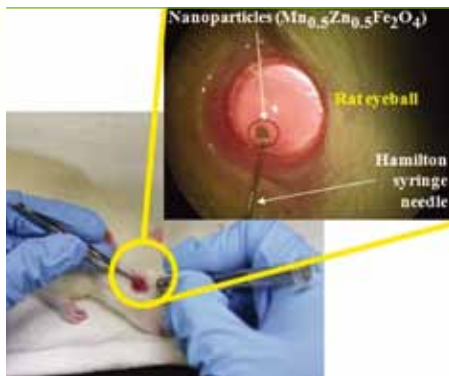




## ECE ALUMNI FAMILY DAY 2010

AN EMAIL INTERVIEW WITH DR YANG ZHI WHERE HE SHARES SOME OF HIS BACKGROUND AND THOUGHTS WITH US. **PAGE 06**



ASST PROF SEONGTAE BAE, TOGETHER WITH HIS RESEARCH TEAM IN BIOMAGNETICS LABORATORY (BML) AT THE ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT, HAS RECENTLY DEVELOPED A NEW BIOTECHNICAL APPROACH. **PAGE 08**

ECE CLUB – JUST ANOTHER CLUB FOR ENGINEERING STUDENTS? **PAGE 17**



**PAGE 13**

FOR MANY, ATTENDING THE ECE ALUMNI FAMILY DAY WAS TIME WELL SPENT. IT MEANT RENEWING OLD TIES AND BUILDING NEW ONES AMONGST EX-CLASSMATES, AS WELL AS BETWEEN ALUMNI AND THEIR ALMA MATER.

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# MESSAGE FROM THE HEAD OF DEPARTMENT



Prof **Chua** Kee Chaing  
Head, Department of Electrical & Computer Engineering, NUS

“ The high quality of our research has been acknowledged by the numerous recognitions, awards and prizes that our faculty, staff and students have won in the past year. ”

In Semester 1, we rolled out our new BEng (EE) programme to freshmen, starting with two brand-new EE core modules: EE1001 Emerging Technologies in EE and EE1002 Introduction to Circuits and Systems. EE1001 has been specifically designed to introduce students to the key EE technologies that have significantly impacted society. Through this module, we were hoping to encourage students to understand the role EE could play in tackling the grand challenges of today, and of the future. It seems the students have thoroughly enjoyed the module, although some were a little overwhelmed by the sheer number of different EE technologies covered by their enthusiastic professors. Module EE1002 was incorporated to allow students to learn major EE concepts in an integrated and hands-on manner. The students had their very first exposure to building circuits and systems, using electrical components and equipment in the laboratory. The module culminated in an exhilarating autonomous vehicle competition on 12 November 2010. It was indeed gratifying to see freshmen getting so much fun from competing to see which team had the best-performing track-seeking vehicle (which they had designed entirely from scratch).

In research, the Department did very well in attracting competitive grants throughout 2010. Compared to the \$14.3m in new grants attracted in 2009, we successfully secured close to \$30m in new research funds by the end of September 2010. Much of this substantial increase came through a thematic strategic research programme with A\*STAR SERC and an NRF Competitive Research Programme grant. These sources of significant funding, along with grants from MoE, MINDEF and industry, will allow us to continue to embark on important and impactful research. The high quality of our research has been acknowledged by the numerous recognitions, awards and prizes that our faculty, staff and students have won in the past year. These accolades include the appointment of Professor Ben **Chen** as Changjiang Guest Professor at Nanjing University of Science and Technology and the election of Professor Sam **Ge** as a Fellow of the International Federation of Automatic Control.

Best wishes for a successful and productive Semester 2 as well as a happy and healthy start to 2011.

**Editorial Team** Assoc Prof Dipti Srinivasan  
Assoc Prof Teo Kie Leong  
Assoc Prof Marc Andre Armand  
Ms Winnie Chua

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**Advisor** Prof Chua Kee Chaing



# FAST LANE TO GREATER EXPERIENTIAL LEARNING

Greater experiential learning is now underway for the latest cohort of 1st-year Electrical and Computer Engineering students. The Department has launched two compulsory modules for 1st-year students that will give them a jumpstart into their learning journey. They will acquire hands-on knowledge and skills that are normally experienced by 3rd-year, or even final-year, students.

Assoc Prof **Loh** Ai Poh, Deputy Head for Undergraduate Programmes at the Department, said: "The new modules will motivate them to learn in a deeper way when they eventually embark on the core curriculum. The modules are targeted to arouse students' curiosity as well as excitement. This will be a good start to their learning journey as they begin to see how problems can be solved before they fully understand the theories. Hopefully this will inspire them to appreciate the engineering concepts which will be delivered in the later years of their study."

Added Mr **Niu** Tian Fang, a teaching assistant for EE1002 and CG1108: "It would be more fun for them to learn the theory through solving problems. They are now acquiring the skills in handling equipment which I did not even possess in my 4th year as an undergraduate!"

Mr Rajesh **Panicker**, who is also a teaching assistant with the department, said: "It is a sheer joy to watch these students progress so rapidly. For most of them, this is their first time building a car model, coming up with their own algorithms and circuits without any ready-made materials provided."

The students are divided into groups, each comprising four students. They work together in one of the most well-equipped teaching laboratories in the Department. Their first project in EE1002 is to build an autonomous car model from scratch, design and construct the various circuits, as well as devise the algorithms required for the car to overcome various obstacles such as climbing up ramps and making turns at sharp angles. At the same time, the students are required to look into the aesthetics of their to-scale car model. The main difference between their vehicles and others that have previously been designed and built is that theirs do not involve any microcontrollers. All the circuits are based entirely on analogue and digital electronics.

One of the students, **Teng** Xiao, noted: "I really find this project exciting. The most challenging part for me was to come out with the algorithm for the car to make a 90-degree turn!"

**Wang** Yan agreed that building the car model was challenging but fun. "We really have to make everything ourselves. In order for the car to work properly, we



Hands-on is fun...especially if it works!



Students working on their robotic cars under the guidance of teaching assistants Mr Rajesh Panicker (standing, centre left) and Mr Niu Tian Fang (standing, centre right).

needed different circuits and algorithms for different tasks. The difficult part is that your model needs to be able to sense and follow the black markings on the track. Should the car stray from the track, it should be intelligent to find its way back and be on track again," she said.

Their efforts will be put to the test at a competition. As their performance will not be graded at the contest, it promises to be a purely fun and exciting exercise.

# EE1001: EMERGING TECHNOLOGIES IN ELECTRICAL ENGINEERING

This unique module was offered for the first time in semester 1, AY2010/11. It serves to open up the minds of students to the key and emerging technologies in electrical engineering (EE) even before they learn any bit of engineering in the BEng programme.

The module was divided into five parts, each focusing on one broad area of technology. The areas were Computers and Networks, Electrical Energy Systems, Micro/Nano Devices and Systems, Intelligent Systems and Robotics, and Electrical Engineering in Medicine. To help students see the linkages between these areas and the EE programme, the first lecture gave an overview of the curriculum components that are designed to lead students from the fundamentals to the specialisations in each of the areas.

Comments from some students about this module have been positive. They particularly appreciated the exposure they had received, without which they would have little knowledge of what EE is all about. Laboratory visits were also organised. Some keen students visited the laboratory twice to learn more

about the research activities there! Students also attended industry talks by A\*STAR and Google. Both talks were well received.

