



MEET PETIMO - SOCIAL NETWORKING ROBOT FOR CHILDREN

THREE ECE STUDENTS
HAD THE OPPORTUNITY
TO SHOWCASE SOME
OF THEIR WORK ON ELECTRONICS
AT THE LAUNCH AND BRIEFING
SESSION OF 'ELECTRONICS FOR THE
COMMUNITY' ON 31 MARCH 2010.

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AN INTERVIEW WITH ONE
OF OUR DISTINGUISHED
ALUMNI MR LEE KOK
CHOY, THE PRESIDENT OF TECH
SEMICONDUCTOR SINGAPORE.

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THREE OF OUR
GRADUATING STUDENTS
SHARE THEIR FINAL
YEAR PROJECTS WHICH WON THEM
THE 'HIGH ACHIEVEMENT AWARD'
(INDIVIDUAL) IN THE 24TH FACULTY
INNOVATION & RESEARCH AWARDS.

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CHILDREN AS YOUNG AS SEVEN YEARS OF AGE ARE NOW
ABLE TO EXPERIENCE A SAFE AND FUN ONLINE SOCIAL
ENVIRONMENT WITH THE WORLD'S FIRST INTERACTIVE
VIRTUAL AND REAL-WORLD SOCIAL ROBOT.

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MESSAGE FROM THE HEAD OF DEPARTMENT



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

“EE will continue to significantly shape our world going forward as we tackle current important problems such as climate change, dense urban living, ageing societies and the spread of infectious diseases.”

I am pleased to present the inaugural issue of *E.ConnEct*, the NUS Electrical & Computer Engineering (ECE) Department's biannual newsletter. As its name suggests, *E.ConnEct* aims to connect with and keep ECE's stakeholders, friends and future students abreast of the Department's plans and developments, and the achievements of our staff, students and alumni. I hope that you will enjoy reading this inaugural issue and we welcome your feedback and comments on how we might improve on the contents and/or presentation of future issues.

The field of Electrical Engineering (EE) today is very diverse, spanning sub-disciplines such as telecommunications, signal processing, micro/nano-electronics, control and intelligent systems (including robotics), and power and energy systems. Over the years, each of these sub-disciplines has grown and shaped the world that we live in today. For example, we have come to take the Internet and smart mobile phones for granted. Our computing power has increased by leaps and bounds while continuing to miniaturise in size, resulting in smart mobile phones today having much more computing power than many of the mainframe computers of early years. EE will continue to significantly shape our world going forward as we tackle current important problems such as climate change, dense urban living, ageing societies and the spread of infectious diseases. At first glance, these new challenges do not seem to be related to the field of EE. However, think about how we can mitigate further climate changes through the use of renewable energy sources, and the importance of EE comes to the fore in power electronics in electric vehicles, conversion of solar/wind/tidal energy to electrical energy, and the efficient distribution of electricity through the smart grid. Similarly, EE will advance technologies in bio-electronics, ambient sensing and intelligence, robotics, etc. to contribute to helping solve problems in healthcare, sustainable cities, etc. Clearly, what is required is for future EE graduates to be equipped to work with experts in other fields, as many of these problems require multi-disciplinary solutions. This is exactly what we aim to do with our new BEng(EE) programme that we will be rolling out from August 2010.

It is now Commencement time and our EE and Computer Engineering classes of 2010 will be graduating. I congratulate them on their achievements, of which they and their families have every reason to be proud. The economic outlook is now brighter and, in particular, the electronics manufacturing sector is again growing strongly. This is a good time to embark on their professional careers, and on behalf of all of us at NUS/ECE, I wish them well.

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

Photography Mr Abdul Jalil Bin Din

Advisor Prof Chua Kee Chaing

NEW MANAGEMENT AND CHANGES TO GROUP STRUCTURE

ECE DEPARTMENT'S NEW MANAGEMENT TEAM

On 1 January 2010, ECE HoD Prof KC Chua appointed the following faculty staff as Deputy Heads with the following portfolios.

Deputy Head (Undergraduate Programmes)

– Assoc Prof **Loh Ai Poh**



Prof Loh is the Deputy Head for undergraduate programmes. In this role, she will lead in making the necessary changes to our Electrical Engineering and Computer Engineering curricula to enhance student learning and to tighten the linkage between disciplinary knowledge and practice. She will also steer ECE to play a major role in the Faculty's new Design Centric Curriculum, working closely with colleagues from other Departments to deliver on this.

Deputy Head (Research & Graduate Programmes)

– Assoc Prof John **Thong**



Prof Thong has served on numerous grant evaluation panels both within and outside NUS, and has a very good view of the local research funding landscape. He also has experience working with colleagues across campus. In this role, Prof Thong will draw on these experience to help build up a small number of multi-disciplinary programmes that will deliver on the Faculty's strategic research programmes of Engineering in Medicine, Smart Sustainable Cities and Future Transportation Systems, while simultaneously enhancing ECE's already strong investigator-led research and graduate education.

Deputy Head (Administration)

– Prof **Choi Wee Kiong**



Prof Choi has been appointed as the Deputy Head for administration to improve the general administration of the Department, including optimising use of space, human and budgetary resources in support of ECE's research and education activities. In addition, he will now oversee efforts to improve ECE's ties and communications with alumni and other stakeholders.

Deputy Head (Student Outreach & International Relations)

– Prof **Lee Tong Heng**



As the Deputy Head for student outreach and international relations, Prof Lee will continue in his efforts to excite and attract high-quality students to ECE. In addition, he will help ECE build up strategic linkages with peer departments in major global universities and research institutions to further enhance ECE's profile and make ECE attractive to high-quality faculty and students.

CHANGES TO DEPARTMENT GROUP STRUCTURE

The previous four *Groups* to which faculty staff belonged have now been expanded into seven focussed *Areas*. These are each led by an Area Director (in brackets) as follows:

- **Communications & Networks**
(Prof **Kam Pooi Yuen**)
- **Signal Processing & New Media**
(Assoc Prof **Cheong Loong Fah**)
- **Control, Intelligent Systems & Robotics**
(Prof **Xu Jianxin**)
- **Power & Energy Systems**
(Assoc Prof **Sanjib K Panda**)
- **Microwave & RF**
(Prof **Yeo Swee Ping**)
- **Microelectronic Technologies & Devices**
(Prof **Wu Yihong**)
- **Integrated Circuits & Embedded Systems**
(Assoc Prof **Lian Yong**)

The Area Directors will lead in developing their Areas to achieve international recognition of excellence. They will also work closely with one another and the Deputy Head (Research & Graduate Programmes) to plan, develop and ensure the success of the Department's flagship programmes, which are integrative research programmes that use ECE capabilities to solve important societal problems of high impact such as those identified by the Faculty's three strategic themes of Engineering in Medicine, Future Transportation Systems, and Smart Sustainable Cities.

PROMOTIONS, NEW APPOINTMENTS AND MENTORSHIP

CONGRATULATIONS FOR PROMOTION AND TENURE

Our congratulations to the following faculty staff on their successful application for promotion and tenure.

Promotion to Associate Professorship with tenure with effect from 1 Jan 2010:

- Dr Marc Andre **Armand**
- Dr Mehul **Motani**
- Dr **Xiang** Cheng

NEW FACULTY APPOINTMENTS

We welcome the following new faculty staff who have joined the ECE family since 1 Jan 2010.

