professor
Aaron Danner**

“ I feel that the classroom is a place where education can best be achieved as a collaborative effort, and where students greatly value on-the-spot performance feedback, especially critical feedback from a professional educator, which they use to immediately learn and improve. ”

Associate Professor Aaron **Danner** really likes to use live demonstrations in his electrical engineering classes to impart knowledge. Creative demonstrations in the classroom can capture the attention of students – in one of his demonstrations, for example, he announces that he will build a radio transmitter using only a large battery and a length of wire. By piquing their curiosity, students begin to wonder “how is he going to do that?” and they pay close attention as he describes various physical concepts necessary to understand his demonstrations. Prof Danner can also be a strict lecturer, because he believes that when working with electricity, mistakes should not be tolerated. Society has high professional expectations of engineers, and he tries to impart professionalism and pride in being an engineer to his undergraduate students. He strongly believes that the best way for a student to learn is to both be interested in a subject, and to pay attention in class. Prof Danner tries to help students out on both fronts during his classes.

ENGINEERING RESEARCHER AWARD 2014



**Professor Adeyeye
Olusola Adekunle**

Professor Adeyeye Olusola **Adekunle's** research focuses on the fundamental understanding and exploration of magnetic nanostructures in applications such as ultra-high density storage, magnetoresistive random access memory and magnetoresistive logic devices. He performed some of the pioneering research work in magnonics; designing and implementing the first magnetic logic device based on a reconfigurable magnonic crystal. He was named one of the top 100 young innovators in the world by MIT's Technology Review in 2002. He was a winner of the 2004 NUS Young Researcher Award and the 2012 Singapore Millennium Foundation Research Horizons Awards Phase II worth \$1 million. In addition to being a 2013 IEEE Magnetics Society Distinguished Lecturer, Prof Adekunle is a Fellow of the Institute of Physics and a Fellow of the Institute of Nanotechnology.



ECE HAWAIIAN GALA NIGHT 2015

Management joining in the performance

On 6 March 2015, ECE held its annual social event, the “Hawaiian Gala Night”, for all ECE staff members and their families.

The evening saw several staff members dressed for the occasion as they turned up in Hawaiian-style attire with colorful and floral prints. Colourful leis were given out to every staff to go with their attire.

Pre-event activities started at 6:30 pm with the opening of a 2-hour unlimited photo-taking service at a professional photo booth that provided the perfect takeaway for staff. Hawaiian props adding an element of fun to every shot proved immensely popular!

Of course, no Hawaiian night could be complete without a Tiki Bar with professional bartenders serving all-time favourites, cocktails such as Mai Tai, Mojito, Sex on the Beach, etc.. To get the adrenaline flowing were “a-minute-to-win” games to challenge ECE staff to demonstrate their wit and ingenuity. Contestants had one minute to perform feats such as stacking of cups on top



Beautiful ladies with leis



“Blessed dressed” nominees



Creative hawaiian attire



Lucky draw tickets

of one another or skewering of tiny cotton balls, etc. in a bid to win extra lucky draw tickets.



Game booth

While the scrumptious buffet spread of halau and international food was well patronised, Assoc Prof Marc Andre **Armand's** electric guitar solo performance, Aloha games, Hawaiian songs accompanied by authentic hula dancing girls drew an appreciative audience. We even had a professional hula dance trainer to conduct a crash course on hula moves for sporting ECE staff, including ECE HOD, Prof John **Thong!**

The evening ended at 9:30 pm with the crowning of the best dressed participants with the best photos. Five lucky draw winners went home happily with their prizes of mini iPads. An evening to be remembered for sure!



Mocktail bar



Performance by sporting staff



Limbo rock



Scrumptious food



Staff enjoying the night

MAKING A DIFFERENCE INDEED



Team M.A.D. receiving the LIQC 2014 “GOLD” award from Professor Barry **Halliwell** during NUS Excellence Day 2015



Team M.A.D. at University Town



Team M.A.D. presenting inside LT50

ECE’s Team “Make-A-Difference” (M.A.D.) was privileged to be selected to participate in the “2014 Learning Institutions Quality Conference” (LIQC) held on 18 November 2014 at the Stephen Riady Centre.

LIQC, run by the Organisational Excellence Office of NUS, aims to provide an enduring platform for the sharing of administrative best practices between organisations and to build collaborative networks of change and innovation across institutions.

For the conference, M.A.D. had to prepare a 20-page report, in addition to a 20-minute presentation to a panel of judges trained and appointed by the Singapore Productivity Association. The project presented by M.A.D. was “RoPLive – Request for Purchase Online”.

“ROPLive” was developed to reduce the time taken to obtain approval for purchase requests, with the aim of achieving service excellence and professionalism in the purchasing process. The project not only allows purchase requests to be created online and approved electronically, but it also facilitates the updating of financial information into the system for tracking purposes.