In terms of assessment, instead of the typical examination at the end of the semester, students were assessed individually on multiple-choice questions on each topic. They also worked in groups of four, writing an essay in which they proposed a grand challenge. Presentations were made at the end of this assignment, which was submitted through the NUS wiki space. Faculty members from the Centre for English Language Communications also pitched in to advise on how their case for the grand challenge should be argued and their essays structured. Overall, it was definitely a grand challenge in itself for all involved to complete this module, including the faculty members!

## EE1002: INTRODUCTION TO CIRCUITS AND SYSTEMS AUTONOMOUS VEHICLE MINI-PROJECT

A new course module, EE1002 “Introduction to Circuits and Systems”, has recently been incorporated into the Electrical Engineering curriculum. It is the first course in Electrical Engineering (EE) for BEng (EE) students from the academic year 2010/11 onwards, and, each week, the students have a two-hour lecture, a one-hour tutorial and a three-hour laboratory session (lab). So far, the highlight of the course seems to be the integrated laboratory sessions, starting from week two.



Students performing the lab experiments

The first six weeks of the labs are linked to the theoretical principles taught during lectures. The students carry out experiments in groups of two and they acquire a good grounding in the use of lab equipment such as DC power supply, multimeter and oscilloscope. The remaining six weeks are used for undertaking project work. Students work in groups of four to build a line-tracking autonomous vehicle that can track a black line placed on a white table. They first build the sub-systems, namely the motor drive, the sensor and the logic system, and finally integrate these to build a complete system.

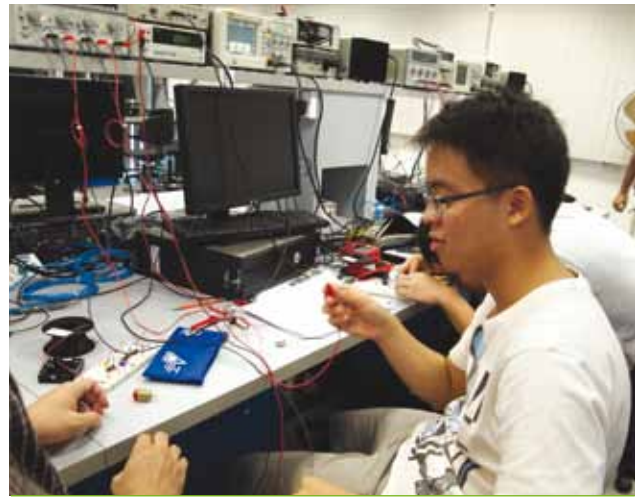
The project is evaluated according to certain criteria: technical functionality, good engineering design knowledge, for example colour-coding of the wires on the breadboard; design of the vehicle and additional features based on the students' own initiative.

On 12 November 2010 in the LT6 foyer, about one-fifth of the groups participated in a final mini competition, purely for fun and excitement. It provided an opportunity for the students to showcase and demonstrate the results of their hard work. The competition was led by Assoc Prof **Loh Ai Poh**, Deputy Head (Academic), ECE Dept, and attracted a large audience of staff and students. Competitors' vehicles had to track a black line, going up and down two ramps with an 18° slope, whilst avoiding several obstacles placed in their path. Prof **Chua Kee Chaing**, Head, ECE Department, was also present and he congratulated the winners, distributing medals and cash prizes to the teams. The competition was sponsored by Mr P **Bala**, Chief Executive and Chairman of Auxineon Pte Ltd.

Overall the competition gave students a great sense of achievement, especially when they saw their vehicle complete the track. As **Poh Wei Jin** put it, "This is our first course in electrical engineering and we hardly knew anything about electrical and electronic circuits. We didn't fully understand the first principles and had no idea of logic circuits. However, the project has been a wonderful experience. We have learned a lot from our team mates and teachers. And we learned fast!"

When asked about the challenges faced in this project, another student, **Tang Buu Vinh**, said: "Initially, our vehicle was not capable of making right turns. We discussed and developed logic and sensor positioning circuits that could enable it to achieve a right turn. For the competition, we incorporated some additional logic functionalities to make our vehicle more agile. We plugged in a capacitor to smoothen output of the DC power supply; we used blue LEDs instead of white, which made our car more immune to the ambient light; we placed sensors in front of the wheel, which helped us to sense the turns in advance – rather than reacting when we were about to go off the track. But, we never thought we would win the first prize as there were many other teams that had extremely well-performing cars."

The project also increased students' interest in the course, as confirmed by Tang Buu Vinh – "I was planning to change to another major but, after this project, I realised just how much fun electrical engineering can be, and so I'm sticking with it!"



Students building the sub-systems in the lab

The sense of pride and achievement attained from not only a first-year but also a first-semester module is very clear for Wei Jin, who says, "We believed that many of the things we did for the project could only be executed by qualified electrical engineers. I wonder how many other disciplines can offer students the same level of confidence in the skills that they are acquiring?"

The course material and the project were developed and executed by a team consisting of the lecturers for the module Assoc Prof Sanjib Kumar **Panda**, Dr **Sahoo** Sanjib Kumar and Teaching Assistants (TAs) **Niu** Tian Fang, **Yang** Rui, Rajesh **Panicker** and **Chua** Ding Juan. The dedication of graduate assistants (GA) towards the students has certainly helped in providing an excellent learning experience. The EE1002 teaching team wishes to express their gratitude to the department's Curriculum Task Force (CTF7) Committee, under the able leadership of Prof Loh in designing such a challenging BEng (EE) programme and an exciting integrated module. Credit must also go to the ECE Department management team for providing logistics, constant support and encouragement towards the implementation of this new integrated module.



The final competition of the mini-project



# PROMOTIONS, NEW APPOINTMENTS AND MENTORSHIP

## CONGRATULATIONS FOR PROMOTION AND TENURE

We congratulate the following faculty on their successful application for promotion and tenure.

- DR **LIAN** YONG on his promotion to Full Professor with effect from 1 July 2010
- DR **CHEN** XUDONG on his promotion to Associate Professor with tenure with effect from 1 January 2011
- DR **HONG** MINGHUI on his award of tenure as an Associate Professor with effect from 1 January 2011

## NEW FACULTY APPOINTMENTS

We welcome the following new members into our ECE family.