DR STEPHEN **HANLY** joined ECE as a tenured Associate Professor on 4 Jan 2010. Prof Hanly was before this, an Associate Professor and Reader in the Department of Electrical and Electronic Engineering at the University of Melbourne. He received his BSc (Hons) and MSc from the University of Western Australia, and his PhD degree in mathematics in 1994 from Cambridge University, U.K. His research interests are in information theory, signal processing and wireless networking.

DR **ZHANG** RUI joined ECE as an Assistant Professor on 11 Jan 2010. He holds a joint appointment between ECE and the Institute for Infocomm Research under the A*STAR Academia Pathway Scheme for NSS scholars. Dr Zhang obtained his PhD in 2006 from Stanford University and his research is mainly in wireless communications, covering multiple-antenna systems, relay-cooperative communications and cognitive radio communications.

DR **KANG** KAI joined ECE as an Adjunct Assistant Professor on 4 Jan 2010. Dr Kang is currently a Senior Research Engineer at the Institute of Microelectronics. He obtained his PhD in 2008 under the joint NUS-Supelec PhD programme and his main research interest and expertise is in microwave and RF CMOS integrated circuit design, device modelling, antenna design for millimetre ICs, and low power integrated wireless sensors in biomedical applications.

DR **LEONG** YOKE CHOY VINCENT joined ECE as an Adjunct Assistant Professor on 1 February 2010. Dr Leong is Head of the Micro-Systems Laboratory at DSO National Laboratories. He obtained his PhD in 2000 from the University of Massachusetts, U.S.A and his research interests are in the areas of MMIC/RFIC design and modelling, synthesis and analysis of novel passive structures including baluns, couplers and hybrids.

ECE DEPARTMENT LAUNCHES MENTORING PROGRAMME FOR FACULTY



Launch of the Mentoring Programme.

ECE launched its mentoring programme for non-tenured junior faculty on 16 April 2010 with an informal lunch session held at the Hibiscus Lounge. ECE Head, Prof KC Chua, announced the launch of a faculty mentoring website in the ECE intranet with biographies of mentors for mentees to identify potential mentors. The department intranet also features an online discussion forum for mentors and mentees to share and exchange ideas on faculty mentoring. Prof Chua also informed that the department would organise regular informal tea sessions for all mentors and mentees to mingle and interact in a group setting to exchange ideas, share experiences and foster friendships.

The ECE Mentoring Programme aims to help, through proper advice and guidance, junior faculty adjust to the local environment quickly and to achieve career advancement in the University. The programme calls upon mostly senior faculty who are keen to assist and guide their younger colleagues to volunteer their time. The informal and voluntary nature of the programme allows junior faculty to opt out of the programme if they so desire.

A FOND FAREWELL

ECE bade three of our senior professors, PROF **LING** CHUNG HO, PROF **CHONG** TOW CHONG and ASSOC PROF RAMESH **ORUGANTI**, farewell in June 2010. Prof Ling and Prof Oruganti are retiring while Prof Chong will be leading the Singapore University of Technology and Design (SUTD) as the founding Provost. As veterans of the Department, Prof Ling, Prof Chong and Prof Oruganti have been with ECE for 32, 29 and 21 years, respectively.

Prof Ling was an ECE pioneer at Kent Ridge Campus. His significant contributions have gone a long way in elevating the profile of ECE, facilitating the global recognition we enjoy today. Also, his early and continuing contributions in the development of our first microelectronics clean room and research in microelectronics paved the way for newer generations of researchers and students alike, all of whom have benefitted from his leadership and guidance.

Prof Chong has received numerous research and teaching awards for his outstanding contributions in the areas of semiconductor materials & devices, processing technology and optoelectronics. As the previous Executive Director of the Science and Engineering Research Council (SERC), he has been instrumental in strengthening the linkage between the Agency for Science, Technology and Research (A*STAR) institutes and NUS.

Prof Oruganti's dedication to students and teaching has been his hallmark and ECE is fortunate to have had him spearhead and steer the area of power electronics. Our younger staff have also benefitted from his leadership and wisdom. During his tenure as Head of the then Drives & Power Division, he increased the profile and significance of the division to its level of importance today.



Prof Ling (left) accepting a token of appreciation from Prof Chua (right).



Prof Chong (left) accepting a token of appreciation from Prof Chua (right).

INTERVIEW WITH ASSOC PROF ORUGANTI



Prof Oruganti recalls that he joined ECE in 1989, inspired by the personal satisfaction he still derives from teaching. In particular, he enjoys the opportunity to interact with young, bright minds found in a University.

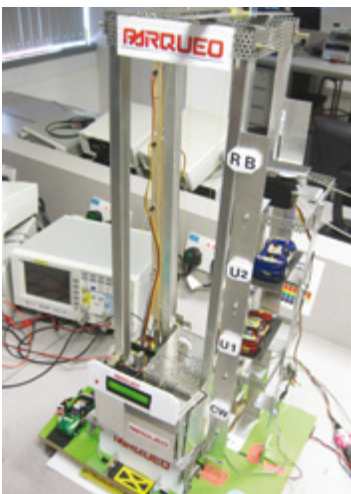
Prof Oruganti cherishes his classroom teaching experiences, counting them among his favourites of the many pleasant memories that he will leave ECE with. Stating his best wishes for the Department, he hopes that ECE will continue to attract top class talent in both students and faculty.

When asked about the philosophy he lives by, Prof Oruganti indicated that treating everyone equally is a tenet he holds close to his heart.

EE PROGRAMME GETS A MAKE-OVER

Change is in the air for the Electrical Engineering (EE) programme. Starting from academic year 2010/11, a revised curriculum will be offered to all first year students admitted into the Bachelor of Engineering (Electrical Engineering) programme. Hard work by our faculty members over the last year has enabled us to introduce the new curriculum this August.

The new curriculum is motivated by several factors: providing more hands-on opportunities to motivate the learning of engineering knowledge, stressing the integration of core concepts, increasing emphasis in design and engineering problem solving abilities and strengthening programming skills. Students will be engaged in teamwork, thus honing writing and communication skills. Open ended problem solving and design opportunities will also enhance thinking skills and improve overall confidence. On the whole, the changes are relevant and exciting and should draw increased interest to the EE programme in the years to come.



Prototype of an automatic parking system built by Year 3 students.

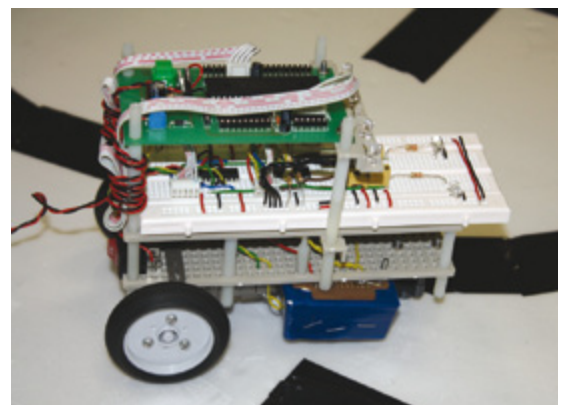
The most significant change will occur in the freshman year where several new modules will be offered. One unique module called Emerging Technologies in Electrical and Computer Engineering (ECE) has been designed to introduce students to the key technologies which have played significant roles in achieving the advances in ECE. This should inspire students to understand and appreciate the need for engineering knowledge to solve the grand challenges faced today. Two other modules: Introduction to Circuits and Systems and Introduction to Signals and

Communications, will allow students to engage with major concepts in ECE in an integrated and hands-on manner. In the first module, students will get their first exposure to using electrical components and equipment to build circuits and systems such as a robot or an autonomous vehicle. The experience in the second module revolves around constructing wireless communications systems in the lab and exploring the problems related to sampling and signal reconstruction. The two modules together will prepare and motivate students to learn more engineering knowledge and concepts in their higher years.