At the end of the conference, Team M.A.D. had won not only “**GOLD**” for the national “Team Excellence Award”, but also the “**Best Impact on Innovation**” ancillary award! Through its participation at LIQC 2014, the team had showcased and shared their experiences, as well as learnt from fellow participants’ working solutions to various operational problems.

THINKING UNDERWATER ROBOTS THAT MIMIC NATURE

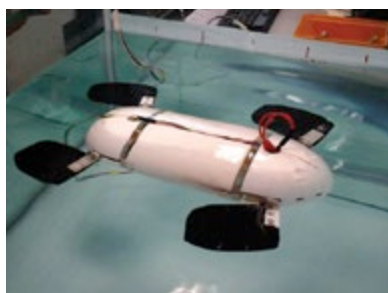
NUS engineering researchers are closer to producing underwater robotic creatures that mimic nature but are, at the same time, equipped with a brain of their own. In the near future, it would not be too tall an order for the team to produce a swarm of autonomous tiny robotic sea creatures capable of hazardous missions such as detecting nuclear wastes underwater or performing other tasks too dangerous for humans.

Assoc Prof Sanjib Kumar **Panda** who leads the team at the Electrical & Computer Engineering Department said that they are currently researching and developing **biomimetic solutions** with robots mimicking natural systems to overcome technical challenges. One example is a robotic sea turtle which can move about underwater, including diving to deeper depths vertically, like a real turtle, by just using front and hind limb gait movements.

Explained Assoc Prof Panda: "Our robotic sea turtle does not use a ballast system which is commonly found in underwater robots designed with diving or sinking functions. Without this ballast system, the robotic turtle is much smaller and lighter. Hence, it can carry bigger payloads so that it can perform more complicated tasks such as surveillance and monitoring, or energy harvesting. Being able to do a dynamic dive or sink vertically means that it can also enter vertical tunnels or pipes in the seabed with very small diameters."



The team with their prototype underwater robots. From left: Bhuneshwar **Prasad**; Assoc Prof S K **Panda** and Abhra Roy **Chowdhury**



The robotic turtle which is scalable and equipped with intelligence. Among underwater robots, turtles are the most manoeuvrable

Being smaller and lighter would also enhance the turtle's energy efficiency. It is also able to self-charge, further reducing its needs to return to its base station for recharging. The turtle is agile and able to turn sharp corners using a small radius without losing speed.

"We can have a swarm of tiny turtles which communicate with each other and act collaboratively to perform their duties. With improved manoeuvrability, they can go into tiny and narrow places like crevices where bigger vessels are unable to do so," added Prof Panda.

Lifelike underwater robots

Abhra Roy **Chowdhury**, who has been working towards lifelike underwater robots for the last three years for his Ph.D., said they have designed and developed five underwater prototypes so far. They are scalable, modular and possess stealth (the ability to avoid detection) features.

His first lifelike fish robot was developed about three years ago after studying energy-efficient movements of real fishes. "Many fishes using body-caudal fin (BCF) locomotion bend their bodies into a backward-moving propulsive wave that extends to the caudal fin while fishes using median-paired fin (MPF) locomotion use their other fins like their dorsal and anal fins to propel themselves," Abhra explained.

He studied the yellow-fin tuna and the freshwater largemouth bass specifically as they have the most common fish body types as well as swimming patterns. Both are found to be efficient swimmers in a sea environment. He also further developed a novel bio-inspired dynamics and behavior-based control architecture for these biomimetic platforms.

Another member of the team, research engineer Bhuneshwar **Prasad**, developed a spherical robot (rather like a puffer fish), with movements modelled after the jellyfish. This robot can be used for a range of functions such as oceanic surveys, pipe and cable inspections, and inspections of a ship hull or a propeller's shaft. "The spherical underwater robot, using a self-ballast system, is able to dock on soft ground to harvest energy from underwater currents. Once on the seabed, the robot can be placed in sleep mode with only monitoring sensors awake. In this way, the robot can harvest power from the underwater current through its dynamo-based rotor blades," said Bhuneshwar.

SENSING WITH NOISE

Mandar **Chitre** & **Ong Lee Lin**

Far from being quiet, the ocean is filled with a cacophony of sounds that often pose a nuisance to sonars and underwater acoustic communication systems.

However, in recent decades, researchers have come to recognise that the noise can be harnessed to provide information about the surroundings.

There are many similarities between photography and sonar. First, flash photography is akin to active sonar. The pulse of light or sound sent reflects off an object and allows the camera or the imaging sonar to form images of the object. Astrophotography, on the other hand, resembles passive sonar. With astrophotography, we capture light from a luminous celestial object or sound from a noisy object.