- DR **YANG** ZHI joined ECE Dept as Assistant Professor on 10 August 2010. He graduated with a PhD degree from the University of California in Santa Cruz, USA, in 2010, specialising in Mathematical Modelling, Biophysics, Biomedical Signal Processing, Analogue Circuit Design, Wireless Power and Data Telemetry, Neural Prosthesis, Computational Neuroscience, and Machine Learning and Computer Vision. Dr Yang's current research topics include Mathematical Modelling of In-Vivo Neural Network and Neuronal Synchronisation, Analogue Frontend Circuitry for Simultaneous Neural Stimulation and Recording, Semi-supervised In-Vivo Neural Signal Detection, Classification, and Decoding, Design and Instrumentation of Integrated Neural Signal Processor, Invasive and Non-invasive Recordings Correlated to Cognitive States and Learning, Wireless Power and Data Links for Biomedical Applications.
- DR AKSHAY KUMAR **RATHORE** joined ECE Dept as Assistant Professor on 16 November 2010. He obtained his PhD in Power Electronics from the University of Victoria, Canada, in 2008. He held postdoctoral research appointments with the University of Wuppertal, Germany from September 2008 to August 2009 and with the University of Illinois at Chicago, USA from September 2009 to September 2010. Dr Rathore's research areas include High-frequency Power Conversion, Design and Development of Power Electronics Systems for Renewable Energy Sources (fuel cells, photovoltaic), Resonant and Soft-switching Techniques.
- DR **ZHANG** JIANWEN joined ECE Dept as Lecturer on 1 September 2010. He obtained his PhD in 2008 from NUS and was, prior to this, Research Fellow in ECE Dept working on research in Coding Theory and Decoder Design in Digital Communications.
- DR PER INGEMAR **WIDENBORG** joined ECE Dept on 1 December 2010 as Research Assistant Professor. He holds a joint appointment between ECE and the Solar Energy Research Institute of Singapore (SERIS), where he is the Head of the Poly-Si Thin-film Solar Cell team under the Silicon Photovoltaic Cluster. Dr Widenborg obtained his PhD in 2004 from the University of New South Wales, Australia. His research interests include Photovoltaic Energy Conversion, Thin-film Silicon Solar Cells, Fabrication and Characterisation of Thin-film Silicon Solar Cells, and Light Trapping in Silicon Thin-Film Solar Cells.
- DR **CHONG** TOW CHONG joined ECE Dept as Adjunct Full Professor with effect from 1 June 2010. Prof Chong was, prior to this, Full Professor in ECE Dept. Prof Chong is currently leading the Singapore University of Technology and Design (SUTD) as the founding Provost.
- DR **JE** MINKYU joined ECE Dept on 1 July 2010 as Adjunct Assistant Professor. Dr Je is a Member of Technical Staff and is leading the Analog and Mixed-Signal IC Group at the Institute of Microelectronics. Dr Je obtained his PhD in 2003 from KAIST, Korea, and his main research areas are in Low-power Analog and Mixed-signal Circuits and Systems interfacing with Bio and MEMS Sensors, Circuit Design and Multi-functional System Integration with Novel Nano-devices, and Wireless Telemetry Circuits and Systems for Bio-medical applications.
- DR **LEE** EE joined ECE Dept on 1 July 2010 as Adjunct Assistant Professor. Dr Lee is Senior Research Fellow at The Institute of Infocomm Research (I2R), A\*STAR. He obtained his PhD in 2002 from the University of Birmingham, UK, and his research is mainly in the area of Mobile Communication and Antenna Design.

- DR RAMESH **ORUGANTI** joined ECE Dept as Adjunct Associate Professor in ECE Dept with effect from 1 July 2010. Prof Oruganti was previously Senior Associate Professor in ECE Dept.
- DR NEELAKANTAM V. **VENKATARAYULA** joined ECE Dept on 1 July 2010 as Adjunct Assistant Professor. Dr Venkatarayula is Research Scientist at EADS Innovation Works, EADS Singapore Pte. Ltd. He obtained his PhD in 2007 from NUS, and his research interests are in Computational Electromagnetics, Applied Electromagnetism, RF and Microwave Engineering and Electromagnetic Compatibility.
- DR **CHEN** CHANG joined ECE Dept on 15 October 2010 as Adjunct Assistant Professor. Dr Chen is Principal Member of Technical Staff at DSO National Laboratories. He obtained his PhD in 2006 from Georgia Institute of Technology, USA, and his research interests are in Helicopter System Analysis, Design of Fixed-wing and Rotary-wing UAVs, Flight Dynamic Modelling and Simulation, Control System Design, Sensor Fusion and Path Planning.
- DR JOSEF LUDWIG **BALK** joined ECE Dept as Adjunct Full Professor on 1 November 2010. Prof Balk was Full Professor of Electronics and Executive Director of the Institute of Polymer Technology at Wuppertal University in Germany. He was NUS Distinguished Visiting Professor in 2003 and was also Visiting Professor in ECE Dept. Prof Balk received his Diplomphysiker (Physicist) and Doctoral degrees in 1971 and 1976, respectively, both at the Technical University of Aachen, Germany, and he is a Fellow of the Institute of Physics.
- DR **WONG** FORD LONG joined ECE Dept on 25 November 2010 as Adjunct Assistant Professor. Dr Wong is Senior Member of Technical Staff at DSO National Laboratories and is currently a Principal Investigator in Software-defined Radio system security. He obtained his PhD in 2008 from the University of Cambridge, UK. Dr Wong works on research and development activities in wireless security, security protocols for authentication and privacy, RFID security, pervasive computing and trustworthy/higher-assurance systems. In addition, Dr Wong carries out vulnerability assessments of systems.
- DR **GUAN** CUNTAL joined ECE Dept on 1 December 2010 as Adjunct Associate Professor. He is Principal Scientist and Programme Manager at the Institute of Infocomm Research (I2R), A\*STAR. He obtained his PhD in 2003 from Southeast University, China. Dr Guan's research areas are brain-computer interface, neural signal processing, machine learning, pattern classification and statistical signal processing, with applications to assistive device, rehabilitation and health monitoring.
- DR **CHAN** KOK LIM joined ECE Dept on 3 January 2011 as Adjunct Assistant Professor. Dr Chan is Senior Research Engineer at I2R, A\*STAR. He obtained his PhD in 2007 from the University of California in San Diego, USA. His research interests are in the areas of High Performance Data Converter, All-digital Phase-locked Loop, High-speed Low-power CMOS IC Design and Digitally-assisted Analogue IC Design.
- DR **WONG** TUNG CHONG joined ECE Dept on 3 January 2011 as Adjunct Assistant Professor. Dr Wong is Research Scientist at I2R, A\*STAR. He obtained his PhD in 1999 from the University of Waterloo, Canada. Dr Wong's research areas are in Wireless/Wireline Multimedia Networks.

## NEW ADMINISTRATIVE APPOINTMENT

- MS **TAN** MUI CHING, OLIVIA joined ECE Dept on 11 October 2010.

### ECE MENTORING PROGRAMME

A Tea Session for the ECE Mentoring Programme was held on 24 September 2010 at the Hibiscus Lounge and it happened to correspond with the period of the Mooncake Festival. The Head of Department, Deputy Heads, Mentors and Mentees who attended the Tea Session enjoyed the opportunity to network whilst, of course, enjoying mooncakes and tea!



# AN EMAIL INTERVIEW WITH DR YANG ZHI

Dr **Yang** Zhi joined the Department in August and we are glad he agreed to share some of his background and thoughts with us.



**Q** Tell us about yourself (Family, educational qualifications, previous work experiences, etc)

**A** I was born in Changsha, Hunan Province, China in 1981. Our family lived in an apartment about 20 meters away from Xiang River, and a few hundred metres away from YueLu Mountain.

I received several awards in national mathematics and physics competitions and these exempted me from taking entrance exams to junior high school, senior high school and college.

I attended No. 1 Middle School in Changsha for both junior and senior high school, in a special programme named "Science Class", attended by 40 students per year selected from Human Province.

During my Undergraduate study at Zhejiang University, I attended "Mixed Class", which was open to the top 5% of students at the University.

At University of California in Santa Cruz, I continued my study for both Master and PhD degrees, majoring in electrical engineering with specialisation in mathematical modelling and neural prosthesis. As an example of the latter, I worked with Prof Wentai **Liu**, Prof Mark **Humayun** and Prof James **Weiland** on an artificial retina project to restore vision of blind patients; this project received about US\$100 million accumulated funding from US government.

