NUS ECE Graduate Student Symposium

3rd NUS ECE Graduate Student Symposium

February 27-28, 2013

PROCEEDINGS

Organized by

GSC
NUS ECE
Graduate Student Council

Hosted by

NUS
National University of Singapore

Venue:
Engineering Auditorium (EA)
Faculty of Engineering
National University of Singapore

MESSAGE FROM HEAD OF ECE DEPARTMENT

I congratulate the ECE Graduate Student Council for successfully organising this third ECE Graduate Student Symposium. A total of 116 oral papers and 25 posters will be presented at the Symposium, covering all the seven areas of research within the Department. Run like a typical IEEE technical conference, the Symposium provides a real platform for students to present their research results and interact with one another for further discussions and deliberations. The ability to present their work well in such a public forum is an important part of their overall education.

The Symposium is supported by many parties who have contributed in various ways. On behalf of the Department, I would like to thank everyone for their generous support. In particular, I thank Professor Low Teck Seng, Chief Executive Officer of the National Research Foundation, for delivering the keynote address; the IEEE Magnetics Society, IEEE Rel/CPMT/ED Society, IEEE Communications Society, IEEE Computer Society, IEEE Vehicular Technology Society, IEEE IAS/PELS Joint Chapter, IEEE Circuits and Systems Society, IEEE Solid-State Circuits Society, IEEE Control Systems Society, IEEE MTT/AP Joint Chapter, IEEE GOLD, PREMIA, NUS ECE Alumni Club and NUS Office of Alumni Relations for their sponsorship of the Symposium; and last but not least, my colleagues who provided valuable advice to the students in the planning and organization of the Symposium.

I wish you all a very fruitful and stimulating meeting.

Dr. Chua Kee Chaing
Professor and Head of Department
Department of Electrical & Computer Engineering
National University of Singapore

MESSAGE FROM PROGRAMME CHAIRPERSON

Good morning distinguished guests, Heads of Department, Area Directors, faculty members, fellow graduate students, ladies and gentlemen. It is a great delight that we are gathered here this morning to participate in the 3rd NUS ECE Graduate Student Symposium. Our gathering here today marks the third of an event which was born three (3) years ago in order to provide a platform for the exchange of ideas and information among students and faculty of the Department of Electrical & Computer Engineering.

The Graduate Student Symposium is the flagship event officiated by the Graduate Student Council (GSC) of the Department of Electrical & Computer Engineering. To my fellow graduate students, as you all are aware, it is a requirement to make a number of public presentations to the ECE community during the course of your PhD programme. It was in the light of this that such an event was conceived, to create a conference-like atmosphere for students to share the outcomes of their research either in the form of posters or oral presentations. Although the initiation of this symposium was of a humble birth, we envisage a bigger and brighter future. It is our dream to see this symposium eventually attaining an IEEE recognized status. This may sound a little outlandish, but it is my firmest belief that with a little support from all and sundry, especially fellow graduate students, this will soon be a reality.

In the next one and half days we will be hearing from over 110 PhD and MEng student speakers delivering oral presentations and also feed our eyes and minds with over 25 poster presentations.

Kindly join me to express appreciation to our keynote speaker in the person of Prof Low Teck Seng, Chief Executive Director of National Research Foundation (NRF), Prime Minister's Office Singapore, who used to be one of our own as a faculty member of the department. In fact, we are more honored to have Prof Low to address us on a topic which is of utmost relevance and importance to all gathered here. To Prof John Thong and Prof Chor Eng Fong, who have advised the organizing committee on pertinent matters right from day one of this event's preparation, we say we are indeed grateful.

Sponsorship for the event keeps on growing from year to year and we are pleased to announce that we will be giving prizes for poster presentations for the first time. Of course the oral presenters in all tracks stand a better chance than ever to win the prestigious best paper award for their individual due to the overwhelming support of our cherished sponsors for this year's event. We are pleased to have as our proud sponsors for best paper awards for the various tracks, Singapore Chapters of the following organizations, IEEE Microwave Theory & Techniques/Antennas & Propagation Society, IEEE Control Systems Society, IEEE Circuits & Systems Society, IEEE Solid-State Circuits & Systems, IEEE Industry Applications Society/Power Electronics Society, IEEE Vehicular Technology Society, IEEE Communication Society, IEEE Reliability/CPMT/ED Society, IEEE Magnetics Society, IEEE Computer Society and Pattern Recognition and Machine Intelligence Association (PREMIA). We are most grateful to all Area Directors of the department who worked behind the scenes in soliciting for sponsorship for the various tracks. We are pleased to announce our first long term sponsorship from MTT/AP Society for a period of five (5) years. We welcome more of such long term partnership with all our current and future sponsors. The door gifts that you are carrying with you were made possible through the generosity of IEEE GOLD, ECE Alumni Club and Office of Alumni Relations. To our faculty members serving as distinguished judges for this symposium, we say a big thank you.

Permit me at this juncture to salute the men and women who constituted the organizing committee for their relentless and zealous call to duty that has made this event come this far. On behalf of the symposium committee, I appreciate your attendance and participation in making the 3rd NUS ECE Graduate Student Symposium a great success.

Thank you.

Ansah-Antwi KwaDwo Konadu
Programme Chairperson
3rd NUS ECE Graduate Student Symposium

KEYNOTE SPEAKER

BIOGRAPHY

Prof Low Teck Seng is the Chief Executive Officer of the National Research Foundation (NRF), Prime Minister's Office. The NRF sets the national direction for research and development (R&D) by developing policies, plans and strategies for research, innovation and enterprise.

Prof Low has been actively involved in the Research and Development (R&D) landscape in Singapore. Prior to joining NRF in July 2012, Prof Low served as the Managing Director of the Agency for Science, Technology and Research. As A*STAR's Managing Director, Prof Low oversaw A*STAR's strategic priorities of driving innovative research and developing scientific talent to support Singapore's economic and industry development goals.

Prof Low was instrumental in setting up the Magnetics Technology Centre in NUS in 1983 where he helped to spearhead world class R&D in data storage technologies. It became the Data Storage Institute (DSI) of today, the foremost research centre in data storage technologies in the world focusing on technologies for data storage and data management.

After leadership roles in the education sector as Dean of Engineering at the National University of Singapore (1998 to 2001) and as the founding Principal of Republic Polytechnic (2002-2008), Prof Low joined A*STAR as the Deputy Managing Director (Research) in April 2009 to synergise the work of A*STAR's Science and Engineering Research Council (SERC) and the Biomedical Research Council. He took on the additional role of Executive Director of SERC in February 2010 to lead SERC into the next decade and shape the future of science and engineering research in Singapore.