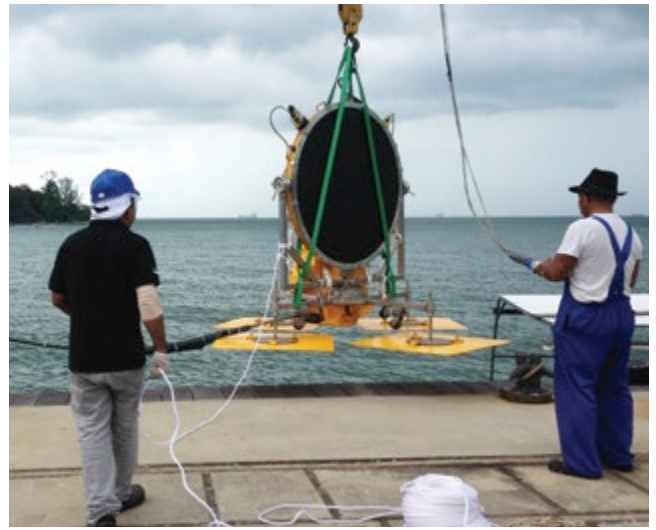
There is a third scenario of visual imaging that is neither active nor passive. In photography, when the camera flash is disabled and the object by itself non-luminous, natural ambient light in the daytime reflecting off an object is used to make an image. We can make use of ambient noise in the same way. In the ocean, ambient noise reflecting off objects forms images of the submerged object. Initially dubbed “acoustic daylight”, this idea was later generalised into ambient noise imaging (ANI).

The first acoustic daylight camera, ADONIS, was built in 1994 at the Scripps Institute of Oceanography in San Diego. While it was an invaluable tool to demonstrate the idea of ANI, its analog design severely limited signal processing.

ADONIS then steered the way for ROMANIS, a second-generation underwater acoustic ambient noise imaging camera developed at the National University of Singapore. ROMANIS employs digital beamforming with a sparse phased-array of 508 directional hydrophones. It is a circular disc 1.3 m in diameter, less than half the size of ADONIS. ROMANIS operates over a broad frequency band from 20 to 80 kHz, to match the predominant frequency range of ambient noise produced by snapping shrimp, a dominant source of high frequency noise in warm coastal waters.

During a 2010 experiment, ROMANIS produced consistent ambient noise images of an L-shaped target made from 1 m x 1 m Neoprene panels at ranges of 65-70 m. This was about twice the range at which ADONIS was able to produce images.

Recently, in August 2014, ROMANIS was used to survey the reefs off the Southern Islands. This task complements the existing marine conservation efforts where scuba divers and snorkelers swim around the reefs to inspect and identify the animal and plant species. A healthy reef is like a city bustling with noise. According to a British study, healthy reefs are three times louder than degraded ones. The data collected by ROMANIS is still being studied. If



A 300kg underwater acoustic camera being deployed near St John's island last year

the experiment proves successful, information provided by ROMANIS can contribute towards Singapore's efforts to save the coral reefs.

Recent advances in signal processing have added new capabilities to ROMANIS. By localising loud “snaps” in space and time, and then utilising the knowledge of the source to deterministically process the echoes, ROMANIS can now perform multi-static imaging using snapping shrimp as sources. This idea is attractive and offers the possibility of passive ranging and 3-dimensional imaging.

While many exciting advances are being made, many more questions surface. Can ANI be applied at longer ranges for larger targets using other noise sources? What temporal and spatial distribution of impulsive noise sources allow reliable 3-dimensional imaging? Do marine animals such as whales and dolphins use ANI techniques to sense their environment, and, if so, can we learn from them?

These, and other challenging questions will continue to pique the interest and curiosity of ANI researchers. We look forward to finding the answers in the coming decades.

SINGAPORE SPINTRONICS CONSORTIUM

Founded by NUS, NTU, Applied Materials Inc, Delta Electronics and GlobalFoundries, the Singapore Spintronics Consortium (SG-SPIN) was established to explore electron spin-based technologies for sensor, memory and logic applications. To facilitate collaborative partnerships between the industry and institutes of higher learning, a Memorandum of Understanding was signed on 5 December 2014 to cement the research collaboration between the five organisations.

Spintronics is widely perceived as one of the most promising pathways for overcoming many of the constraints faced by Si CMOS technology, ranging from architecture to performance and power dissipation. In addition to well-established applications in hard disk drives, spintronics can potentially lead to other such applications as more energy-efficient non-volatile memory, non-conventional logic, microwave nano-oscillator, biomedical sensor, energy harvester and magnetocaloric devices.

The main research thrusts of the consortium range from spin transfer torque magnetoresistive random access memory, domain wall memory and logic. Other research thrusts include electric field-controlled spintronics, spin-wave and pure spin-current devices.