During my five years of PhD study, I have published 30 papers in around 20 different journals and conference meetings, covering subjects from integrated electronics, neural engineering, electromagnetic to machine learning and mathematical modelling.

**Q** How have you been settling in/adjusting to Singapore?

**A** Singapore is beautiful. Living here means you have access to beaches, islands, the Botanic Gardens, big shopping malls, tasty food, casinos, etc. In a sense, Singapore is just like a "Disney City"!

**Q** Why NUS ECE/Singapore? What do you hope to achieve within the next five years?

**A** NUS ECE is highly ranked world-wide. It has visionary faculty members, smart and diligent students, start-of-the art facilities, a collaborative research environment and expansive engineering resources. NUS ECE is an ideal environment to conduct cutting-edge, interdisciplinary research projects.

My vision for a faculty career is to develop a world class interdisciplinary research and teaching programme in biomedical engineering design and instrumentation bridging engineering, information science, life sciences and medicine.

**Q** Please share your research interest and/or recent projects.

**A** During the past five years, I have collaborated with leading experts in ophthalmology, neurophysiology, nanotechnology, and microelectromechanical devices. The technology and prototypes from these projects are transferred to real world systems including a multi-channel neural recording system, a biological signal processor, wireless power and data telemetry, a retinal prosthesis stimulator, and an in vitro magnetic neural stimulation platform.

I will conduct research that will help us to better understand the brain, from the following three perspectives:

- mathematical modelling of in-vivo neural network and neural information generation and processing
- developing advanced neuroscience platform technologies to enable simultaneous neural stimulation, recording and signal processing
- non-invasive research correlating to cognitive states and learning

**Q** Research aside, what other hobbies do you have? What do you do during your free time?

**A** I enjoy playing different types of computer and PS games, but am never very good at any of them! Some games I have played over the past five years include strategy, role-playing and action games.

I enjoy listening to music, mostly Chinese pop music from the 80s and 90s and sometimes classical too. My favourite singers are Sam **Hui**, Leslie **Cheung**, Hacken **Lee**, Danny **Chan**, Michael **Jackson** and Shirley **Kwan**.

I also like to watch TV series such as *Lost*, *Desperate Housewives* and *Prison Break* via the Internet.



# FUTURE HUMAN TRANSPORTATION SYSTEM

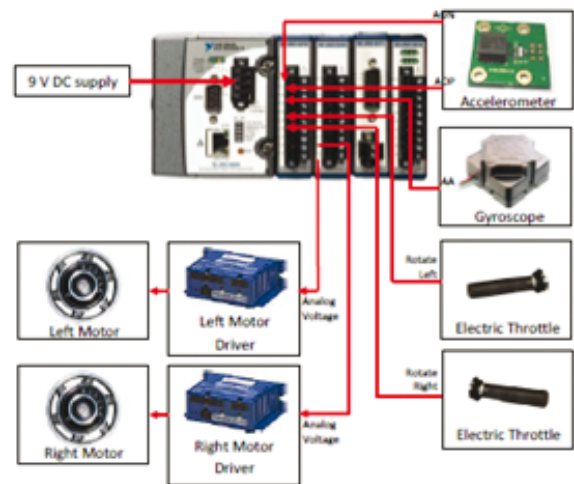
The Personal Transporter (PT) came into the market in 2002. Formally known as the Segway, some projected that it would have a similar impact on society as the personal computer. But the PT has experienced several highs and lows since its launch.

While celebrities such as Jackie **Chan** ride on the PT as an alternative transportation device (with great publicity), George W. **Bush** famously fell off one in 2003. In Britain, the PT can be used only within private property, but it is legal in several other European countries. In the United States, PTs are only approved for limited use in many states.

Nevertheless, the PT is a landmark invention offering a negligible turning radius to enable mechanised human transportation and manoeuvring within spaces where it was never before thought possible. As an apparatus, it is an inverted pendulum, offering tremendous opportunities for R&D in mechatronics and control-leveraging on gyroscopic and advanced sensing technology. As a transportation system, there remains great potential in expanding the use of the PT beyond plain fun and excitement.



Wenyu (left) and Chee Siong with the Personal Transporter



Interconnections between CompactRIO and other components

A project team from the Mechatronics and Automation Laboratory (comprising laboratory officer Mr **Tan** Chee Siong; students Mr **Ang** Jinxiang (FYP) and Mr **Liang** Wenyu (RS); and staff members Assoc Prof **Tan** Kok Kiong, Dr **Tang** Kok Zuea and Prof **Lee** Tong Heng) envisions a future subsidiary human transportation system in parallel to, and complementing, the current vehicular transportation systems. Such a system can use the PT as the backbone and allow scalability to synergise with existing transport frameworks and traffic-control mechanisms. It can additionally realise auto-tracking routes and transportation for commuters, including the less privileged groups such as the elderly and physically challenged, transporting them from key stations and transport points back to their homes and amenities safely and efficiently. This requires a platform that is able to integrate to standard and advanced sensing technology such as RFID and GPS, and yet small, compact and energy-efficient enough to be embedded into a PT.

The team has built the first version using the National Instrument's CompactRio as the control engine. Intelligent and adaptive algorithms were programmed to enable fast stabilisation of the inherently unstable system and yet instil a high level of robustness. A further version is currently in the pipeline, utilising a third retractable wheel in its preliminary design sketch. It will aim to provide the elderly and physically challenged with a personal transportation option that incorporates both speed and agility.

A paper on the development of this system was awarded the Best Innovation in Robotics in the ASEAN Virtual Instrumentation Applications Contest 2010, organised by National Instruments. The contest is open to participants from ASEAN University and industries.

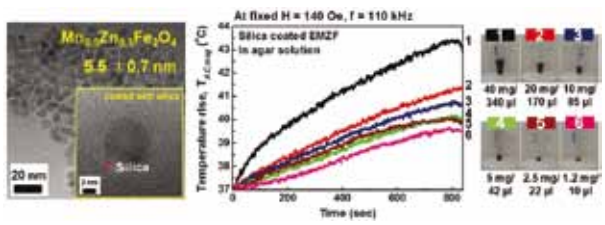
# OCULAR NEUROPROTECTION IN GLAUCOMA (A NANOMEDICINE APPROACH)

Glaucoma is an optic neuropathy disease wherein the optic nerve is damaged with loss of retina ganglion cells (RGC), mainly due to an increase in intraocular pressure, leading to progressive and irreversible loss of vision.

For the past few decades, vast research activities have been undertaken to develop biotechnical approaches that will protect the damaged optic nerve. Eventually, it was discovered that neuroprotection of the optic nerve or RGCs is effectively made by heat-shock proteins (HSPs), or stress proteins. These proteins exist in all living creatures from bacteria to human beings and are induced by hyperthermia, metabolic stress or oxygen deprivation. In particular, it was clinically confirmed that the induction of HSP 70 families is powerfully efficacious for the protection of damaged optic nerve or RGC resulting from glaucoma. To date however, all attempted methods to induce HSPs from optic nerve or RGC have proven ineffective. This is due to undesirable chemical and physical side effects caused by difficulty in inducing HSPs and controlling heating temperature in the localised RGCs (or optic nerve).