In the second year, building on the experiences of the first year, students will pursue core knowledge through a number of modules. In particular, two new lab modules will be designed to help students apply and make connections between core concepts in digital and analog electronics, energy systems, signals and linear systems. The lab sessions will culminate

in open-ended problem solving projects to allow students to apply their newly acquired knowledge. The third and final years will see students working on more complex projects while they embark on their journey of discovery in the various specialisations. Our specialisation modules cover a broad range of sub-disciplines. Faculty members will be working hard to develop elective modules which are contemporary, and in some cases, involving more than one sub-discipline. The project modules will be a 2-module sequence and can be expanded to form a 3-module sequence for some passionate and innovative students. The 2-module sequence will expose students to product design before they begin the prototyping process. This more holistic approach allows students to explore the broader perspectives involving user-oriented design, marketability, sustainability and affordability. For ambitious students, the projects can be expanded into a multi-disciplinary team based project involving the industry. Students will be encouraged to propose solutions for the grand challenges which have been identified by the US National Academy of Engineers. Internships are also valuable opportunities for the new incoming students.

Overall, the changes in the new curriculum will be exciting and engaging for students. It is expected to anchor students firmly in engineering problem solving and synthesis skills involving hardware and software. It will also prepare students well for research.



Track – seeking vehicle built by Year 1 students.

ECE FACULTY RECEIVE ANNUAL TEACHING EXCELLENCE AWARD (ATEA)

Education has always been at the forefront of the mission of the ECE Department, and some recent university level awards received by ECE faculty have recognised the extraordinary efforts that our faculty exhibit in teaching our students. ATEA identifies teachers who qualify as educators who facilitate learning that is of value even outside the boundaries of their specific disciplines and professions. Such teachers help learners to acquire not only discipline-/profession-specific knowledge and abilities, but also the ideas, mental capacities, mindsets and habits we expect every university graduate to have, regardless of their areas of specialisation.



PROF **LEE** TONG HENG has received the ATEA award for the second time this year for his outstanding teaching, dedicated commitment and leadership in innovative curriculum development. Prof Lee is a passionate teacher who uses a wide variety of media to actively engage his students and maximise

student learning in an interactive manner. Prof Lee also received this year's Faculty of Engineering's top "Engineering Educator" award for the second consecutive year.



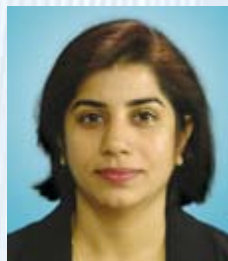
ASSOC PROF ANJAM **KHURSHIED**'s teaching initiatives over the years have concentrated on developing foundation-level courses which introduce fundamental principles of electrical engineering through hands-on experimentation and historical case studies. Using multimedia and live demonstrations, Prof Khursheed explains fundamentals and gives demonstrations

of many of his own creations. In his classes, students are challenged to create their own circuits from simple materials, designing and making their own instrumentation amplifiers and other measurement devices, and analyse them using LabView to transfer the data on a computer. Prof Khursheed's teaching techniques inspire students not only to master the material he teaches, but also to appreciate the intimate link between engineering innovation and the physical world.



ASSOC PROF **LIAN** YONG employs a four-in-one teaching strategy that effectively enhances learning in a large class. The proposed strategy advocates personalised teaching and learning by extensively using information technologies. It seeks ways to increase the effectiveness and enhances the learning experience in a large class

through the use of conceptual learning, adaptive teaching, adaptive tutoring, and experiential learning. The proposed teaching strategy makes learning more effective, efficient, meaningful and joyful in a large class. The e-Learning tools developed by Prof Lian, e.g., eLearning Hub and LearningVista, not only support the new teaching strategy but also make it possible to resemble the process of one-to-one instruction in a large classroom. Prof Lian has previously won the Faculty of Engineering's Innovative Teaching Award for his innovative teaching methods.



ASSOC PROF DIPTI **SRINIVASAN** employs a variety of instructional techniques to create new learning environments and explore innovative application of new methods which help to make the learning process more effective and better adapted to student needs. The power of technology is combined with proven instructional

design and innovative approaches. She has developed the course material, on-line tutorials, animations and quizzes in order to develop a series of interactive tutorials and demonstrations for teaching her courses. These comprehensive and wide-reaching instruction tools complement and extend the curriculum and encourage critical thinking. Prof Dipti has also been placed on the Honour Roll for winning the ATEA award for the third time to honour her sustained high performance in teaching.

ELECTRONICS FOR THE COMMUNITY

Three ECE students had the opportunity to showcase some of their work on electronics to groups of enthusiastic upper secondary and pre-university students at the launch and briefing session of 'Electronics for the Community' on 31 March 2010. These innovators wowed the crowd with demonstrations of how their work could be applied to help the elderly.



Welcome Address delivered by Prof Chan Eng Soon, Dean, Faculty of Engineering.

Held at LT3 in collaboration with Agilent Technologies, Southwest CDC and River Valley High School (RVHS), the theme for this year is "Assistive Electronics for the Elderly". It provides the opportunity for students to be immersed in the development, design and implementation of technology that can solve a life challenge for the benefit of humanity. The teams involved will chalk up a number of hours doing community work at the unit they are assigned to, and in the process, identify the problems that can be solved with electronics. Subsequent brainstorming sessions allow students to conceptualise ideas and put them to paper. Selected teams will also have a chance to take their projects further by being involved in prototyping, testing and the manufacturing process.

After an opening speech by the Guest-of-Honour Prof **Chan** Eng Soon (Dean, Faculty of Engineering) and words of encouragement by Mr Mike **Kawasaki** (Worldwide Education Manager, Agilent Technologies) and Ms Karen **Wong** (Manager, Southwest CDC), the audience was briefed on the project and got to see some of our students' works including a project designed to watch over the safety of the elderly (a NUS NGS project), new low-cost hearing solutions and 'e-Guardian'.

As Prof **Lee** Tong Heng (ECE Deputy Head for Student Outreach and International Relations) summed up, "It is certainly gratifying and meaningful for us to be also able to contribute to society as part of our NUS ECE's outreach."

The event certainly inspired a great many of the participants. As of 27 April 2010, twenty-five teams (of three or four students per team) from River Valley High School, Cedar Girls, Victoria Junior College, Hwa Chong Institution, Raffles Junior College and Meridian Junior College have registered. We look forward to the projects ahead, as well as the competition, for the participating teams in January 2011.

The launch was made successful thanks to the invaluable contributions of our co-organisers: Agilent Technologies, who sponsored the prizes and gave representation in the panel of advisors and judges; Southwest CDC, who facilitated the interaction of the teams with the elderly around the Boon Lay area; and RVHS, who co-ordinated work within the schools in the west zone.