Singapore has been ramping up its spintronics capabilities since the late 1990s. Existing strengths in data storage

and the concentration of companies in the electronics sector have helped to create an ideal environment for spintronics research.

SG-SPIN was spearheaded by the NUS Industry Liaison Office under the auspices of NUS Enterprise. Led by ECE's Professor **Wu** Yihong, SG-SPIN is supported by the National Research Foundation (NRF) Singapore and NTU's NTUitive. The NRF has supported five Competitive Research Programmes in this area with an investment of approximately \$39 million. Four of the five programmes are sited in NUS.

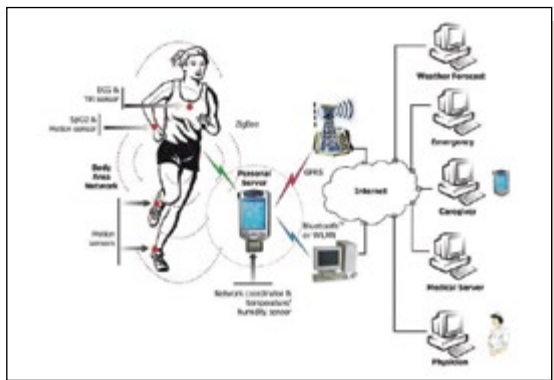
As a leading department in spintronics research, ECE hosts the largest number of faculty members working actively in the area of spintronics. The SG-SPIN members from ECE include Professor Adeyeye Olusola **Adekunle**, Albert **Liang** Gengchiao, Mansoor Bin Abdul **Jalil**, Massimo **Alioto**, Vivian **Ng**, **Teo** Kie Leong, **Wu** Yihong, **Yang** Hyunsoo and **Zhu** Chun Xiang.



Front row from left: Mr Russell **Tham** (President, Applied Materials South East Asia), Mr Rajesh **Nair** (Vice President, GlobalFoundries Singapore), Prof Barry **Halliwell** [Deputy President (Research & Technology), NUS], Dr **Lim** Jui (CEO NTUitive), Mr Patrick **Chang** [Director, Delta Electronics International (Singapore)]

Back row from left: Prof **Ding** Jun (NUS), Prof **Teo** Kie Leong (NUS), Prof Adekunle Olusola **Adeyeye** (NUS), Mr George **Loh** (Director, Physical Sciences and Engineering, NRF), Prof **Low** Teck Seng (CEO, NRF), Prof **Wu** Yihong (NUS), Ms Irene **Cheong** (Director, ILO, NUS), Mr David **Toh** (CTO, Nanyang Innovative & Enterprise Office), Dr **Lew** Wen Siang (NTU)