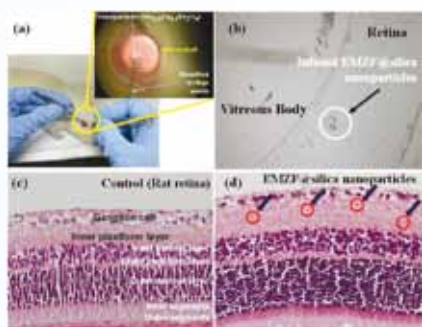
For a more effective and safer method, Asst Prof Seongtae Bae, together with his research team in Biomagnetics Laboratory (BML), ECE, has recently developed a new biotechnical approach that induces localised HSPs in the optic nerve or RGCs by local magnetic hyperthermia using engineered superparamagnetic  $Mn_{0.5}Zn_{0.5}Fe_2O_4$  nanoparticle agents with a 5.5 nm mean particle size. Their scientific achievement, published in "Biomaterials" in the Sep. 2010 online issue, can be summarised into three main areas:

- 1) Developed a very small size of nanoparticles with 5.5 nm mean diameter as a localised HSPs inducing agent. The nanoparticles were coated with a very thin (~2 nm) silica layer and showed a higher SAR (specific absorption rate) as well as higher heat generation in a short time.
- 2) Developed a new infusion technique of nanoparticles into the retina layer through the vitreous body. Most of the current technologies regarding infusion are through intravenous injection via blood vessels. However, the eye does not have any blood vessels, with the exception of the choroid that consists of reticular structures located in the back side of the eye. For this reason, a new technique through the vitreous body was developed as part of this research, wherein the nanoparticles were injected into the eyeball and diffused through the vitreous body to the surface of the retina.
- 3) Successfully demonstrated the heating temperature in a similar environment to RGC for inducing HSPs (in the range of 39–41°C) particularly in the biologically and physiologically safe range of AC magnetic field (<140 Oe) and frequency (<110 kHz).



Left: 2 nm-thick silica coated engineered superparamagnetic  $Mn_{0.5}Zn_{0.5}Fe_2O_4$  nanoparticles (EMZF@silica, 5.5 nm in diameter).

Right: Successful demonstration of AC magnetically induced heating characteristics of EMZF@silica for localised heat-shock proteins (HSPs) in an agar solution with the same viscosity of cytoplasm (retinal ganglion cells).



A new infusion technique to introduce nanoparticles to the retina: (a) injection of nanoparticles into the rat eyeball; (b) image of successfully infused nanoparticles in the retina.

Histological exam results of infused EMZF@silica in in-vivo: (c) Control rat retina (RGCs); (d) Infused EMZF@silica nanoparticles in RGCs

This work was also featured in "Nanowerk spotlight, USA online": <http://www.nanowerk.com/spotlight/spotid=18646.php> on 25 October 2010. In the article, Dr Bae said: "All the experimental results shown in our study strongly suggest that the ocular neuroprotection, based on the HSPs induction by local magnetic hyperthermia using silica coated superparamagnetic  $Mn_{0.5}Zn_{0.5}Fe_2O_4$  nanoparticle agents, can be an innovative approach for the efficacious treatment of glaucoma. Furthermore, it emphasises that our new nano-bio technology can be extended to treating other neural diseases such as Parkinson's disease, Alzheimer's, epilepsy, and other bioelectric transmitting-related diseases as well as immunology-related diseases."



# THE APPLICATIONS OF DIGITAL SIGNAL PROCESSING IN 100-GBIT/S COHERENT OPTICAL COMMUNICATION SYSTEMS

Electrical digital signal processing (DSP) is already a very cost-effective and powerful technique for wireless communications. Here we introduce its applications into the field of 100-Gbit/s coherent optical communications, which may replace the current expensive optical techniques and also improve the system performance in the presence of fibre degrading effects. The work is done by the collaboration of Prof **Kam** Pooi Yuen, Asst Prof **Kim** Hoon, Asst Prof **Yu** Changyuan, and their team members.

With the exponential increase in data traffic, especially due to the demand for ultra-broad bandwidth driven by multimedia applications, cost-effective ultra-high-speed optical networks have become highly desired. A 100-Gbit/s data rate of serial data transmission per wavelength is needed for next-generation optical communication systems. To achieve this data rate while complying with current system design specifications such as channel spacing, chromatic dispersion and polarisation mode dispersion (PMD) tolerance, coherent optical communication systems with multilevel modulation formats are highly sought after. These systems can provide high spectral efficiency, high receiver sensitivity and potentially high tolerance to fibre dispersion effects. Compared to conventional direct detection in intensity-modulation/direct-detection (IMDD) systems, which only detect the intensity of the light of the signal, coherent detection can retrieve the phase information of the light and can therefore tremendously improve the receiver sensitivity. Digital signal processing (DSP), which has been widely used in wireless communications, will play a key role in the implementation of coherent optical communication systems.

As shown in Figure 1, we apply DSP techniques for coherent optical detection to eliminate the impractical optical phase-locked loop (PLL) and to improve the performance of the transmission systems in the presence of fibre degrading effects (including chromatic dispersion, PMD and fibre nonlinearities). We use the decision-aided maximum likelihood (DA ML) carrier phase estimator to approximate ideal coherent detection in optical phase modulation systems. The DA ML phase estimator requires only linear computations and is thus more feasible for online processing in real systems than with the conventional Mth power method.

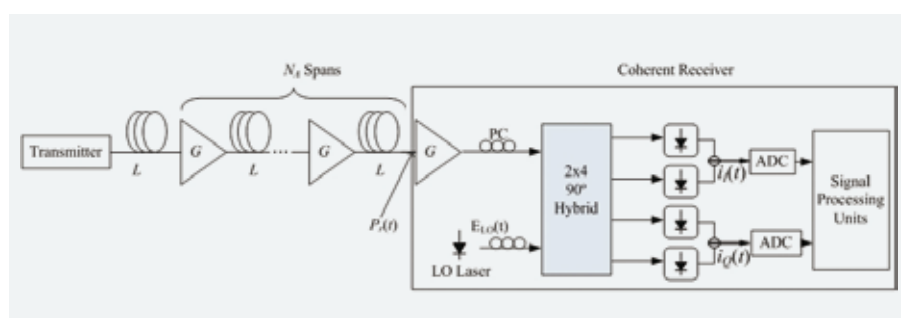


Figure 1: A typical long-haul transmission system with a coherent receiver. ADC: Analogue-to-Digital Converters

As shown in Figure 2, the DA ML receiver also outperforms the Mth power method, especially when non-linear phase noise is dominant, thus significantly improving the receiver sensitivity and tolerance to non-linear phase noise. We are developing our DA ML phase estimation algorithm further and studying the performance of the coherent optical communication system with our proposed receiver for different MPSK and MQAM modulation formats, using both simulation and experiments.

The team would like to thank A\*STAR SERC PSF for the funding support.