Students paying attention to the speech by Mr Mike Kawasaki, Worldwide Education Manager, Agilent Technologies.



Group photo of staff from NUS-ECE, Agilent Technologies, Southwest CDC & school teachers.

ADVANCED MEMORY LAB SPEARHEADS NEW RESEARCH

Explosive demand for non-volatile memory products with ever-increasing storage capacity has driven the scaling of the flash memory device to sub-30 nm dimensions. Conventional flash memory technology, however, encounters immense scaling challenges. Therefore, there is strong motivation to develop the next generation of non-volatile memory technologies that might replace flash memory.

A new Faculty of Engineering (FoE) joint laboratory with the Data Storage Institute (DSI), known as the "Advanced Memory Laboratory", was recently set up to spearhead advanced research into non-volatile memory and logic devices. Key members (shown in the picture) of this lab have recently been awarded major research grants by A*STAR SERC through an Advanced Memory Research Programme (\$\$10 million over three years).

The joint laboratory will embark on three main foci, namely phase-change random-access memory (PCRAM), resistive random-access memory (RRAM), and spin torque transfer magnetic RAM (STT-MRAM). The research programme will be led by ECE's Dr **Yeo Yee Chia** to push the boundaries of advanced memory technologies.



Key members of the FoE-DSI Joint Lab on Advanced Memory and Logic Devices

(From left to right) Dr Viloane Ko (DSI), Dr Randall Law (DSI), Assoc Prof Tom Liew (DSI), Assoc Prof Teo Kie Leong (ECE), Dr Rong Zhao (DSI), Dr Luping Shi (DSI) and Dr Yeo Yee-Chia (ECE). Research activities are funded by A*STAR SERC.

The programme spans fundamental materials studies to integration with logic technologies. Other members of the programme include Prof **Yoon** Soon Fatt, Prof **Pey** Kin Leong, Assoc Prof **Sun** Xiaowei and **Yu** Hongyu from Nanyang Technological University and Dr **Chia** Ching Kean from the Institute of Materials Research and Engineering.

FRONTIERS IN MAGNETIC RECORDING RESEARCH: VISION FOR 10 TERABITS PER SQUARE INCH

The data storage industry continues to experience a remarkable 40% compound annual growth rate. The US based Information Storage Industry Consortium (INSIC) has recently moved their research target to 10 Tbit/in². ECE's Prof **CS Bhatia** has been involved in developing key research project ideas for this ambitious goal of the magnetic data storage industry. Prof Bhatia was previously recognised by INSIC with the Distinguished Contribution Award for leading a team in defining tribological



(Standing row from left to right) Dr Aaron Danner, Prof CS Bhatia, Assoc Prof Mamun Abdullah, Dr Hyunsoo Yang (Sitting row from left to right) Dr Qing-Hua Xu, Dr Dan Pickard, Assoc Prof Marc Armand and Dr MS Saifullah (Other co-PIs and collaborators were not present for the picture).

research projects for 10 Tbit/in², which puts the magnetic data storage technology roadmap beyond that of solid state memory, which is believed to become obsolete by 2017. Achieving this goal will require high-level, interdisciplinary scientific and engineering approaches to accomplish key tasks. Three different high-risk approaches were proposed by INSIC.

The NUS team, in collaboration with local and international researchers, has recently been awarded a major grant by the National Research Foundation to work on one of the approaches — Bit Pattern Media (BPM). The work will require fundamental research into the basic physics of magnetism of small structures as well as atomic and molecular level tribology. Moreover, it will push the frontiers of servo systems with dual/triple stage actuation and coding schemes for signal processing. If the scientific challenges can be worked out as proposed in the grant proposal, then it can be argued that the hard disk drive industry can remain viable in the long term.

Prof Bhatia and his team are hopeful and confident about creating breakthroughs in magnetic recording research in the 10 Tbit/in² magnetic data storage laboratory in ECE.

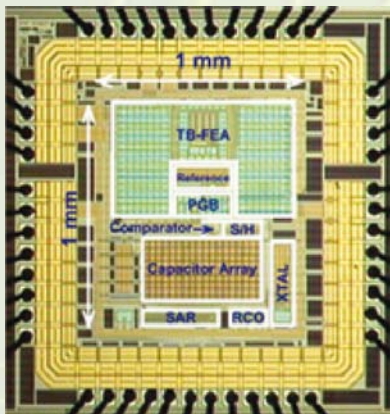
ECG-ON-CHIP PROVIDES ECG MONITORING ON-THE-GO

In one to two years, heart patients will be able to monitor their heart condition on-the-go and send ECG (electrocardiogram) results to their doctors remotely via mobile phone. This improvement in healthcare services will be made possible by a revolutionary 450 nanowatts fully integrated programmable interface chip, ECG-on-Chip, developed by a team of researchers led by ECE's Assoc Prof **Lian** Yong.

The ECG-on-Chip contains a low-noise amplifier with programmable gains of 45/50/55/60 dB, a patented low voltage tunable band-pass filter covering a frequency range of 4.5 mHz-290 Hz, a 12-bit ADC and an on-chip oscillator. The chip operates on a 1-V supply voltage and consumes only 450 nanowatts when configured for QRS (heart rate) detection. The low power consumption makes it possible to power the chip using the patient's body heat.

Keen to bring this revolutionary technology to market quickly, the research team has designed a prototype wireless ECG device based on the ECG-on-Chip, which acquires ECG signals from the human body through the chip, and transmits the data over a wireless link to a mobile phone or personal computer. In a bid to make the device truly mobile, the team is developing a plaster-based wireless ECG sensor that will allow the wearer to transmit ECG results remotely, negating the need for multiple time-consuming hospital appointments.

Assoc Prof Lian is currently exploring opportunities for commercialisation of the chip beyond its ECG application; it has the potential to be used in other biomedical devices such as the electroencephalogram (EEG), which records the electrical activity of the brain, and for devices used to monitor a person's respiratory rate.



Die photo of 450 nW ECG-on-Chip.



Wireless ECG Prototype.



Wireless ECG Sensor for Mobile Healthcare Application.

VISUALISING THE INVISIBLE – NEW ADVANCES IN OPTICAL RAY TRACING

A team of researchers led by ECE's Asst Prof Aaron **Danner** has been creating photorealistic images of metamaterials in action. The most intriguing of these are invisibility cloaks. Invisibility devices are hard to make. Real materials have an index of refraction of approximately $1 < n < 2.4$. Some perfect cloaking device designs require materials with an index of refraction of approximately *infinity*!

The gulf between what is needed and what is possible being rather large, it makes sense to look at less-than-perfect materials and how they would behave, not only for cloaking, but for all metamaterial devices. To that end, Dr Danner has developed software that can calculate complicated light ray trajectories through materials with gradient anisotropic indices of refraction.

Figure 1 shows how an imperfect invisibility cloak would look — one that could be built with real materials. It is not perfect, but it is not bad either (and it is interesting to see how it would actually appear). Figure 2 shows another type of device, a perfect imaging structure where all light emanating from a point gathers at another point. Being able to do that without resorting to negative refractive indices is important because it can beat the diffraction limit for imaging. Images from Dr Danner's team, such as those shown in Figures 1 and 2, have appeared on Discovery Channel, MSNBC News, in Laser Focus World, etc., and are important for garnering public interest in science and engineering.