RESEARCH UPDATE: WEARABLE DEVICE

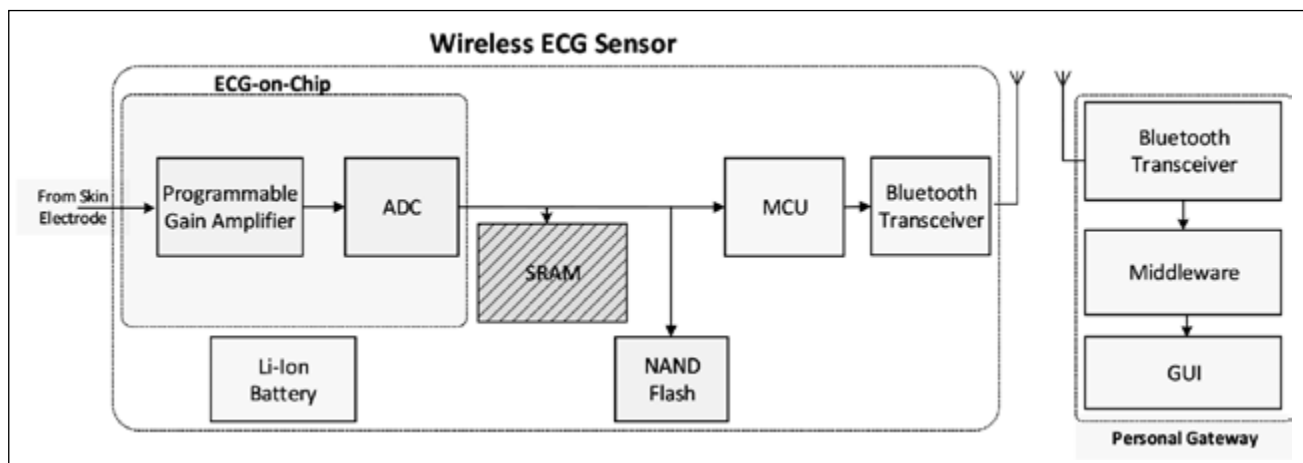


Overview of Telehealth System

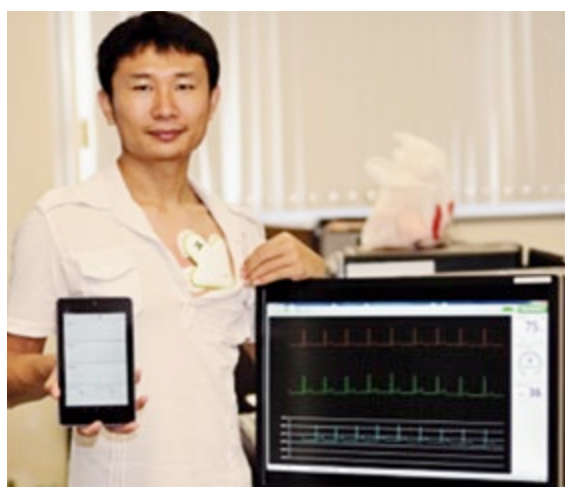
As the saying goes, “Prevention is better than cure.”

With the ageing population in Singapore and worldwide, global demand for healthcare is ever increasing. A healthcare model which focuses on prevention and early detection of diseases, provides 24/7 health monitoring, remote diagnosis and data analysis, with minimal human intervention would be a welcome option indeed.

Telehealth systems together with wearable devices can provide fast solutions to the challenges of health monitoring. However, wearable devices can be inconvenient if they are bulky and dependent on battery power. With the advent of low power



Wearable ECG Monitoring System Architecture



Wearable sensor prototype and personal gateway running in PC or mobile application

biomedical integrated circuit (IC) sensors, wearable sensors can be designed with intelligent embedded software that can dramatically extend battery life while being less bulky.

The ECE wearable device consists of a low power ECG (electrocardiogram) acquisition chip for ECG signal acquisition, a wireless transceiver for wireless transmission, programmable micro-controller for overall control, flash memory and a battery for internal storage and powering up the device. The wearable device is accompanied by a personal gateway to display and transmit the acquired vital signs to Cloud for storage and further analysis. In addition, a lossless low-complexity compression algorithm which uses a linear predictor to estimate ECG samples is deployed into the wearable device for further power reduction.

The ECE Integrated Circuits & Embedded System (ICES) group envisions in future a wearable vital-sign monitoring device that has low power requirements. This wearable device of the future will be powered through the harvesting of readily available energy sources such as body heat, ambient temperature, kinetic activities, etc. Keep a look out for more of our research updates!

BUILDING OUR NATION THROUGH SCIENCE AND TECHNOLOGY



Mr **Wong** Ngit Liong and Prof **Tan** Chor Chuan watch a UAV take flight during the opening ceremony

An exhibition showcasing NUS' contribution to nation-building through ground-breaking research was launched at the University Cultural Centre on 9 April 2015.

Themed "Building Our Nation through Science & Technology", the exhibition demonstrated the University's emphasis on transformative education and impactful research. More than 20 projects, which address key challenges faced by the community, were on display at the exhibition.

Gracing the exhibition launch was Mr **Wong** Ngit Liong, Chairman of the NUS Board of Trustees. NUS President Professor **Tan** Chorh Chuan said in his address: "Right from the start, science, and the importance of its application, was identified as an important competitive advantage for Singapore".

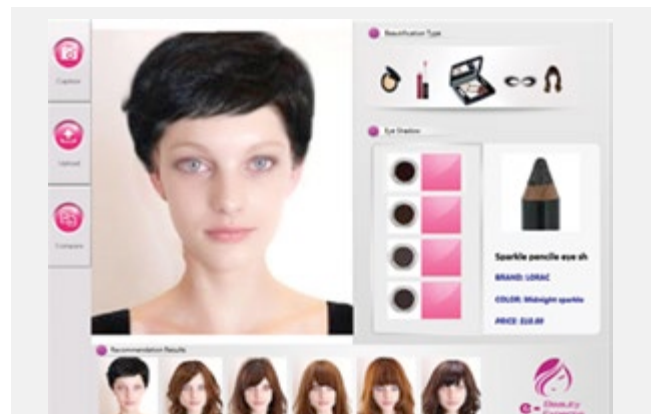
Prof Tan added that the exhibition epitomises the varied ways in which the University's research has been successfully applied, thus contributing to national development.

"This exhibition also reflects our strong desire to take the ground-breaking research findings out of our labs and to showcase the thrills and value of their commercialisation to the public," he said.