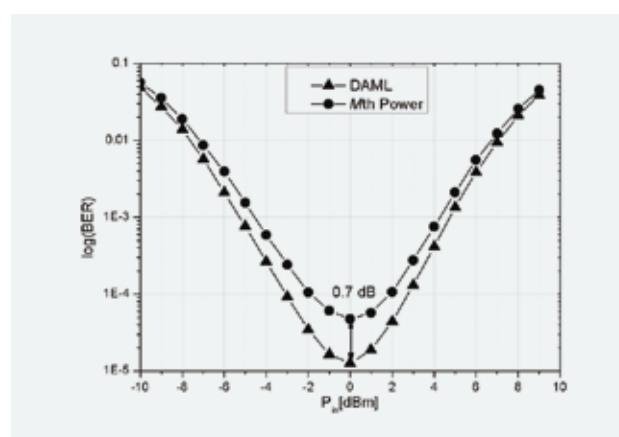


Figure 2: Simulated non-linear phase effect of QPSK signals in a 22-span non-linear optical channel



# FACILITATE REAL LIVES WITH MULTIMEDIA TECHNIQUES

A research team, *Learning and Vision Group*, led by Assistant Professor Shuicheng **Yan**, has been creating practical multimedia techniques to solve real-life problems. Founded on advanced visual, audio and text analysis, the team has developed some award-winning systems for shredded photo recovery and video accessibility enhancement for hearing impairment. Dr Yan shared two recent international awards for Best Paper.

Shengjiao **Cao**, Hairong **Liu**, and Shuicheng **Yan**, “Automated Assembly of Shredded Pieces from Multiple Photos”, won the best paper award at the IEEE International Conference on Multimedia and Expo 2010. Their paper investigates the problem of the automated assembly of shredded pieces from multiple photos widely employed in old document recovery and forensic investigation. This proposed system can deal with cases in which materials are lost and/or pieces belonging to multiple photos co-exist. The flowchart of the whole system is shown in Figure 1.

Richang **Hong**, Meng **Wang**, Mengdi **Xu**, Shuicheng **Yan** and Tat-Seng **Chua**, “Dynamic Captioning: Video Accessibility Enhancement for Hearing Impairment”, won the best paper award in ACM Multimedia 2010. ACM Multimedia 2010 is the worldwide premier multimedia conference and a key event for the presentation of scientific achievements and innovative industrial products. There are more than 66 million people who suffer from hearing impairment, and the disability results in extreme difficulty in understanding video content, primarily due to the loss of audio information. This joint work with NUS School of Computing (SOC) introduces a scheme to enhance video accessibility using a *Dynamic Captioning* approach that explores a rich set of technologies, including face detection and recognition, visual saliency analysis and text-speech alignment. An excerpt of the demo system is illustrated in Figure 2.

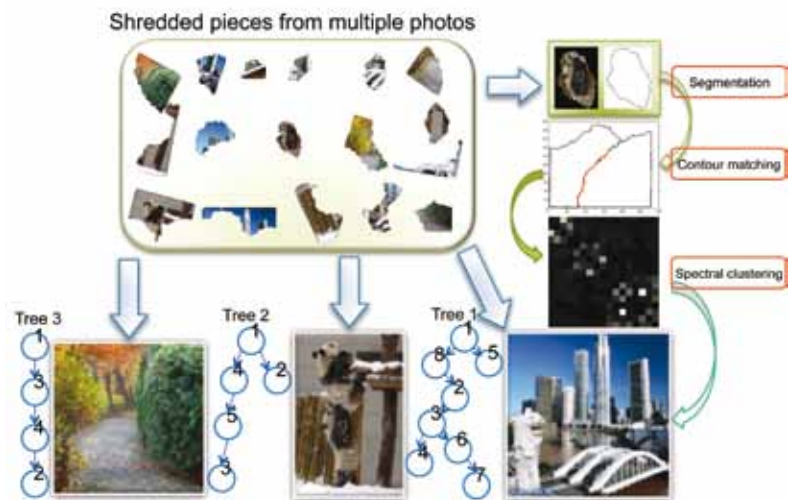


Figure 1: The flowchart of the system for assembling shredded pieces from multiple photos, including piece segmentation, contour matching, piece clustering and final spanning tree-based piece assembly.

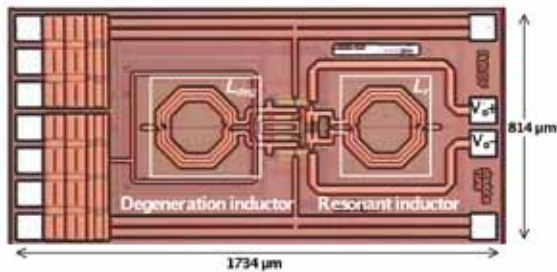


Figure 2: Dynamic caption benefits hearing-impaired audiences by presenting scripts in suitable regions, synchronously highlighting them word-by-word and illustrating the variation of voice volume.

# NOVEL SOLUTIONS FOR MILLIMETRE WAVE COMPONENTS: VARACTORLESS VCOS

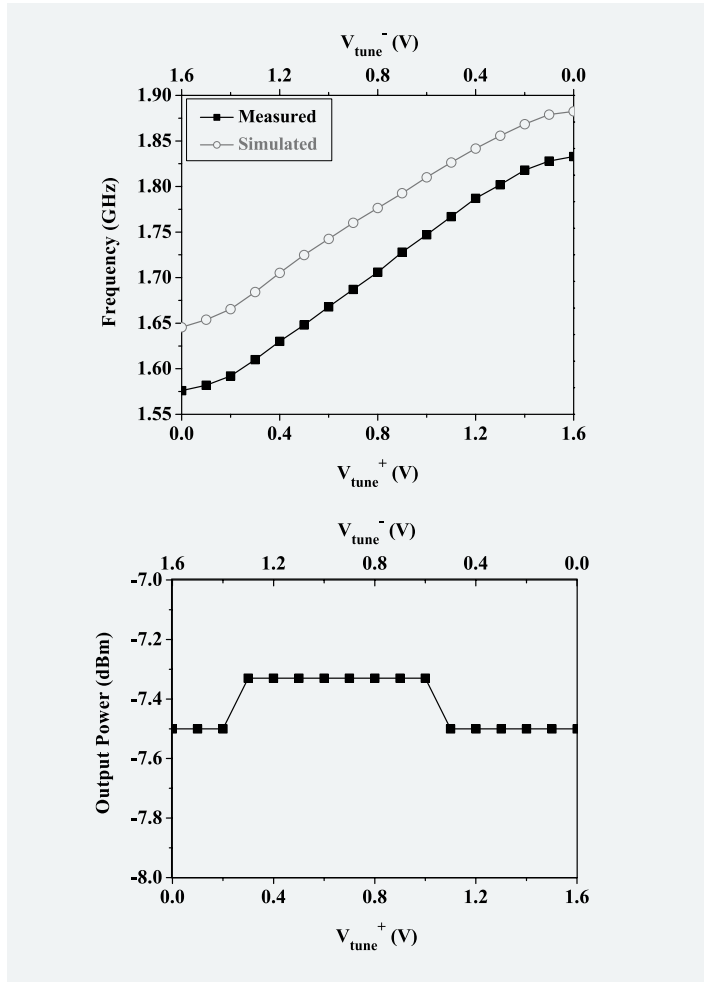
Due to demand for higher data rates in wireless communication systems, operating frequencies are being pushed higher and higher. Millimetre wave frequencies, such as 40 GHz and 60 GHz, are now considered for short-range, high data rate communication systems and positioning systems.

Designers of the necessary circuits and components increasingly face challenges at millimetre wave frequencies as the performance of constituent components rapidly deteriorates due to parasitics. Taking their cue from this development, a research group led by Asst Prof Koen **Mouthaan** is researching Voltage Controlled Oscillators (VCOs).