Figure 1 (left) Original scene in the Chinese Garden. (right) Photorealistic depiction of performance of an imperfect invisible sphere with relaxed material requirements. Fabrication is plausible with dielectrics.

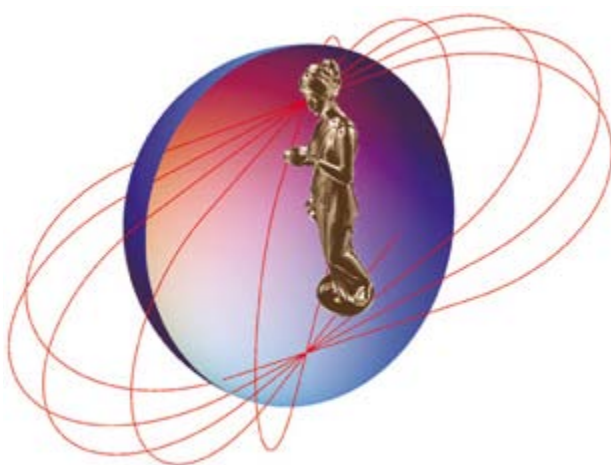


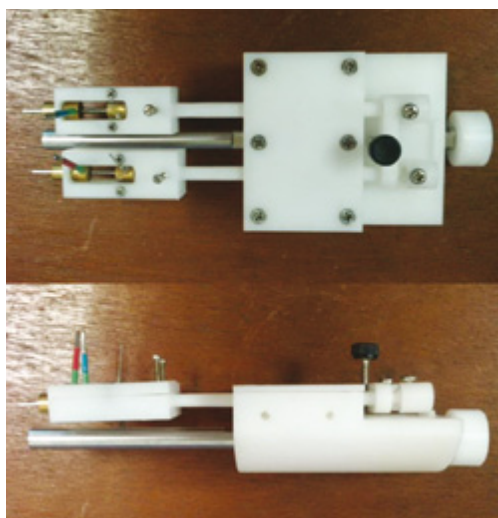
Figure 2 (left) The Greek goddess Hebe standing inside a region where $n=1$, holding a cup, and surrounded by a perfect imaging structure. (right) Hebe's view of the world consists of an inverted image of the back of her head, regardless of the direction in which she looks or the size of the room.

PORTABLE TISSUE MICRO-ARRAYERS

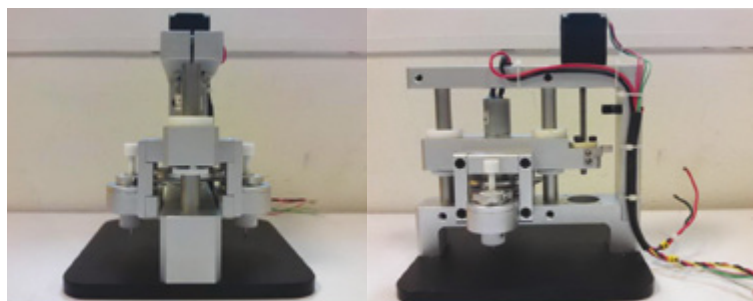
Tissue Micro Array (TMA) works based on the idea of applying miniaturisation and a high throughput approach to hybridisation-based analysis of tissues. It facilitates biomedical research on a large scale in a single experiment, thus representing one of the most commonly used technologies in translational research. TMAs consist of paraffin blocks in which hundreds to thousands of individual tissue cores are assembled in an array fashion to allow simultaneous histological, immunohistochemical and in-situ hybridisation.

In the creation of a TMA, a hollow needle is first used to punch tissue cores from a pre-defined region of a donor paraffin wax embedded tissue block with sizes ranging from 0.6 mm to 2.0 mm in diameter. These tissue cores are then transferred to a recipient paraffin wax block, into pre-formed holes at defined x-y positions. This technique minimises tissue damage and still allows sections to be cut from the donor paraffin wax block with all the necessary pathological details, even after the removal of multiple cores.

The main challenges with the creation of these TMAs lie in the precision control and instrumentation needed to complete this process accurately. To this end, commercial TMA instruments are available, but there are strict constraints associated with them, specifically in their portability, size, complexity and cost, limiting their usage mainly to "tissues-to-instruments" situations.

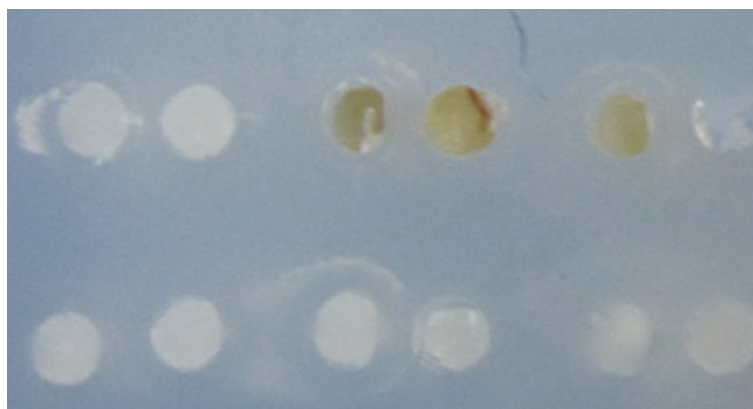


Manual TMA.



Semi-auto TMA.

A team of staff members from ECE (KK **Tan**, AS **Putra**, PL **Phuong** and TH **Lee**), along with staff members from NUHS (Manuel **Salto-Tellez** and LG **Kim**) collaborated to conceive and realise the idea of a portable TMA instrument which is low cost and configurable to enable the efficient collection of tissues, especially in "instruments-to-tissues" scenarios commonly arising due to institutional protocols. Two lightweight, portable and simple-to-use prototypes have been developed; a purely mechanical instrument requiring no energy source and a semi-automated version with a small footprint and running solely on batteries. A patent has been filed for the invention.



Array sample obtained with instrument.

MEET PETIMO - SOCIAL NETWORKING ROBOT FOR CHILDREN

Children as young as seven years of age are now able to experience a safe and fun online social environment with the world's first interactive virtual and real-world social robot (Figure 1).

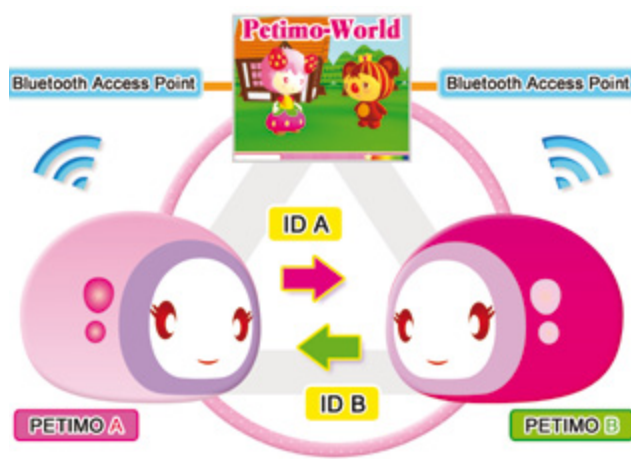


Figure 1 System description.



Figure 2 Physical friends adding feature with Petimo.