Prof Low is a Senior Advisor to President, Nanyang Technological University and a tenured Professor with National University of Singapore.

Awards

Prof Low was awarded the National Science and Technology Medal in 2004, the highest honour bestowed on an individual who has made distinguished, sustained and exceptional contributions, and played a strategic role in the development of Singapore through the promotion and management of R&D.

In 2007 he was awarded the Public Administration Medal (Gold) by the President of Singapore for his outstanding contributions to the development of technical education and the management of science and technology for the nation.

On 22 Jul 2009, Prof Low was conferred the Honorary Doctor of Science by Southampton University in recognition for his contributions to Singapore and his profession internationally, in the IEEE.

Education

Prof Low graduated with First Class Honours in Electrical & Electronic Engineering in 1978 from Southampton University and subsequently received his PhD from the same university in 1982, specializing in computational electromagnetics. He was a Research Fellow at Southampton University from 1981 to 1983. He joined the National University of Singapore (NUS) in 1983 as an academic staff of the Department of Electrical Engineering. His research interests were in magnetics and their applications to data storage and in recent years his interests included aspects of nanomagnetics. He has published over 100 research papers in internationally refereed academic journals and conferences. He is a recognised expert in the design and control of permanent magnet machines.

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SYMPOSIUM STATEMENT & TECHNICAL HIGHLIGHT

THE main objective of the Symposium is to further enhance the quality of graduate seminar as well as providing a platform for undergraduates & graduates students, faculty to exchange the latest research findings and ideas. This symposium provides a unique networking opportunity for students and faculty from NUS with leading industry experts in the field.

Thus, it will focus on research works and progress under the 7 research areas: namely, Communications & Networks, Control, Intelligent Systems & Robotics, Integrated Circuits & Embedded Systems Circuits, Microelectronic Technologies & Devices, Microwave & RF, Power & Energy Systems and Signal Processing & New Media. These works reflect the students' efforts in the state-of-the-art R & D.

PROGRAMME SCHEDULE

Day 1 (February 27, 2013, Wednesday)							
	EA (Main Venue)	EA-06-02 (Track 1)	EA-06-03 (Track 2)	EA-06-04 (Track 3)	EA-06-05 (Track 4)	EA-06-06 (Track 5)	EA-06-07 (Track 6)
08:00 AM – 09:00 AM	Registration	-	-	-	-	-	-
09:00 AM – 09:10 AM	Opening Speech by Prof Chua Kee Chaing, Head, ECE Department	-	-	-	-	-	-
09:10 AM – 9:45 AM	Keynote Speech by Professor Low Teck Seng	-	-	-	-	-	-
9:45 AM – 10:30 AM	Tea break + Poster Session						
10:30 AM – 12:30 PM	-	Communications & Networks	Control, Intelligent Systems & Robotics	Microelectronic Technologies & Devices	Microelectronic Technologies & Devices	Microwave & RF	Signal Processing & New Media
12:30 PM – 01:30 PM	Lunch break						
01:30PM – 03:30 PM	-	Communications & Networks	Control, Intelligent Systems & Robotics	Microelectronic Technologies & Devices	Microelectronic Technologies & Devices	Microwave & RF	Signal Processing & New Media
03:30 PM – 04:00 PM	Tea break						
04:00 PM – 06:00 PM	-	Communications & Networks	Control, Intelligent Systems & Robotics	Microelectronic Technologies & Devices	Microelectronic Technologies & Devices	-	Signal Processing & New Media

Day 2 (February 28, 2013, Thursday)							
	EA (Main Venue)	**EA-06-02 (Track 1)**	**EA-06-03 (Track 2)**	**EA-06-04 (Track 3)**	**EA-06-05 (Track 4)**	**EA-06-06 (Track 5)**	**EA-06-07 (Track 6)**
08:30 AM – 09:00 AM	**Registration**	-	-	-	-	-	-
09:00 AM – 11:00 AM	-	**Integrated Circuits & Embedded Systems**	**Control, Intelligent Systems & Robotics**	**Microelectronic Technologies & Devices**	**Microelectronic Technologies & Devices**	**Power & Energy Systems**	-
11:00 AM – 12.00 PM	**Lunch break**						
12:00 AM – 02:00 PM	-	-	**Integrated Circuits & Embedded Systems**	**Microelectronic Technologies & Devices**	**Microelectronic Technologies & Devices**	**Power & Energy Systems**	-
02:00 PM - 02:30 PM	**Closing Speech by A/P Thong TL, John, Dy Head, ECE Department**	-	-	-	-	-	-
02:30 PM onwards	**Tea break & Networking**						

ORGANIZING COMMITTEE

Programme Chairperson	**KwaDwo Konadu Ansah-Antwi**
Programme Advisor	**A/Prof Chor Eng Fong**
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HOSTED BY

Department of Electrical and Computer Engineering,

Faculty of Engineering

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Singapore Section

ECE ALUMNI CLUB

SESSION 1

February 27, 2013 (DAY 1)

10:30 AM to 12:30 PM

TRACK 1

COMMUNICATIONS & NETWORKS

LOCATION: EA-06-02

PRESENTERS		
1.	Lin Xuzheng	Error Performance Analysis of Differential Detection for Amplify-and-Forward Relay Systems
2.	Nguyen Duy Hieu	Effect of Receive Spatial Diversity on the Degrees of Freedom Region in Multi-Cell Random Beamforming
3.	Shengjiao Cao	Full-Range Pilot-Assisted Frequency Offset Estimation for OFDM Systems
4.	Song Tianyu	Receiver Design for FSO IM/DD Channel
5.	Wu Tong	Joint and Separate Detection-Decoding on BPMR Channels

Error Performance Analysis of Differential Detection for Amplify-and-Forward Relay Systems

Candidate:	Supervisor/s:
Lin Xuzheng	**Kam Pooi Yuen**

Abstract:

We consider a differential amplify-and-forward transmission scheme for a two-user cooperative system with a single relay. We propose a new analytical approach based on first principles, and obtain a closed-form expression for the exact bit error probability (BEP) in Rayleigh fading. This result involves only a single exponential integral function. It applies generally to the case where the channel statistics on different links are non-identical. As expected, the BEP decreases monotonically with the source transmission energy, or the relay transmission energy. The explicit BEP result allows us to study optimum energy allocation between the source and the relay, given total transmission energy. By lower bounding the exact BEP expression via Jensen's inequality, we obtain a closed-form optimum energy allocation solution between the source and the relay. Numerical results show that the BEP bound and the optimum energy allocation solution are very tight.