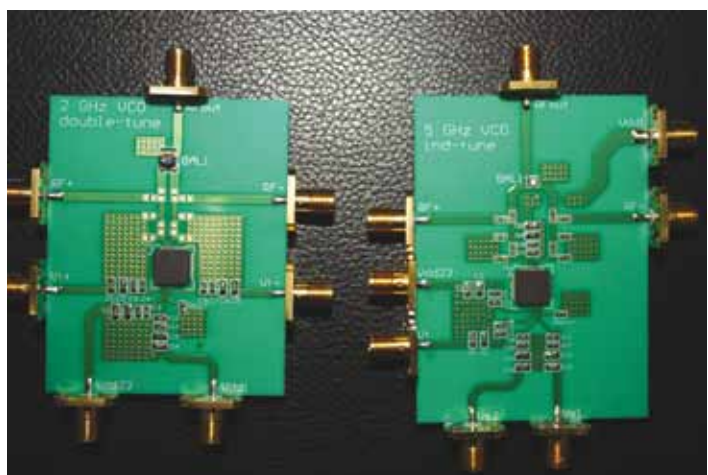


Varactorless VCO

VCOs traditionally use varactors as the tuning element to vary the frequency of oscillation. However, at millimetre wave frequencies, varactors exhibit significant parasitics that reduce their performance significantly. Dr Mouthaan's team explores novel solutions for the problems inherent in millimetre wave design. A varactorless VCO has been developed to demonstrate the feasibility of varactorless VCOs, which exhibit a 15% tuning range and an output power variation of only 0.2 dB over the tuning range. The technique is directly amenable to the design of millimetre wave oscillators.



Measured frequency and output power versus tuning voltage



Application demonstrators of the packaged VCO

# ECE GRADUATION NIGHT 2010

The ECE Department organised its first Graduation Night on 3 July 2010. The event attracted nearly 200 graduating students and their families, as well as ECE staff members.

It was a celebratory yet sentimental evening as a group of ECE3, ECE4 and PhD students put together a special programme that led us down memory lane on a nostalgic trip to the good old days on campus.

The night began with the welcome address by the Head of Department Prof **Chua** Kee Chaing in which he congratulated all graduates and their parents, encouraging the former students to become involved with their alma mater. The evening's entertainment programme started with a game of "Do you remember ECE" with enthusiastic participation from the audience. The game involved identifying places on Campus from sections of their photographs. The highlight of the night was the ECE professors' creative rendition of "Gaudeamus Igitur", a popular song mainly sung at university graduation ceremonies. Prof **Liew** Ah Choy rewrote the lyrics, creating a light-hearted composition with the message to the graduates: now armed with ECE knowledge, go forth, succeed and remember that you are ECE and NUS alumnus.

The audience was spellbound by the dance performance of Mr **Ganesh** Neelakanta Iyer, our PhD Student. He enacted an extract from the great epic "Mahabharata", where the Pandavas were living in the jungle after they were defeated in a game of dice.



Enthusiastic participation from the audience



Professors enjoying themselves



A scene from the great epic Mahabharata by PhD student Mr Ganesh Neelakanta Iyer





A band performance by ECE 4 students



A Chinese ballad by Mr Zhang Peng



Emcees Mr **Kee** Boon Chuan and Ms **Neha** Anna George



Everyone standing up singing Auld Lang Syne

A four-man live band by our ECE Year 4 students went into hyper-drive, while, alone in the spotlight, Mr **Zhang** Peng sang a beautiful version of the Chinese ballad 祝福.

The finale had everyone on their feet singing Auld Lang Syne while flashbacks that returned us to past events on Campus appeared on the screen. To all that were present, it was an unforgettable night.

## ECE ALUMNI FAMILY DAY 2010

The ECE Department held its 3rd Alumni Family Day on 14 August 2010. The event attracted nearly 150 alumni members and their families, as well as present and past ECE staff members.

Gracing this year's event was President of TECH Semiconductor Pte Ltd, Mr **Lee** Kok Choy, who is the recipient of the 2010 ECE Distinguished Alumni award, given by the Department. This award recognises outstanding ECE alumni who have distinguished themselves, nationally or internationally, by their excellent, sustained contributions and achievement in public and community service, entrepreneurship, or in a professional or scholarly field.

The day began with a tour of the Department's Interactive Multimedia Lab and Mechatronics & Automation Lab. Our alumni had the opportunity to see the latest developments in robotics and interactive mixed reality technologies, spearheaded by ECE faculty.



Alumni enjoying the lab tour

Running in parallel with the lab tours was a seminar for our investment-savvy alumni, given by a senior fund manager from Phillip Securities, Mr Anthony **Hoe**. There was also an interactive storytelling programme for the kids, who were further spoilt with free flow of candy floss, face painting and Henna art. The ladies, in particular, watched some cooking demonstrations, including a lesson on making kaya (a Malay word for a local favourite – coconut egg jam) in just 15 minutes.

In his welcome address, Head of Department, Prof **Chua** Kee Chaing, spoke about recent developments and achievements of the Department and encouraged ECE alumni to be more involved with their alma mater. Mr **Lee** Kok Choy then took the stage to share his experiences as an emerging leader in the semiconductor industry and to receive the ECE Distinguished Alumni award.

At the end, everyone was treated to a sumptuous buffet lunch, followed by a lucky draw that gave many alumni much to cheer about.

For many, attending the ECE Alumni Family Day was time well spent. It meant renewing old ties and building new ones amongst ex-classmates, as well as between alumni and their alma mater. In the days that followed, thank-you messages flowed in from ECE alumni. Mr Melvin **Low**, CEO of Equvo Pte Ltd, in particular, wrote: "It was great to reconnect with our alma mater and to see the vast changes it has gone through since we graduated 24 years ago. The lab tour was enlightening and the speeches were short but informative enough to tell us what has progressed through the years. We'll look forward to attending the next one, next year. Thank you once again for the invite. It was time well spent on Saturday for my son and me."



Alumni members networking



Prof **Liew** Ah Choy and an alumna's son



An alumna's daughter enjoying candy floss



Mr Lee Kok Choy receiving the ECE Distinguished Alumni Award from Prof Chua Kee Chaing



The sumptuous buffet lunch



An alumna collecting his lucky draw prize



An alumna renewing ties with ECE staff members



# UNDERGRADUATE STUDENTS' ACHIEVEMENTS



Ong Wee Ling

**Ong** Wee Ling received the 1st prize at the IEEE Region 10 Undergraduate Student Paper Contest in September this year for her paper: "New solutions to EM scattering by a gyrotropic sphere". Prior to this award, she received the IEEE MTT-S Undergraduate/Pre-Graduate Scholarship earlier in March for the same paper.

In this work, Wee Ling employed a multiple scattering spheres approach to derive new solutions to the electromagnetic scattering of plane waves by a 3D gyrotropic sphere. The approach involved jointly examining both gyroelectric and gyromagnetic characteristics. While this approach leads to solutions more complicated than those for the scattering of plane waves by a single uniaxial, gyroelectric or gyromagnetic sphere, they are very general and are capable of dealing with electromagnetic fields of arbitrary incident angle and polarisation. In particular, they reveal some previously unknown features of the gyrotropic sphere.