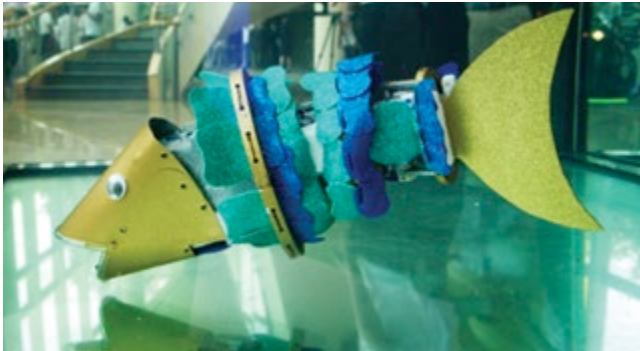
Six ECE projects were highlighted during the exhibition.

The first to steal the limelight during the opening ceremony was the Unmanned Aerial Vehicle (UAV). Since 2003, the NUS UAV team has been working on various research topics related to defence technologies. Its current research focus is on topics related to navigation systems for indoor and foliage environments, vision-based navigation and motion coordination, micro aerial vehicles and unconventional aircraft.

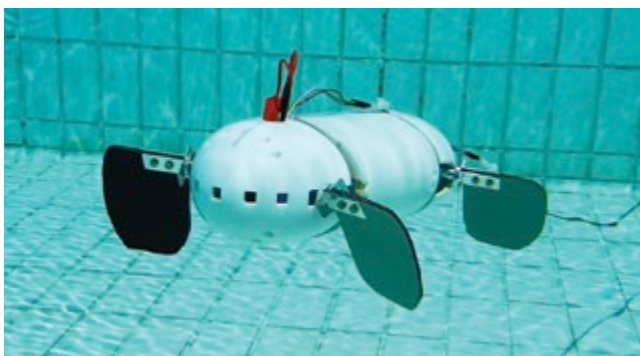
Under the category of "Multimedia Nation", Assoc Prof **Yan** Shuicheng and his team showcased a Beauty e-Expert System that can recommend hairstyles and makeup to help individuals look their best. The team is looking at adding an ageing feature to the system to add realism.



The Beauty e-Expert System



The robotic carp



The robotic turtle

Assoc Prof **Tan** Ping's work was showcased under the theme of "Digital Nation". The project titled "3D Architectural Modelling with Single Image" demonstrated a technique that can create textured and mapped 3D models from a single photograph. Previously, such quality 3D models had to be reconstructed painstakingly using manual methods that made use of blueprints as a guide. Many historic and traditional buildings have intricate geometric structures and curved roofs that are highly non-planar. While manual methods can capture the details of such buildings, current image-based techniques are inadequate for the job. With the 3D Architectural Modelling technique, 3D models of old buildings can be created quickly and accurately from photographs.

In addition to the team of UAVs on display, ECE showcased the robotic carp, eel and turtle in the "Smart Nation" category. The ECE underwater robotic team took inspiration from the swimming and diving abilities of sea animals such as the carp and turtle. The team led by Prof **Xu** Jianxin created the Robot Carp, a first in Asia with 3D movements. The robot can be programmed to perform specific functions that are difficult for divers or traditional AUVs to carry out, such as underwater archaeology, military activities, pipeline leakage detection, and the laying of communications cables.

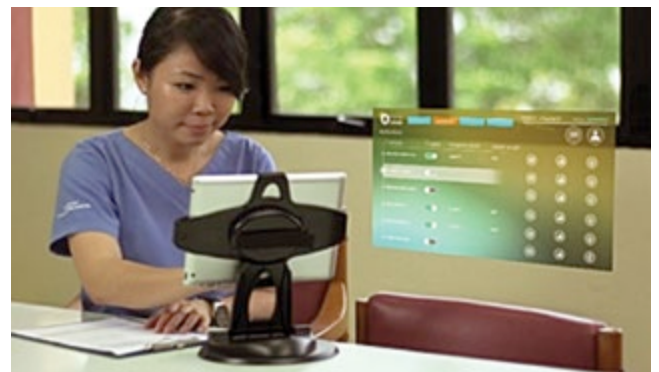
Another member of the ECE underwater robotic team is the robotic turtle developed by Assoc Prof Sanjib Kumar **Panda** and his team. "We expect to invent robots capable

of performing collaborative intervention missions three to five years down the road. What we plan to do in the near future is to develop fish with muscles that can undulate the way real fish do," said Assoc Prof Panda. The NUS robotic turtle, besides being manoeuvrable, can go about performing what it is tasked to do, while being able to react to challenges and obstacles. In addition, it can self-charge, further reducing the need for it to return to its base station for recharging.