Effect of Receive Spatial Diversity on the Degrees of Freedom Region in Multi-Cell Random Beamforming

Candidate:	Supervisor/s:
Nguyen Duy Hieu	**Hon Tat Hui**

Abstract:

The random beamforming (RBF) scheme, by exploiting multi-user diversity based scheduling, is able to achieve interference-free downlink transmissions with only \emph{partial} channel state information (CSI) at the transmitter. The impact of receiver spatial diversity on RBF rate performance, however, is not fully characterized even in a single-cell setup. In this paper, we study a multi-cell multiple-input multiple-output (MIMO) broadcast system with RBF applied at each base station and either the minimum-mean-square-error (MMSE), matched filter (MF), or antenna selection (AS) based spatial receiver at each mobile terminal. We investigate the effect of different spatial diversity receivers on the achievable sum-rate of the multi-cell RBF system subject to both the intra- and inter-cell interferences. We first derive closed-form expressions for the distributions of the signal-to-interference-plus-noise ratio (SINR) with each diversity technique, based on which we compare their performance at finite signal-to-noise ratio (SNR). We then focus on the high SNR regime and for a tractable analysis assume that the number of users in each cell scales in a certain order with the per-cell SNR. Under this setup, we characterize the DoF region for the multi-cell RBF system, which consists of all the achievable DoF tuples for the individual sum-rate of all cells subject to their mutual interference. Our results reveal significant sum-rate DoF gains with the MMSE-based spatial receiver as compared to the case without spatial diversity and/or with suboptimal receivers (MF or AS). This observation is in sharp contrast to the existing one that spatial diversity only yields marginal sum-rate gains based on the conventional asymptotic analysis in the regime of large number of users but with fixed SNR per cell.

Full-Range Pilot-Assisted Frequency Offset Estimation for OFDM Systems

Candidate: **Shengjiao Cao**
Supervisor/s: **Changyuan Yu**

Abstract:
We experimentally demonstrated a novel frequency offset compensation method with the widest estimation range by inserting one pilot-tone at the centre of the OFDM spectrum.

Receiver Design for FSO IM/DD Channel

Candidate: **Song Tianyu**
Supervisor/s: **Kam Pooi Yuen**

Abstract:
Atmospheric turbulence and pointing errors cause intensity fluctuation of Free Space Optical (FSO) communication signals and impair link performance. In this paper, we briefly review a mathematical model of FSO communication channel which is under atmospheric turbulence with pointing errors. Intensity modulation and direct detection (IM/DD)are used. Several receiver technologies which could mitigate the signal fluctuations are reviewed. However, these technologies highly depend on the knowledge about the channel and are sensitive to the channel condition. A new generalized likelihood ratio test-maximum likelihood sequence detection (GLRT-MLSD) receiver for FSO communication which does not require any channel information is proposed for the first time. The performance of the GLRT-MLSD receiver is analyzed and compared with the one of others. It is found that the GLRT-MLSD receiver is more robust, easier to design and has better bit error rate (BER) performance over other receivers for FSO communication while sacrificing the implementation simplicity. A further simplification of the GLRT-MLSD receiver is done and a new decision feedback receiver is obtained. The memory efficiency of the decision feedback receiver is higher and the implementation complexity is lower compared to the GLRT-MLSD receiver.

Joint and Separate Detection-Decoding on BPMR Channels

Candidate: **Wu Tong**
Supervisor/s: **Marc Andre Armand**

Abstract:
The presence of written-in errors is recognized as a challenging issue that limits the performance of bit-patterned media recording (BPMR). In this paper, we consider the Davey-MacKay (DM) coding scheme for a BPMR channel model which consists of a write channel producing dependent insertion, deletion and substitution (DIDS) errors and a single-track equalized read channel with a generalized partial-response (GPR) target. Three detection-decoding algorithms are proposed to work with an outer low-density parity-check (LDPC) decoder to recover data encoded by the DM coding scheme on the BPMR channel. These include the BCJR-binary input inner decoder (BCJR-BIID) algorithm, the joint detection-decoding (JDD) algorithm and the separate detection-decoding (SDD) algorithm. Computer simulations show that at low to moderate (resp. high) signal-to-noise ratios (SNRs), SDD (resp. BCJR-BIID) provides good performance-complexity trade-offs.

TRACK 2

CONTROL, INTELLIGENT SYSTEMS & ROBOTICS

LOCATION: EA-06-03

PRESENTERS		
1.	Ang Kar Tien	Development of confocal 3D profilometers for microfluidic devices
2.	Arun Kumar Chandran	Vision based Analysis of Crowd as Pedestrian Groups
3.	Henry Tan	Study of web guide slippage phenomena in roll-to-roll system
4.	Kumar Yogaprakash	Smart Indoor Localisation Technology
5.	Liang Wenyu	Surgical Device for Office-based Treatment of Otitis Media with Effusion

Development of confocal 3D profilometers for microfluidic devices

Candidate: Ang Kar Tien
Supervisor/s: Arthur Tay, Fang Zhong Ping

Abstract:
The quest of high speed, in-situ inspection of high precision parts has posed a new challenge to existing 3D profilometry. Industry has great demands for high speed and high accuracy 3D profilometers. Confocal 3D profilometry is advantageous over all other optical profilometry techniques. For example, confocal profilometry do not encounter phase wrapping problem. Interferometric profilometry that encounters phase wrapping problem has difficulty in measuring surfaces with discontinuities such as large steps, pillars and isolated area. Confocal profilometry also does not suffer the drawbacks faced by triangulation and pattern projection such as occlusion and multiple reflection problems. Although common confocal 3D profilometry is able to provide high vertical resolution and large measurement range, it has low surface measurement speed because it is a point-wise sensor and needs to do move-and-stop for sampling. Typically, a confocal profilometer may take minutes to hours to complete a surface scanning measurement depending on size of the measurement area and sampling density. In the poster, the concept of high speed confocal 3D profilometer that could measure the surface topography of an area within a few second would be illustrated.

Vision based Analysis of Crowd as Pedestrian Groups

Candidate: Arun Kumar Chandran
Supervisor/s: A/P Loh Ai Poh, A/P Prahlad Vadakkepat

Abstract:
A novel similarity based clustering algorithm is proposed to automatically detect groups of people traveling together in a static region of interest. These pedestrians are represented by their centroid information extracted out of a Detection and Tracking algorithm. The clustering algorithm is supplied by motion parameter trajectories proposed by related social psychological research work because human movement is understood by heuristics defined by humans. Adopting these motion trajectories aids the objective of detecting social groups of people. Automatic group detection is achieved without any prior training from sample database. The clustering algorithm utilizes the principle of triangle inequality to discover new members to an existing group. The triangle inequality principle reduces the number of motion parameter trajectory comparisons in the clustering algorithm. The clustering algorithm can eliminate false detections of people. A framework is developed to detect social groups in an online manner to aid in continuous monitoring of human activity. The real-time performance and group detection accuracy reveal that the proposed clustering algorithm performs better than existing similar algorithms even for scenes with large number of people. The work is used to statistically analyze the crowd flow in an event held at National University of Singapore.