Parents can now feel safe and comfortable with their children using social networks because the friend-making must be conducted only in the physical world through the children's robot (Figure 2). An experience like no other, the robotic toy, named "Petimo", responds to touch and movement. Its outer finish is an adorable plush toy, and its small, round physical shape evokes a warm and tender feeling likened to carrying a baby animal.

Developed by a team led by ECE's Assoc Prof Adrian **Cheok**, the Petimo project has already been selected by an international review panel as one of the best three submissions for the Como for Children

(C4C) design competition held at the 8th International Conference on Interaction Design and Children (IDC 2009) during its debut in Europe. And recently, "Petimo" – social networking robot for children, won the first prize in an international innovation competition in Milan, Italy (22 April 2010).

Prof Cheok and his team conducted a user study with 36 people – 21 children and 15 parents – by holding a kids workshop at a community festival in Punggol, Singapore (Figure 4). The study evaluated the system and found that the physical interaction is capable of enhancing communicative enjoyment between children, and also improving the safety factor for parents, who subsequently feel more relaxed about children

participating in online social activities. As a result, compared with only using Petimo world (Trial A), children can receive more pleasure and satisfaction in communication by using both Petimo world and Petimo robot (Trial B). Results revealed that many children responding to the system with physical interaction not only experienced a heightened sense of fun (Figure 3), especially in the physical friends-adding feature, but also revealed a desire to use Petimo in their real daily lives.

Many participating parents who observed their children playing with Petimo thought that the online SNS environment with physical interaction is safer and addresses their fears of allowing their children to interact online. More in-depth analysis revealed that parents thought the system could aid in educating their children on how to make friends and maintain their friendships in a secure way via the Internet.

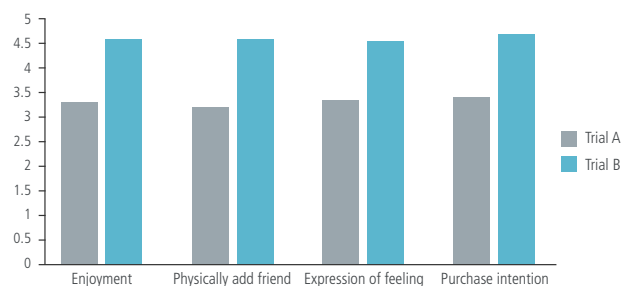


Figure 3 Children responses from user study.



Figure 4 Petimo user study with children.

AN EMAIL INTERVIEW WITH MR LEE KOK CHOY

In this inaugural issue, we are very honoured to be able to feature an email interview with one of our distinguished alumni, Mr **Lee** Kok Choy. Mr Lee is the President of TECH Semiconductor Singapore Pte Ltd. He holds a Master of Engineering Degree and a Bachelor of Engineering (Electrical Engineering) Degree from the National University of Singapore.



Which year did you graduate from NUS?

I graduated from the University of Singapore with a B. Eng (EE) degree in 1974. At that time, the Engineering Faculty was in the Singapore Polytechnic Campus at Shenton Way. Later in the 1980s, I embarked on a part-time degree conducting research into semiconductors, helping to set up the new Semiconductor Laboratory in NUS in Kent Ridge. In 1988, I received my M. Eng degree.

Share some memorable experiences you had as a student in NUS.

My student days in University of Singapore were full and extremely fulfilling. In my first year, I was still training twice a day as a national swimmer, but also ran cross country and road relays for the Engineering Faculty. In my second year, our Engineering Faculty classmates decided to prove that we were not just a bunch of nerds in a distant Polytechnic Campus and so we fielded a very large slate of candidates for the Student Council elections. I ended up in the ExCo of the University of Singapore Students Union as Student Welfare Secretary. My active student life broadened my perspective in many areas including politics, social work, law, business and contracts (the Union House was under my responsibility) as well as adventure recreation (diving, mountain climbing and boating).

What are the major milestones in your career progression?

I joined Texas Instruments in 1977 after National Service, rose up the corporate ladder and technical ladder quite quickly to become Engineering Manager in 1980 and Operations Manager in charge of DRAMs Assembly Test in 1986. In 1991, TECH Semiconductor Singapore Pte Ltd was formed with Texas Instruments as one of the founding shareholders, and I took on the responsibility of Vice President of Wafer Fab Operations in the first 200mm Wafer Fab in Singapore. In 2002, I was promoted to President of TECH Semiconductor.

How would you attribute your success to NUS, if any?

My successes in my career and life have definitely been enabled by an amazing education in NUS and very supportive and nurturing professors, both during my undergraduate and post graduate days. I had the freedom to dabble in areas of interest ranging from computer science to power systems to operations research to semiconductors, all of which helped me develop an analytical mind and a curiosity about everything. Having benefited so much, I definitely want my Alma Mater to succeed.

What are your hopes and aspirations for the department?

My hope and aspirations for the ECE department is that it continues to improve the quality of University education it provides, to regain its rightful place as the department that all the top students in Singapore want to apply to.

What philosophy do you live by?

My personal philosophy is to make a positive difference in the lives of people I work with and to enjoy the gift of family and friends.

OUR HIGH ACHIEVEMENT AWARD WINNERS

In the following section, three of our graduating students (in no particular order) share briefly their final-year projects, which won them the 'High Achievement Award' (individual) in the 24th Faculty Innovation & Research Awards (2010).

REMOTE MOTION DETECTION SYSTEM BASED ON VISION AND NETWORK TECHNOLOGIES

By **LEE ZHI CHIEN**

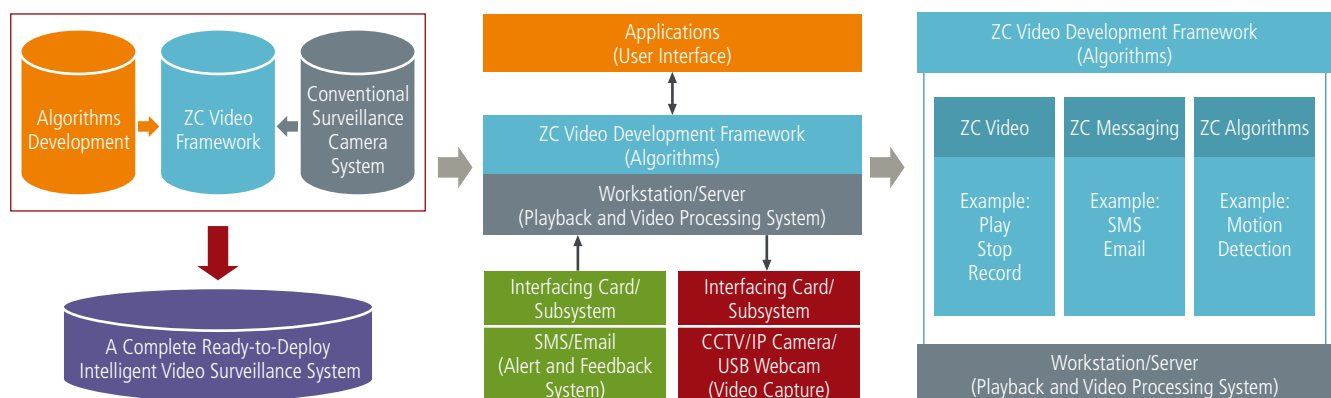
The aim of the project was to design a video surveillance system for security. In today's society, investment in security protection has played a vital role in various organisations to secure human life and assets. Each year millions of surveillance devices such as CCTVs and IP cameras are installed worldwide. With increasing demand for security surveillance systems, the global video information gathered also doubles. This leads to two major problems: efficiency and accuracy of the surveillance camera system, and real-time and simultaneous video processing. Furthermore the greater number of video surveillance systems means more manpower is needed, hence a high-intelligence backbone system has to be implemented to automate features such as traffic flow management, human detection and tracking, etc.