On display in the category of "Healthy Nation" was ECE's tele-rehabilitation system which allows patients to perform prescribed exercises with biofeedback in the comfort of their home. With the system, caregivers can focus on helping patients with their rehabilitation at home instead of having to spend time commuting to therapy centres. The system, showcased during the National Day Rally 2014, has been tested by more than 80 patients from the Ang Mo Kio Thye Hua Kwan Hospital and Singapore General Hospital. The system was developed by Assoc Prof Arthur **Tay** and Dr **Yen** Shih Cheng from ECE, and Assoc Prof Gerald **Koh** from the Saw Swee Hock School of Public Health.

The NUS Science and Technology Exhibition was held at the University Cultural Centre from 9 to 18 April 2015. Selected exhibits forming a roving exhibition debut at two shopping malls: VivoCity from 27 April to 3 May and Great World City from 27 May to 2 June. Admission is free.

By bringing the exhibition to the masses, NUS hopes to share how some of its research has benefited and will continue to benefit the wider community.



The tele-rehabilitation system

DOING NUS PROUD – SMART CUSHION

In this issue, we are proud to feature one of our distinguished alumni, Dr **Hu Junhao**, founder and CEO of Darma. Located in the Silicon Valley, Darma developed the world's first smart cushion that monitors sitting habits. Dr Hu shares with us his experience in building a startup company.

Which year did you graduate from NUS?

I graduated and earned my Ph.D. degree from ECE in 2011. I was associated with the Optical Communication Lab in NUS, focusing on the research topic of optical fibre sensors.

Would you say your NUS training helped you in any way?

Yes. I took a launchpad course by Prof **Luda** that motivated me to keep a lookout for market needs. I learned that no technology was perfect. When we do research, the ultimate objective is to improve the performance of something by fixing possible disadvantages. However, for product development and commercialisation, this concept may not be exactly true. A disadvantage may turn out to be useful. Learning this changed my way of thinking about commercial ideas.

How did you come up with the idea of a smart cushion?

Back when I was a Ph.D. student, I suffered seriously from back pain very often after being seated for a long time. My experience motivated me to start thinking about how to address this issue. I found out that we can develop a device to track our posture throughout the working day. I realised there could be a great demand for such a product and that my product has lots of potential.

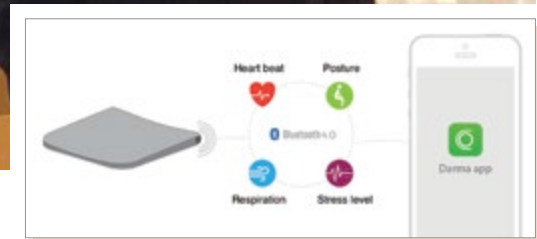
How did you build up the Darma? What kind of difficulties have you met? Are there any special experiences you would like to share?

In the beginning, my staff and I had to learn how to read market demand. So we reached out to the Life Sciences Director of NASA to learn how she helped people with her research to sit better. We also spent time talking to people who had to sit in the office for a long time and listened to their complaints. At last, we came up with our final idea and tried to make it happen.

However, we found it hard at first to recruit talented iOS developers and hardware engineers. In Singapore, many talented students prefer to do banking and consulting, while others are in semiconductor companies. We were just a small startup and could not pay high salaries initially. We also needed to convince people that we were doing great things. Fortunately, our team now has about 10 full-time members, and we are growing well.

What skills and qualities do you think an engineering graduate should have to remain competitive in today's ever-changing landscape?

Engineering students should have, at the very least, programming skills. "Design thinking", which is used by IDEO, is the other necessary skill that every graduate should learn.



Darma ecosystem

What advice would you give to aspiring entrepreneurs out there?

Dealing with issues that customers really care about is the first and most important step for any aspiring entrepreneur.

Do you think an innovative mind is important nowadays? How would it affect our career?

While we are students, academic results are an important judgement criterion of our performance but it is not all. Staying curious and trying to learn more outside our professional field are vital. In addition to innovation, learning from others is essential. I know that some graduates only focus on their own jobs, and know little about frontier technologies. You need to stay curious to come up with innovative ideas.

What's your goal?

From the very first day that I started my business, I aimed to build a global company. Developing a product that is really loved by customers is my goal.

What are your hopes and aspirations for ECE and our NUS ECE Alumni Committee?

There could be more opportunities and chances for ECE students to communicate with different entrepreneurs and learn from their experience and knowledge. As for the NUS ECE Alumni Committee, I think it is already doing a great job!

MSRA AWARD FOR MR CANYI LU

Canyi **Lu**, a Ph.D. student supervised by Assoc Prof **Yan** Shuicheng, was awarded the 2014 Microsoft Research Asia (MSRA) Fellowship, at the 21st Century Conference held in Beijing on 24 October 2014.

Canyi has published a total of eight papers in leading journals and conferences in his work. His award winning research entitled “Block diagonal affinity matrix pursuit for subspace clustering” addressed some fundamental problems in the field of block diagonal affinity matrix learning for subspace clustering, convex and non-convex optimisation in computer vision.