Study of web guide slippage phenomena in roll-to-roll system

Candidate: Henry Tan
Supervisor/s: Arthur Tay

Abstract:
This paper reports our recent study on web guide slippage phenomena in our roll-to-roll (R2R) prototype system constructed for UV and/or hot embossing intermediate processes. Using the design of experiment (DOE) method, we developed a model for lateral slippage occurring on flexible plastic at the web guide. Both simulation and experimental work were performed to further enhance our understanding of its effect on the web tension and speed under normal operating conditions.

Smart Indoor Localisation Technology

Candidate:	Supervisor/s:
Kumar Yogaprakash	**Arthur Tay**

Abstract:

An indoor localisation system would be useful to track patients or critical equipment within hospitals located in Singapore. Conventional outdoor positioning technologies such as GPS and assisted GPS would fail to work in an indoor multi-floored environment since the GPS signal gets scattered by roofs, buildings and walls and the assisted GPS does not improve the vertical positioning of GPS. After noting that most of the hospitals in Singapore have Wireless Local Area Networks (WLAN), a localisation system based on these networks can be proposed. thus, this paper proposes a system that uses received signal strength indicator (RSSI) values of unique WLAN beacons to derive the position of a mobile node. The system has to undergo a training to develop a database of RSSI values at known points within an area. It then uses this data together with an algorithm to derive an estimate for the location of the node. This paper discusses the implementation details and the accuracy of 2 indoor positioning algorithms that have been tested in a lab area of 165 square meters.

Surgical Device for Office-based Treatment of Otitis Media with Effusion

Candidate:	Supervisor/s:
Liang Wenyu	**Tan Kok Kiong**

Abstract:

Otitis media with effusion (OME) arises from accumulation of fluid that occurs within the middle ear space. It is a very common ear disease occurring in adults and children alike when the middle ear is infected or the eustachian tube becomes dysfunctional. The common treatment for OME, when medication as first treatment fails, is to surgically insert a grommet is onto the ear membrane of the patients to discharge the fluid. In this paper, to overcome the disadvantages of the conventional surgery methods for OME and the challenges of limited space, surgical time and cost, the current ways of inserting a grommet are revisited and the extensive setup and requirements simplified to a novel “all-in-one” surgical device allowing office-based grommet insertion in an awake patient with chronic OME. A simple, automated and quick “point, click and insert” device is developed to carry out both myringotomy and grommet insertion in a single procedure, avoiding GA, costly expertise and equipment, treatment delays, and enhance the precision and performance of the current devices. It is a highly integrated and intelligent device comprises of the key components of a mechanical system, a sensing and guidance system and a motion control system. Each system is presented in this paper in details. The main mechanical system includes 2-DOF ultrasonic motor (USM) stage, cutter, hollow holder and mechanism for cutter retraction, etc. The sensing and guidance system includes the built-in endoscope camera subsystem and the force sensing subsystem. Furthermore, the motion control system for the USM stage is presented. Finally, the device has been put to test and the experimental results show that the prototype is able to carry out the procedure with a success rate of 98% with the Shah type grommet. The process time durations needed by the two key processes of myringotomy and grommet insertion are less than 2s, and the overall time for the full procedure from the time of cutter/membrane contact to grommet insertion is about 3.5 to 5.5s.

TRACK 3

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-04

PRESENTERS		
1.	Guo Yan	Effects of Thickness and Dielectrics in GaSb DG-UTB NMOS
2.	Soon Bo woon	Nanoelectromechanical Toggle Switch for Non-volatile Memory Application
3.	Mehrdad Elyasi	Multi-bit Non-volatile Memory Cell Using Non-anchored Transduction
4.	Shimon	Fabrication and Reversal Mechanisms of Coupled Bi-Component Magnetic Dots

Effects of Thickness and Dielectrics in GaSb DG-UTB NMOS

Candidate:	Supervisor/s:
Guo Yan	**Liang Gengchiau**

Abstract:

In this work, we investigate the thickness and dielectric effects on the transport performance of GaSb double gate ultra-thin body (DG-UTB) MOSFET. We study the band structure of GaSb UTB with different atomic layers (AL) using sp3d5s* tight-binding (TB) model coupled with atomistic self-consistent Poisson equation. The transport is simulated using semi-classical top-of-barrier (TOB) model. In particular, GaSb of 24AL has the largest ON-state current for both EOT=1.0nm (SiO2) and EOT=0.16nm (HfO3) because of its highest injection velocity and large electron density. The current of 12AL is almost equal to 24AL by using HfO3 as the oxide layer due to the improved carrier effective mass. When switching from SiO2 to HfO3, the transport differences between different ALs are enlarged because the operation is changed from classical to quantum limits. When the thickness is large enough (24AL for SiO2 and 48AL for HfO3), we observe charges accumulate towards the surface of UTB instead of concentrating in the centre of the UTB, as in the case of thinner layers. We also noticed that for both SiO2 and HfO3, 12AL has the least intrinsic delay while 24AL has the least power-delay product.

Nanoelectromechanical Toggle Switch for Non-volatile Memory Application

Candidate:	Supervisor/s:
Soon Bo woon	**Asst. Prof. Lee Cheng Kuo**

Abstract:

This paper reports critical length optimization of electrostatic nanoelectromechanical (NEM) switches that demonstrate hysteresis behavior under influence of van der Waals force. This is achieved through study of various length of high aspect ratio (1:35) silicon nano-fins (Si-NFs) which work like NEM switches. The switch's contact state is maintained even after the bias voltage is switched off, demonstrating non-volatile capability. The lowest pull-in-voltage (VPI) reported is 10V and reset-voltage (VRESET) is -12V (by opposite gate). The device shows potential NVM applications such as storage in harsh environments, where FLASH memory suffers from poor performances due to the high temperature. Lateral 80nm thick Si-NF with length of 2μm, 8μm and 12μm with 80nm actuation gap is characterized. Si-NF's critical length is analyzed so that adhesion energy can overcome the cantilever spring restoration force to maintain contact state. In contrast, this energy cannot be too high in order to ensure that low VRESET is enough to reset the switch. Si-NFs are characterized as the source electrode which switches between fixed electrodes (lateral gate). The Si-NF can move the fin in one of two different positions by electrostatic force. The van der Waals attraction between the interface of Si-NF and electrode is used to hold the switched Si-NF without on-hold bias, resulting in a hysteresis behavior. Finite element analysis (FEM) is coded in ANSYS to compute the electrostatics and van der Waals forces which actuate and hold the Si-NF in contact. As a result, the required critical length can be determined for the switch to be actively actuated and exhibits bi-stability. This method may serve as a guideline for such device's design which leverages on van der Waals force. From the experiment results, we show that the length is crucial in designing a resettable switch. The measurement is repeatable for 5~10 cycles. The device is initially pulled in at VPI = 10V and able to reset at VRESET = -12V. The contact area of the device is shown in SEM where the switch is pulled to the right of the applied VGATE. Meanwhile, a device with 12 μm x 80nm Si-NF is measured. This device shows a large contact area and is not able to reset due to strong adhesion. It is clear that the area of contact is determined by the length of the device, which corresponds to the adhesion strength of the Si-NF to the gate. Permanent adhesion is usually considered as a failure mode for electrostatic switches. The trade-off between the required pull-out energy and the van der Waals force is analyzed. The measurement is performed statistically for twenty devices and results show that longer length reduces the pull-in voltage while the non-volatile hysteresis behavior is only shown in 2μm devices and 8μm devices. In summary, trade-off between adhesion energy, VPI and VRESET can be optimized by varying the length of the device. The critical length for a device to exhibit hysteresis behavior can be determined by evaluating the contact area and the surface property of a NEM switch.

Multi-bit Non-volatile Memory Cell Using Non-anchored Transduction

Candidate:	Supervisor/s:
Mehrdad Elyasi	**Chengkuo Lee**

Abstract:

A novel micro-electro-mechanical (MEM) based non-volatile memory (NVM) is proposed. The storage principle is based on Lorentz's transduction, utilizing long-range motion of a non-anchored element which has current carrying sliding contact with a conductive path. Position of the moving element indicates the stored data in the multi-bit cell. Data is written in the cell with displacing the moving element by Lorentz's force, is read by utilizing differential port resistances, and is held by adhesion forces. Data writing at up to 350C, and data retention and reading for higher temperatures are reliable. Each memory cell comprises a magnetic field generator current loop, magnetic flux guiding core, two circular conductive paths with probing ports, i.e., writing and reading, and a free moving element, that has sliding contacts with the paths. Applied current signal to one of the ports will pass through the moving element current line. Interaction between moving element current and the magnetic field which is generated by the current loop and guided by the ferromagnetic core, induces Lorentz's force on moving element. Moving device current signal shape, defines the position in which moving element resides or in other words, the bit word that is stored in the cell. The reading process of this device is based on differential port resistances. Permanent retention of the data is obtained by adhesion forces in the contact of moving element and the conductive paths. Friction and adhesion behavior in the sliding contact which is carrying current is studied and characterized. Also, high temperature effect on the structure and performance of the device is characterized. For 30um diameter of each cell, storage density and average writing time, will be 1.4Kbits/mm^2 and 90us/bit respectively. Energy consumption in each data writing process is dominated by the magnetic field generator current loop, which is typically 0.45uJ/bit.

Fabrication and Reversal Mechanisms of Coupled Bi-Component Magnetic Dots

Candidate:	Supervisor/s:
Shimon	**Adekunle Olusola Adeyeye**

Abstract:

Recently, there has been a growing interest in fabricating nanostructures made from two different materials (a bi-component system) arranged alternately in-plane to form periodic nanostructures such as magnonic crystals, in which distinct static or dynamic behaviors occur. These structures can be made using conventional processing, but requires multi-level lithography and pattern transfer processes. In this work, we present a self-aligned fabrication technique for making magnetostatically coupled bi-component dots which combines angle deposition, lift-off and selective etching processes in a single mask step. Array of circular holes was patterned on a resist using 248nm wavelength deep ultraviolet (DUV) lithography. Onto this patterned resist, first we did a shadow deposition step at 45deg off-normal of Ni80Fe20(25nm)/Ti(3nm)/Al2O3(50nm) and then normal (0deg) angle deposition of Fe(25nm)/Ti(3nm) using e-beam evaporation, followed by lift-off. Subsequently, a selective etching of Al2O3 was done which removed Al2O3 layer and Fe(25nm)/Ti(3nm) layers above it. The resulting structure is made of a self-aligned Ni80Fe20 (NiFe) lens and Fe-crescent. A uniform gap between NiFe and Fe is created as a result of tapered profile formed in the first 45deg deposition step which led to shadowing in the subsequent 0deg deposition. Interestingly, we observed a three-step switching in bi-component dots which is very different to single component dots. Micromagnetic simulation agrees well with the MOKE loop, in which the three steps correspond to NiFe-lens reversal, and vortex core nucleation and annihilation in Fe-crescent respectively. The characteristic of vortex core in bi-component dot is evident in its magnetic contrast and a complementary stray field contrast from the gap is visible when the field is cycled to saturation. The reversal of the separate NiFe-lens and Fe-crescent and their normalized sum highlight the effect of magnetostatic coupling in the bi-component case, e.g. the separate NiFe-lens shows two-steps (vortex nucleation and annihilation) instead of single step switching in bi-component case. Moreover, the NiFe in bi-component case reverses at much lower field than separate NiFe-lens. Fe-crescent reversal is similar in both cases indicative of lesser effect of the NiFe stray field. Simulation results agree well with the experimental findings.

TRACK 4

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-05

PRESENTERS		
1.	Yun-Hsiang Wang	Analytical Modelling of High Temperature Characteristics on the DC Responses in AlGaN/GaN HEMT Devices
2.	Pannirselvam S/O Somasuntharam	Study of Surface Passivation on AlGaN/GaN MOS-HEMT
3.	Ang Shan Zheng	Power-Spectrum Estimation for Optomechanical Force Sensing
4.	Lee Hui Min	Impact of TSV Induced Thermo-mechanical Stress on Semiconductor Device Performance

Analytical Modelling of High Temperature Characteristics on the DC Responses in AlGaN/GaN HEMT Devices