Wee Ling's work can potentially be applied in microwave and RF cloaking. Further, the present formulations can be easily extended to other scenarios, such as a coated conducting sphere, a layered sphere and multiple spheres consisting of hybrid gyroelectric and gyromagnetic spheres. This work was carried out under the supervision of Prof Joshua **Li**, who is now her PhD advisor.



Team photo

An NUS team comprising **Jiang** Xueqian (ECE), **Long** Xiaoxing (ChE) and **Wen** Di (Physics) clinched the champion title (University/ Poly Category) at the Amazing Science X Challenge 2010.

Jointly organised by Singapore Science Centre, DSO Laboratories and the NUS Faculty of Science, the challenge encourages creative thinking, requiring participants to design a stand-alone device that best demonstrates a science principle.

Certain materials are optically active because of their chemical structures. When linearly polarised, light passes through an optically active material, and its direction of polarisation is rotated. The angle of rotation is wavelength dependent. This demonstration, therefore, aims to show the effect of optical rotation of white light.

The demonstration is constructed using a motor with a rotation that will move the polariser landing upon it, causing an automatic rotation of light beams. The high-power LEDs enable a great contrast between the outer environment and the syrup container. Most importantly, it save precious space in the demonstration. In addition, a further two polarizing disks generate mechanical rotation so that the audience can experience the effect first-hand. When the LEDs are turned on, the light coming into the syrup tube will rotate in two different directions, each of which is dependent on the distance travelled. This will cause a phase angle between the two rays, and after passing through the polariser, such a difference will be reflected and will be picked up by the rotational angle of the polarising disk. Only the light with the correct phase angle as that of the rotational disk will be allowed to pass out from the syrup tube. Therefore, by rotating the disk, the light reflected onto the inside walls will be seen to exhibit various colours. Similarly, the light inside the tube will be seen by an effect of superposition, and the light will rotate upwards with different colours, similar to a barber's pole.

The NUS team was guided by Dr **Liaw** Hwee Choo; Dr Liaw is a lecturer with the Faculty of Engineering's Design Centric Curriculum (DCC).



Set-up of the demonstration



# GRADUATE STUDENTS' ACHIEVEMENTS



## FANG WEIWEI LINA (MEng student)

Fang Weiwei Lina received the 4th Taiwan Semiconductor Manufacturing Company (TSMC) Outstanding Student Research Award (Commendation) in August this year for her contributions to physics and chemistry of electronic materials, embodied by her winning entry: "Phase change memory engineering and integration with CMOS technology". Her work, which was among 37 winning entries (chosen from a total of more than 200), opens the door to phase change memory device integration with CMOS technology by exploiting the characteristics of the energy band alignment in phase change materials. A potential application of this work is in the identification of new chalcogenide materials for information storage devices. Lina is supervised by Dr **Yeo** Yee Chia.

## ZHANG SHAOLIANG (PhD student)

Zhang Shaoliang is one of ten recipients of the 2010 Graduate Student Fellowship awarded by the IEEE Photonics Society. This fellowship recognises Shaoliang's outstanding contributions in the field of optical communications, having published 20 first-author papers over the last three years on carrier phase estimation in coherent optical phase-modulated communication systems. The award includes a USD 5,000 cash prize and an invitation to attend the Photonics Society 2010 annual meeting. Shaoliang is supervised by Dr **Yu** Changyuan and Prof **Kam** Pooi Yuen.



## CHEN YING (PhD student)

Chen Ying is one of three recipients of the Gallium Arsenide Application Symposium (GAAS) Association Student Fellowship 2010 for his paper "A Varactorless VCO with 15% Continuous Frequency Tuning Range and 0.2 dB Output Power Variation". His fellowship was presented at the 2010 European Microwave Integrated Circuits Conference (EuMIC). Chen Ying's work, which was selected from over 100 papers presented at EuMIC, proposes a new varactorless wideband LC VCO based on a tunable negative inductance cell and a tunable negative capacitance cell, whilst keeping the bias currents through the core circuits the same, limiting variations in the VCO output power. The proposed frequency-tuning technique is suitable for microwave and millimetre-wave applications. Chen Ying is supervised by Dr Koen **Mouthaan**.

## XIN MAOQING (PhD student)

Xin Maoqing received the 1st prize at the IEEE Region 10 Postgraduate Student Paper Contest in September this year for his paper: "High speed electro-optic phase shifter based on a lateral P-G-N diode capacitor". The proposed phase shifter exploits the highly efficient spatial overlap between the optical field and carrier plasma in a P-G-N diode capacitor to provide a significantly improved 3 dB transmission bandwidth at 17.5 GHz and modulation efficiency of 6.2 V-cm, compared to other existing designs. This device is particularly suited for low-cost, on-chip integrated photonic systems in high-speed optical communication networks and core networks. Maoqing is supervised by Dr Aaron **Danner**.



# THE ELECTRICAL & COMPUTER ENGINEERING (ECE) CLUB... WHO ARE THEY?

To someone who has simply heard about the ECE Club, it may sound like just another club of engineering students from the ECE Department. However, ask anyone who has ever attended their events or participated in one of their many colourful competitions, and you will quickly discover that the ECE Club is about so much more!

The Club began humbly as the Electronics Club and has steadily grown in strength each year to become what is now known to its 300 plus members as the ECE Club. Predominantly made up of ECE students, it is also open to engineering students from different departments, forming one of the largest student bodies in the Faculty of Engineering. All members appear to share certain things in common – a passion for engineering and technology, as well as a desire to find something meaningful outside of their studies that will help to complete their university experience.

The ECE Club's mission is simply this: "to provide a platform for members to engage in activities that go beyond academic studies, to have opportunities to develop enriching life skills through volunteer leadership and to build strong bonds and networks with peers". By organising various events, from the ice-breaking Member's Day at the start of every academic year to past paper sales just before the semester's final examinations, they seem to be achieving just that.



Welcome to the Family!



Perhaps one of the largest events that the Club organises is the aforementioned Member's Day. This is the first event that most new members will attend, and it is particularly important for first-year students as it is a great way for them to mingle and make friends with seniors from their department. The event also serves to introduce the vision of the Club and its activities to all new members.

Another of the Club's aims is to assist members with academic issues by organising workshops and past paper and book sales, giving students that extra boost to stay ahead in their studies. Guest lecturers are often invited to speak at the workshops.

Organising any event requires volunteers and a dedicated committee. The ECE Club therefore provides the opportunity for students to take on leadership roles by joining the Club's exco. There is a total of 39 exco members that make up eight key departments of the Club.

The ECE Club tells us that they are very much looking forward to another year of new exciting events and that they are expecting to nurture and grow the Club in terms of numbers and the experience that they can offer engineering students.



Member's Day 2010



Matlab Workshop

# ECE CLUB EVENTS FOR SEMESTER 2, AY2010/2011

## INDUSTRIAL TRIP TO IBM

A one-day trip is planned with the primary objective of enhancing participants' understanding of how their contextual knowledge can be applied within real industrial production. It will also allow attendees to learn more about the local electronics industry, allowing them to make more informed decisions concerning their future career plans. The date of this event and registration instructions will be broadcast to all students via email shortly.

## ECE BAZAAR

It's time for great bargains once again! The three-day annual ECE Bazaar will be held from **12-14 January 2011** at the **NUS Central Forum**. This year, the Bazaar will feature a large variety of booths as well as special performances and shows during the lunch hour. So come on down, and remember to bring all your friends!