The MSRA award was conferred in recognition of Canyi’s outstanding contributions in the field and to encourage his future research endeavours. His award comprised US\$10,000 and a trophy.

MSRA aims to empower and encourage Ph.D. students in the Asia-Pacific region to realise their potential in computer science-related research. It recognises outstanding Ph.D. students majoring in fields such as computer science, electrical engineering, information science and applied mathematics.



Lu Canyi with his trophy



Canyi (3rd from left) at the award ceremony

MOBILE APP ON POLICE “WANTED” LIST



Carol **Cheng** with Assoc Prof Hari Krishna **Garg** (far right) and her other mentor from the Ministry of Home Affairs at the Ministry's Excel Fest



Carol (2nd from left) playing french horn in NUS Wind Symphony participating in Tempo 2014 Concert

We see this often enough on TV and the movies -- where witnesses help police come up with sketches or images of suspects. And we always marvel at the speed the artist works. A few flourishes of the hand and voila, the suspect's face is ready to be flashed as “Wanted”.

Third-year ECE student, Carol **Cheng**, has come up with an even faster method, a mobile application using templates. Aptly called Speed Photofit, the app enables one to complete the sketch in practically no time.

“Usually, the witness must recall the suspect's facial features and then describe the details to the artist who would then sketch out the face accordingly. With my app, witnesses can come up with the sketch themselves. They can also do it anytime, anywhere,” said Carol.

Carol's app won the silver award in the new University Students Mobile Application category of the SAFE Competition 2014. The Ministry of Home Affairs (MHA) organises the annual programme called SAFE (Security Awareness for Everyone) to encourage young Singaporeans to come up with new ways to help make the country safer and more secure. The challenge is for the prototype to take only a maximum of five minutes to be set up.

Carol's invention was displayed with other innovations in January 2015 at the MHA Excel Fest which celebrates the Home Team's efforts in innovation and service excellence.

Carol's contribution was part of the Undergraduate Research Opportunities Programme at NUS. She said, “My mentor, Assoc Prof **Garg** was looking for students to work on the project. It sounded fun and interesting, so I signed up.”

Perhaps her liking for DIY and doodling contributed to her interest in the project. She turned out to be the only student working on the project with her mentor. However, it took them a mere five months to complete it. Besides Assoc Prof Garg, Carol had some help from Google, “a relatively good consultant”, to use Carol's words.

Carol's other interest lies in music. An alumna of Temasek Junior College, she played in the college symphonic band. However, she thinks Engineering will be her profession when she graduates as she prefers something more hands-on.

NUS TEAMS SOAR AT THE SAFMC 2015



Top: Team LV-Lion: **Cui** Jinqiang (adviser), **Bi** Yingcai, **Li** Jiaxin, **Shan** Mo, **Qin** Hailong, **Liu** Wenqi.
Bottom: Team AP-Lion: **Wang** Shuai, **Liu** Kaijun, **Zhang** Mengmi, **Lin** Jiaxin, **Lan** Menglu, **Phang** Swee King (adviser)

The Singapore Amazing Flying Machine Competition (SAFMC) is an annual competition co-organised by DSO National Laboratories and the Science Centre Singapore. The competition is divided into six categories, namely A, B, C, D1, D2, and E.

Category D2 consists of mission elements to be accomplished using autonomous unmanned aerial vehicles (UAVs). This category is open to the public, and, as usual, attracted several university and polytechnic teams such as from the National University of Singapore (NUS), the Nanyang Technological University (NTU), Singapore University of Technology and Design (SUTD), Nanyang Polytechnic (NYP) and Singapore Polytechnic (SP) and many more.

This category had several mission elements, each simulating real life application in urban search-and-rescue missions. Participating UAVs had to perform feats such as autonomous navigation in unknown buildings, target searching and precise payload dropping, curtained door and windows penetration, navigation through forest areas, and precise landing on marked targets.

To meet these challenges, the NUS teams used state-of-the-art sensory technologies such as laser range scanners and high performance inertial measurement units, together with sophisticated navigation and target searching algorithms implemented on-board on the UAV.

In the competition held on 20 March 2015, both NUS teams, the AP-Lion and the LV-Lion, were the only two teams among the competitors to tackle all the given mission elements with the self-customized UAVs and landed safely.

For their excellent performance, AP-Lion, a team comprising our Department's final-year project (FYP) students, won the following awards under category D2 :

- Overall Championship Award (Gold)**
Prize comprises \$7,000 cash and 5 Samsung Tablets
- Best Performance Award (Gold)**
Prize comprises \$1,000 cash
- Best Theory of Flight Award (Gold)**
- Best Video Award (Silver)**