Candidate:
Yun-Hsiang Wang

Supervisor/s:
Yung C. Liang, Ganesh S Samudra

Abstract:
The AlGaN/GaN power High Electron Mobility Transistor (HEMT) semiconductor device is a suitable candidate for high-voltage, high-current and high-temperature power electronic applications. It is already known that temperature variations will result in obvious change in the threshold voltage and the current-voltage characteristics of the device. The effect of temperature to threshold voltage could be attributed to the variations on the Schottky barrier height and the 2DEG (Two-Dimensional Electron Gas) density, which is mainly caused by the change in conduction band energy near the AlGaN/GaN interface that alters the depth of the quantum well at the interface. A quantitative analysis of such a variation is usually computed by the full Fermi-Dirac statistics for the calculation of the conduction band level and Poission equation for the space charge derivation. It is known that solving both of these relationships requires heavy numerical arithmetic. Meanwhile, the derivation of I-V characteristic under different temperatures, which is mainly attributed to the mobility degradation by phonon scattering at higher temperatures, is also numerical. The proposed work is to analytically model the threshold and the current-voltage (I-V) characteristics of the device by simplifying the 2DEG (Two-Dimensional Electron Gas) derivation with respect to temperature variations by using the Fermi level approximation methodologies for degenerate semiconductors as well as space charge approximation by polarization charge distribution analysis near the AlGaN/GaN interface. The approximations are verified by comparing with the laboratory measurement results as well as the numerical results obtained from Sentaurus TCAD simulation. As a result, different trend of the threshold voltages for the Schottky-gated HEMT and the Metal-Insulator-Semiconductor HEMT (MISHEMT) at different temperatures were observed experimentally and explained by the decrease in the Schottky barrier height under higher temperature as demonstrated in the model; the degradation of the drain current at both linear and saturation region at higher temperatures were observed and also accurately modelled.

Study of Surface Passivation on AlGaN/GaN MOS-HEMT

Candidate:
Pannirselvam S/O Somasuntharam

Supervisor/s:
Associate Professor Tan Leng Seow

Abstract:
AlGaN/GaN metal-oxide semiconductor high electron mobility transistors (MOS-HEMTs) are very attractive for high power and high frequency applications with low gate leakage current. However, it is believed that surface-related charge trapping at the insulator/AlGaN interface limits the performance of AlGaN/GaN MOS-HEMTs. It has been experimentally shown that in situ passivation of this interface during fabrication can enhance the performance of the AlGaN/GaN MOS-HEMT. To study the effects of the surface passivation, TCAD simulations using SILVACO ATLAS were used to fit the experimental data. In order to achieve a good fit to the experimental data, discrete, deep donor-like traps (Ec – 0.37 eV) and discrete deep acceptor-like traps (Ev + 1.0 eV) were incorporated to represent the AlGaN surface defects due to nitrogen-vacancies and gallium-vacancies respectively, at the HfAlO/AlGaN interface. For the unpassivated and passivated devices, the density of the donor-like trap density was set to be 2.96×1013 cm-2. The simulation fitting shows that the unpassivated device has an excess of 6.0×1012 cm-2 of acceptor-like traps compared to the passivated device. The simulated energy band diagram shows that the reduction in acceptor-like trap density results in a significant lowering of the energy band at the HfAlO/AlGaN interface. The triangular quantum well at the AlGaN/GaN interface is also affected by the reduction of the acceptor-like trap density at the HfAlO/AlGaN interface. From the ID-VG plot simulated at VDS = 5 V, the threshold voltage (Vth) was extracted to be -4.12 and -4.78 V for the unpassivated and passivated devices respectively. Also the calculated two-dimensional electron gas (2DEG) sheet charge densities (ns), which are 7.3×1012 and 8.5×1012 cm-2 for the unpassivated and passivated devices respectively. The calculated 2DEG ns shows reasonable values with a difference of < 20% compared to the experimental devices, which were measured using room-temperature Hall measurement. The increase in ION in the passivated

device, for the same gate overdrive, could be due to increase in mobility because of decrease in carrier scattering. The extracted gm peaks from the simulation for the unpassivated and passivated devices are 62.6 and 97.8 mS/mm respectively. This increase in gm can be attributed to an increase in mobility due to reduction in carrier scattering. The extracted values of the Sub-threshold Swing (SS) for the unpassivated and passivated devices from the simulation are 134.7 and 100.2 mV/dec, in good agreement with experimental values. The reduction in SS for the passivated device is directly related to the reduction in acceptor-like trap density. This simulation study provides a plausible reason for the changes in the electrical characteristics of the passivated device compared to the unpassivated device. The in situ passivation process could have led to a reduction in the acceptor-like trap density at the insulator/AlGaN interface, which in turn results in enhanced performance of the passivated device.

Power-Spectrum Estimation for Optomechanical Force Sensing

Candidate:
Ang Shan Zheng

Supervisor/s:
Mankei Tsang

Abstract:
We consider the problem of estimating the power spectral density of a force from continuous measurements of an optomechanical force sensor. We propose an asymptotically efficient estimator, which theoretically saturates the Cramer-Rao lower bound in the long-time limit, and study its performance by applying it to simulated and experimental data.

Impact of TSV Induced Thermo-mechanical Stress on Semiconductor Device Performance

Candidate:
Lee Hui Min

Supervisor/s:
Assoc. Professor G. S. Samudra, Dr. Li Er-Ping

Abstract:
Evaluation of the impact caused by Through-Silicon Vias (TSV) induced thermo-mechanical stress on device performance is becoming important due to the close proximity between TSVs and the semiconductor devices in 3D integration. From the literatures, there exist discrepancies between theory, simulated and experimental results presented. For accurate predictions, we simulated stress build-up by taking the full CMOS process flow into consideration. We considered the interaction between TSV, stressors such as tensile stress liner and Shallow Trench Isolation (STI) and device channel. From the results, it was found that the nMOSFET Ion variation is less than 2% at Keep Out Zone (KOZ) of 1 μm due to TSV induced stress while the Ion variation is about 30% due to the tensile stress liner. Hence, the impact of TSV induced stress on nMOSFET performance is insignificant compared to that of tensile stress liner in the device.

TRACK 5

MICROWAVE & RF

LOCATION: EA-06-06

PRESENTERS		
1.	Chen Rui	Aplanatic solid immersion lens scanning microscope for failure analysis of integrated circuits
2.	Hua Peng Ye	Application of Vectorial Rayleigh-Sommerfeld Integral to Design Planar Lens for Subwavelength Longitudinal Beam
3.	Muhammad Qasim Mehmood	Far field Light Twisting and focusing by log spiral lens
4.	Song Jian	Evaluation of Connetors' Uncertainties in EMC Measurement
5.	Zhao Jiajun	Acoustic Wavefront Manipulation: Impedance Inhomogeneity and Extraordinary Reflection

Aplanatic solid immersion lens scanning microscope for failure analysis of integrated circuits

Candidate:	Supervisor/s:
Chen Rui	**Chen Xudong, Jacob C. H. Phang**

Abstract:

Continuous miniaturization of integrated circuits requires more effective failure analysis techniques. As a non-invasive technique, optical imaging is a good tool for failure analysis of integrated circuits, especially for the backside imaging through silicon substrate using solid immersion lens (SIL) [1]. Many researchers have experimentally demonstrated better resolution using SIL, but the underlying optical model for the whole microscope was not fully understood. At best, the prediction of resolution based on focal spot size was studied [2, 3].