A generally applied solution is to introduce computer intelligence into the surveillance system to perform simple video processing and alerts. However, this is insufficient for large-scale security surveillance. A more organised system needs to be implemented. Taking Singapore as an example, camera systems can be installed all over the island, routed to

one or more high-intelligence centralised server situated somewhere on the island. The system will process the collected video information automatically and alert the authorities in the event of certain predefined occurrences.

In order to achieve this, I have proposed a system deployment framework, built to allow multiple types of input as well as multiple kinds of video processing running concurrently to provide relevant and accurate results. For instance, the system can be used to track a specific car and locate its travel route, utilising the video cameras installed along the roadside. The framework is also meant to be a platform to bridge the gap between software and hardware developers. Newly created video processing algorithms, whenever possible, could be integrated into the platform easily. Engineers can then proceed to design and adapt the best algorithms depending on the surrounding environment of the surveillance area. To conclude, this innovation may lead us into a new era of large-scale and well-organised high-intelligence video security surveillance networks.

THE FRAMEWORK



Left New framework to bring various algorithms under one hood and apply them to a new or existing video surveillance network.

Centre Application is built on top of the video development framework. The framework will be installed in the workstation or server. Inputs and outputs are connected to the workstation as well.

Right Currently the framework has several categories which group similar features together. The application can call the necessary functions and apply it to the video on-the-fly. More functions can also be added thus increasing the functionality and robustness of the framework to cater to different requirements.

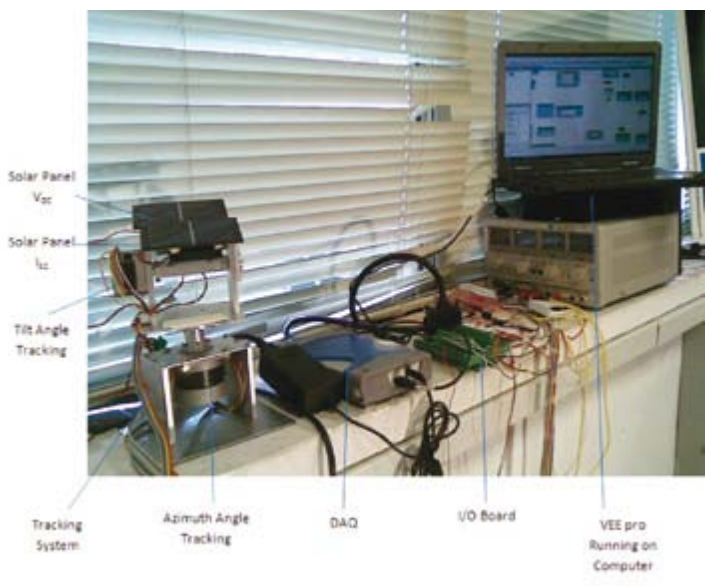
DUAL-AXIS, CLOSED-LOOP SUN-TRACKING SYSTEM (UTILISING PV PANEL AS THE SENSOR)

By FREDDY WILYANTO **SUWANDI**

The aim of the project was to design a tracking system based on the electrical characteristics of a solar panel, as opposed to using other sensors in determining the greatest insolation (the measurement of solar radiation energy received on a given surface area in a given time). Measuring the open circuit voltage of the solar panel will give a direct relation of insolation. Based on this concept, a simple perturb-and-observe searching algorithm can be implemented to search the optimum tilt angles of the solar panel. This approach is easy to implement as it provides better measurement resolution and ease of direct measurement of the open circuit voltage.

This tracking system not only accurately tracks the sun's movement, but also provides a temperature regulator, which protects the solar panel from heat damage. Furthermore, the system includes real-time performance monitoring and data logging for further performance analysis.

As opposed to geometrical and statistical tracking system, this closed-loop system provides a better control of the tilt angles and is ready to be deployed anywhere without prior calibration and alignment. The performance, versatility and ease of implementation are factors believed to have led to the winning of the high achievement award.



Sun Tracking Prototype implemented using Agilent DAQ and VEE Pro.

The project is sponsored by Agilent Technology and the system is mainly implemented using an Agilent Data Acquisition Module and VEE Pro programming environment.

TOUCH MEDIA IN THE MIXTURE OF PHYSICAL REALITY AND VIRTUAL REALITY

By **XIE DU**

This project introduces a conceptual interior design framework that integrates the Multi-Touch tabletop as an input device and implements the concept of mixed reality to improve user experience in terms of intuitiveness and interest. Under this framework, multiple designers can carry out design work on the layout top view on a tabletop, while the 3D perspective view of the interior design is mixed with the real-time captured video of the tabletop and shown on the vertical display.

The design can be viewed remotely by the client. The client's camera view of the physical space is mixed with the interior layout design in 3D form, and then the final design output is vividly displayed on the client's screen. The client can even view the design from different perspectives by rotating the camera.



Multiple users and multi-finger gesture supported.



Different perspectives of design.

Integration of both the multi-touch tabletop system and the mixed reality implementation in this project is a successful attempt to improve the user experience in terms of intuitiveness and interest based on the basic principles of human-computer interface design. A completely new model of the design work environment is established to be more efficient and flexible than the traditional environment. The sensor-based tracking applied at the client's side, which is not constrained by available tracking features, is a promising alternative method for visual tracking.

GREETINGS FROM KENYA

Sharing by CPE4 student SHUBHANGI **FAUJDAR** (who was in Kenya when she contributed this article).

“Here’s to the crazy ones. The misfits. The rebels. The troublemakers. The round pegs in the square holes. The ones who see things differently. They are not fond of rules. And they have no respect for the status quo. You can quote them, disagree with them, glorify or vilify them. About the only thing you can’t do is ignore them. Because they change things. They push the human race forward. And while some may see them as the crazy ones, we see geniuses. Because the people who are crazy enough to think they can change the world, are the ones who do.”

– Apple Computer Inc.



With Esther in the slums (Esther is waiting to get sponsored so that she can go to Uni).

With a dream to make a positive impact in the lives of those who had lost a lot to HIV, I embarked on my journey to work for Living Positive Kenya (<http://www.livingpositivekenya.com/about.htm>) soon after finishing my final exams at NUS. LPK is a not-for-profit, non-political, non-religious organisation located in the slums of Ngong Division, Rift Valley Province, Kenya. This community-based organisation strives to make positive and sustainable changes in the lives of HIV positive women and their families.

Singapore, I watched the movie ‘Blood Diamond’, which I took as a sign confirming that what I was thinking then, was the right thing to do.

Just one week into the internship and I can already feel satisfaction in what I am doing: making a difference to the lives of people who have little hope left and learning the right spirit of life from them. I think it is only after the completion of this internship that I can say I have completed my higher education and have grown enough to face the world in its true self – without the security which the University and our families offer us.



Digging a trench at daycare with another volunteer.

I am working in the slums for HIV-positive women and children for seven weeks. My job description is:

- to raise funds with marketing efforts.
- to set up Microfinance Infrastructure (something along the lines of Grameen Bank from Bangladesh).
- to help the inhabitants set up small businesses because not all of them have AIDS and will live a longer life.
- to counsel them in their struggle to accept the reality and live with strength in the face of abandonment.

Throughout my education in NUS, I was encouraged to have a spirit of giving and to work for the greater good of the community. At this point in time, I am pleased that this spirit has inspired me to make an active contribution to the lives of people who have been abandoned even by their families.

It was during my participation in the AIESEC International Congress 2008 in Brazil that I decided to go for a Development Traineeship in Africa. We were urged by Mr Martin Bean from Microsoft to unite together and help Africa to grow. He said that AIESEC members have always been the forerunners in many vital changes in the world. It is time to change the situation in Africa and we should do our part. Co-incidentally, at that time on my way back to



With the kids at daycare located in the Mathaare slums.

GRADUATE STUDENTS' ACHIEVEMENTS

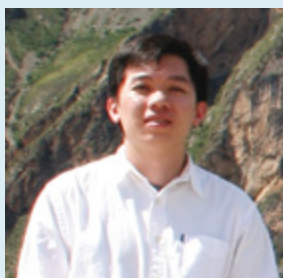


MUHAMMAD CASSIM MAHMUD MUNSHI (MEng student)

Muhammad Cassim received the Gold Leaf Award at the 2009 Asia Pacific Conference on Postgraduate Research in Microelectronics & Electronics for his paper "An efficient threshold setting algorithm for digital ultra wideband communication (UWB) systems", which he co-authored with his advisor, Assoc Prof **Lian** Yong. In this work, Cassim proposed a new UWB receiver architecture and analytically showed that the performance of this receiver asymptotically approaches that of conventional receivers, while consuming less than 1% of the power. The Gold Leaf Award recognises the top 10% of papers presented at the conference.

LEE TEK PO RINUS (PhD student)

Rinus received the IEEE Electron Devices Society (EDS) Graduate Student Fellowship at the 2009 IEEE International Electron Devices Meeting (IEDM). Four of these prestigious one-year fellowships are given out each year to promote, recognise and support the pursuit of doctoral dissertations within EDS's field of interest. Rinus was the only recipient of this award from the Asia Pacific region in 2009. He was recognised for his ability to perform independent and significant research in the field of electron devices, in addition to his excellent academic record. Rinus is supervised by Dr **Yeo** Yee Chia and Dr **Chi** Dongzhi from the Institute of Materials Research & Engineering.



TEO KIAN JIN JASON (PhD student)

Jason won 1st prize at the hArtes Design Contest 2009. His winning entry, "Smart2oon solar farm management system", is a solar energy management system employing active feedback control for automatic solar tracking to maximise solar energy throughput under any daylight condition. This contest was launched by hArtes project partners for students at universities and colleges, as well as for small and medium enterprises. Its aim is to turn participants' ideas on future, real-time, embedded systems into reality through the use of heterogeneous processing platforms. Jason is supervised by Prof Jacob **Phang**.



YANG JING & HU JUNHAO (Both PhD students)

Yang Jing and Junhao received the Certificate of Merit at the OptoElectronics and Communications Conference (OECC) 2009 for their paper "Multi-channel 80-GHz pulse train generation based on four-wave mixing in highly non-linear fibre", co-authored with Dr **Yeo** Yong Kee and Dr **Wang** Yixin from the Institute for Infocomm Research and Dr **Yu** Changyuan. Their approach exploits the optical parametric process in highly non-linear fibre to achieve high-speed optical return-to-zero pulse train generation over a wide bandwidth. Traditional methods for high-speed pulse generation use mode-locked lasers, which are designed for a single channel and therefore, do not provide a cost-effective solution in wavelength division multiplexing applications due to the need for multiple mode-locked lasers. Yang Jing and Junhao are supervised by Dr Yu Changyuan.

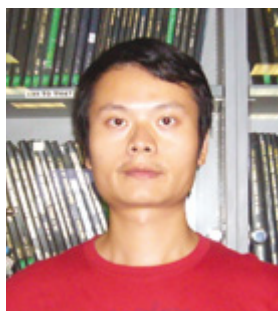


WU YUMING (PhD student)

Yuming received the 2nd Prize at the 2009 IEEE Region 10 Postgraduate Student Paper Contest for her paper "Resonance of coupled gold nanoparticles as effective optical antenna", which she co-authored with her advisor, Prof Joshua **Li** Le-Wei. In this paper, Yuming investigated the near-field properties of coupled gold nanoparticles and achieved, in particular, an accurate characterisation of the surface plasmon resonances (SPR) occurring at the gaps of these coupled structures. Her work has potential applications in near-field microscopy, spectroscopy and optoelectronic devices.

LI CHAO (PhD student)

Li Chao was the runner-up in the Young Scientist Awards under Category 3 (Medical Image Computing: Registration), at the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI) 2009, for his paper "Non-rigid registration of myocardial perfusion MRI using pseudo ground truth", which he co-authored with his advisor, Dr **Sun** Ying. Motivated by the fact that myocardial perfusion MRI has great potential for diagnosing cardiovascular diseases, Li Chao introduced a novel approach for overcoming the challenges of correcting heart deformation that is required to accurately trace perfusion signals. For his contributions, Li Chao's work was among 15 papers that were selected from 186 papers eligible for the Young Scientist Award



HU LI (PhD student)

Hu Li won the 3rd Prize at the 2009 IEEE Region 10 Postgraduate Student Paper Contest for his paper "ASED-AIM analysis of scattering by large-scale finite periodic arrays", which he co-authored with his advisor, Prof Joshua **Li** Le-Wei. In this work, Hu Li extended the Adaptive Integral Method (AIM) to characterise electromagnetic scattering by large-scale finite periodic arrays, by utilizing accurate sub-entire-domain (ASED) basis functions. The proposed ASED-AIM approach significantly reduces the memory and computational time requirements of the conventional AIM, without compromising its accuracy.

TAN JUN (PhD student)

Tan Jun received the Gold Leaf Award at the 2009 Asia Pacific Conference on Postgraduate Research in Microelectronics & Electronics for his paper "A 1-Volt, 2.5-mW, 2.4-GHz frequency synthesizer in 0.35 μ m CMOS technology" which he co-authored with his advisor, Assoc Prof **Lian** Yong. The proposed PLL frequency synthesizer is able to span the entire 2.4-GHz ISM band with a tuning step of 1MHz. This is afforded by a novel tri-modulus prescaler, which is incorporated in the pulse swallow counter to extend the tuning range of the synthesizer. It is therefore, suitable for wireless sensor network applications.



ECE ALUMNI FAMILY DAY 2010

Block out the date in your diary for this year's ECE Alumni Family Day! We have a fun-filled, yet educational, family day organised for ECE alumni, packed with activities and events for the whole family to enjoy. Highlights include interactive story-telling for the kids, an investment talk by Phillip Securities, a guided tour to selected ECE labs, Henna art, a sumptuous buffet lunch and lucky draw. **ADMISSION IS FREE!**

Date Saturday 14 August 2010

Time 10.30 am to 2.30 pm

Venue Block EA, Engineering Auditorium



Snapshots from the previous ECE Alumni Day.

If you have any comments on this issue or would like to contribute an article for subsequent ones, please email to e.connect@nus.edu.sg.