Recently, a complete modeling of subsurface microscopy system based on aplanatic SIL (ASIL) has been developed [4]. In this presentation, a complete and computation efficient model of aplanatic solid immersion lens scanning microscope with finite-sized detector is presented. The concept of secondary sources and several fast algorithmic approaches have been employed. The secondary source on object structure induced by the focused light produces the image in the focal plane of detector lens. The object structure in the focal plane of ASIL is assumed to be scanned relative to the optical system, and the total intensity is measured with a detector of finite size. Simulations of imaging object structures are designed to analyze image formation of ASIL scanning microscope using linearly and circularly polarized illumination of wavelength, λ=1340 nm in free space. In addition, experiment results are also obtained using SEMICAPS ASIL microscope and the Metrochip resolution target [5]. It is found that the simulation results produced by the proposed model are in very good agreement with experimental results. These works lay the groundwork for optimizing ASIL scanning microscope imaging parameters and further improving the resolution of the scanning system.

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[5]. Ted Pella INC, "http://www.tedpella.com/metrochip_html/metrochip-calibration-target.htm", retrieved.

Application of Vectorial Rayleigh-Sommerfeld Integral to Design Planar Lens for Subwavelength Longitudinal Beam

Candidate:	Supervisor/s:
Hua Peng Ye	**Dr. Chengwei QIU, Prof. YEO Swee Ping**

Abstract:

We find that planar diffraction-based lens could be used to generate subwavlength hotspot with strong longitudinal electric component (FWHM=lambda/2.53 in air), which may find applications in particle acceleration and high density data storage with phase-change materials. We propose to design and optimize this kind of planar diffraction-based lens (consisted of concentric annuli) with first kind vectorial Rayleigh-Sommerfeld (VRS) integrals. Moreover, the validity of first kind VRS is demonstrated by studying diffraction by circular apertures and planar diffraction-based lens consisting of dozens of concentric annuli, where all results are verified by commercial software Lumerical FDTD (Lumerical FDTD Corp.). This work unveils the potential of efficiently designing and optimizing planar diffraction-based lens with first kind VRS.

Far field Light Twisting and focusing by log spiral lens

Candidate:	Supervisor/s:
Muhammad Qasim Mehmood	**Dr. Qiu Cheng Wei**

Abstract:

The phenomenon of light twisting around its axis of travel as a result of its interaction with specific matters in space has extensively been studied in the past from fundamental researches to technological applications. At optical frequency, light waves can be twisted when they impinge on spiral nanostructures, which are one type of deterministic aperiodic nanostructures (DANS) offering new avenues for creation and manipulation of complex scattering resonances and localized optical field at nanoscale. In this work, we have reported numerical and experimental study on a deterministic aperiodic nanostructure (DANS) of spiral, which results in a unique and interesting phenomenon of light focusing and twisting, when illuminated by linear or circular polarized light, in far field due to the presence of a geometrical phases arising from the interaction of light with DANS. Tight focal spot follows a spiral trajectory during its propagation in the free space where handedness of the twisted spot is independent of polarization of the incident excitation. The 100-nm thick Au spiral structure was patterned by electron beam evaporation and electron beam lithography followed by dry etching. It was optically characterized by confocal imaging microscopy with an incident light of 633 nm wavelength. Lumerical FDTD simulations are done for the said design to double confirm the validity of results. Both experimental and simulation results demonstrate that this work provides an innovative way for light manipulation. This intriguing phenomenon will open a new trend of light manipulation and can find potential applications in the areas of data communications, microscopy, optical tweezing, remote sensing and optical data storage. Most importantly it will lead to think differently about the light focusing and momentum inter-conversions.

Evaluation of Connectors' Uncertainties in EMC Measurement

Candidate:	Supervisor/s:
Song Jian	**Dr. Hui Hon Tat**

Abstract:

This paper focuses on the uncertainties of RF connectors occur during EMC measurements, which are often not taken into consideration by some of the testing laboratories. The performances of various RF connectors were evaluated experimentally with a frequency range from 100 kHz to 8.5 GHz. The results showed that although the uncertainties contributed by the RF connectors are negligible at the above mentioned frequency range, some defect RF connectors may have a higher insertion loss which will significantly affect the overall measurement uncertainties if not treated properly.

Acoustic Wavefront Manipulation: Impedance Inhomogeneity and Extraordinary Reflection

Candidate:	Supervisor/s:
Zhao Jiajun	**Qiu Chengwei**

Abstract:

Optical wavefront can be manipulated by interfering elementary beams with phase inhomogeneity. Therefore a surface allowing huge, abrupt and position-variant phase change would enable all possibilities of wavefront engineering. However, one may not have the luxury of efficient abrupt-phase-changing materials in acoustics. This motivates us to establish a counterpart mechanism for acoustics, in order to empower the wide spectrum of novel acoustic applications. Remarkably, the proposed impedance-governed generalized Snell's law (IGSL) of reflection is distinguished from that in optics. Via the manipulation of inhomogeneous acoustic impedance, extraordinary reflection can be tailored for unprecedented wavefront manipulation while ordinary reflection can be surprisingly switched on or off. Our results may power the acoustic-wave manipulation and engineering. We demonstrate novel acoustic applications by planar surfaces designed with IGSL.

TRACK 6

SIGNAL PROCESSING & NEW MEDIA

LOCATION: EA-06-07

PRESENTERS		
1.	Abeykoon Mudiyanselage	Automatic Cardiac Motion Analysis in Tagged MRI
2.	Atieh Bamdadian	Pre-cue EEG data predicts the performance of MI-based BCI
3.	Nguyen Van Tam	Context-aware Action Recognition in Kitchen Environment
4.	Wang Yuxiang	Stability of Matrix Factorization for Collaborative Filtering

Automatic Cardiac Motion Analysis in Tagged MRI

Candidate:	Supervisor/s:
Abeykoon Mudiyanselage	**Sun Ying**

Abstract:

Cardiac motion analysis is a widely used technique for identifying many different types of cardiovascular diseases, as it enables the quantification of the elasticity and contractility properties of the myocardium and therefore the detection of regional movement abnormalities. Tagged magnetic resonance imaging (MRI), which was firstly proposed in 1988 as a means for non-invasive motion tracking within the myocardium of the heart, is nowadays the reference modality for studying the regional myocardial function. The techniques for rapid and automatic reconstruction of 2D and 3D heart wall motion using tagged MRI images have been proposed while introducing detailed measures about heart wall motion such as strain and torsion. However, existing automated analysis methods and computational models are not able to exploit full 4D (3D + time) information and fail to exploit full range of quantitative multi-dimensional MRI data. The underlying assumptions of these cardiac computational analysis methods (e.g., rigid rotation, linear vertical compression, uniform pressure) are quite far from the realism. To overcome these issues and to provide more advanced clinical support through a single integrated application while having more accurate information, this research aims to develop a novel method for automatic cardiac motion analysis and to analyze correlations with other cardiac MRI modalities, so as to provide more realistic computational models that can be used for inference on future data. In this research, tagged intersections (features) in tagged MRI images are firstly detected using frequency based methods and secondly it has been used CPD (Coherent Point Drift) non rigid point set registration method to track the sparse features throughout the consecutive tagged MRI frames. Moreover, dense strain calculations are done using tracked sparse features. Further, the analysis of correlations is expected to produce new dimensions and insights in to cardiovascular diseases diagnosis while having the potential for advanced clinical applications in planning and evaluation of cardiovascular therapies and surgeries.

Pre-cue EEG data predicts the performance of MI-based BCI

Candidate:	Supervisor/s:
Atieh Bamdadian	**Prof Xu Jianxin**

Abstract:

Motor imagery-based BCI is one of the recent methods used for stroke rehabilitation. However, one of the unsolved challenges of using such system for stroke rehabilitation is incapability of the non-negligible number of users in performing motor imagery. In fact, there is a big variety in performance of the users. The exact reason of such variation is still unknown. One of the possible reasons could be because of the subject incapability in modulation of their electroencephalogram (EEG) rhythms. EEG rhythms modulations are typically induced by motor imagery and show the intent of the subject. They contain useful information about the performance of the users. Studies had shown that EEG rhythms have significant role on BCI performance and hence can be used to predict the performance. Some performance predictors had also been introduced, but so far none of them was good enough to be used in different BCI experiments. Predicting the performance of the patients prior to the rehabilitation process is highly noteworthy, since using MI-based BCI system for stroke rehabilitation is costly and time consuming for patients and rehabilitation center. Moreover, it may be helpful in avoiding patients' frustration in rehabilitation process. Moreover, it may lead to better understanding of the possible reasons of performance variation in different subjects. In this study we aim to investigate the discrimination ability of the EEG data before providing the cue to the patients. To do so, we focus on EEG rhythms of different frequency bands over all channels: alpha (8-13 Hz), beta (16-24 Hz), and theta$ (3-8 Hz) and define a new coefficient ($\theta/(\alpha+\beta)$). We hypothesize that there is a correlation between this coefficient and performances of the patients. To investigate our hypothesis several analyses have been done. The analyses are based on group of patients, namely 30 hemiparetic stroke patients. To evaluate the performance of the patients Filter-bank common spatial pattern (FBCSP) with SVM classifier was used. There is no significant difference between mean accuracy of the patients with right-affected hand ($\mu\_R=73.80\%$) and left-affected hand ($\mu\_L=70.93\%$,

p=0.53). Due to opposite location of the lesion in the brain, the activation patterns of each group of patients are different; hence data analysis of each group is performed separately. The results suggested that for right affected hand patients the parietal area is anti-correlated to accuracy of the patients (r=-0.71, p=0.01). For left affected hand patients both motor area and parietal area had significant role on performance of the patients (r=-0.51, p=0.03). This is mainly due to the fact that before performing MI task the alpha and beta band EEG power start to increase and this increase is more significant comparing to increase of theta band power. In conclusion, monitoring the EEG rhythms over parietal area right before presenting the cue has shown to be a good indicator of user's performance in discrimination of motor imagery versus background rest condition. This is a good indicator which may help us to design a new experiment based on this finding.

Context-aware Action Recognition in Kitchen Environment

Candidate:
Nguyen Van Tam

Supervisor/s:
Yan Shuicheng

Abstract:
In this work, we proposed the context-aware action recognition framework for cooking action recognition from videos captured in kitchen environment by RGBD camera. As addressed in the "Kitchen Scene Context based Gesture Recognition" dataset, the cooking actions should be recognized by both the human action and the objects interacting with the human. In our framework, these two kinds of information are respectively extracted by encoding the appearance and motion of the human skin area and the object area in the videos.

Stability of Matrix Factorization for Collaborative Filtering

Candidate:
Wang Yuxiang

Supervisor/s:
Cheong Loong Fah; Xu Huan

Abstract:
We study the stability vis a vis adversarial noise of matrix factorization algorithm for matrix completion. In particular, our results include: (I) we bound the gap between the solution matrix of the factorization method and the ground truth in terms of root mean square error; (II) we treat the matrix factorization as a subspace fitting problem and analyze the difference between the solution subspace and the ground truth; (III) we analyze the prediction error of individual users based on the subspace stability. We apply these results to the problem of collaborative filtering under manipulator attack, which leads to useful insights and guidelines for collaborative filtering system design.

SESSION 2

FEBRUARY 27, 2013(DAY 1)

1:30 PM to 3:30 PM

TRACK 1

COMMUNICATIONS & NETWORKS

LOCATION: EA-06-02

PRESENTERS		
1.	Neda Edalat	Combinatorial Auction-Based Task Allocation in Multi-Application Wireless Sensor Networks
2.	Alvin C. Valera	ETD: A Sleep Latency and Link Quality Aware Metric for Environmentally-Powered Wireless Sensor Networks
3.	Wu Gaofeng	Power-Profile-Aware Integrated Routing with Traffic Splitting in IP over WDM Networks
4.	Yu Wang	Cooperation-Based Asynchronous Directional MAC for Ad Hoc Networks with Considering Minor-Lobe Interference
5.	Anshoo Tandon	On the impact of channel coding on average packet delay in a polling based multiple access system

Combinatorial Auction-Based Task Allocation in Multi-Application Wireless Sensor Networks

Candidate:	Supervisor/s:
Neda Edalat	**Mehul Motani**

Abstract:

Wireless sensor networks (WSNs) are usually assigned tasks for a single application. Recently, the concept of shared sensor networks, which support multiple concurrent applications, has emerged, reducing the deployment and administrative costs, and increasing the usability and efficiency of the network. Supporting task allocation for multiple concurrent applications in sensor networks (such as target tracking, event detection, etc.) requires sharing applications' tasks (such as sensing, computation, etc.) and available network resources. In this paper, we model the distributed task allocation problem for multiple concurrent applications using a reverse combinatorial auction, in which the bidders (sensor nodes) bid the cost value (in terms available resources) for accomplishing the subset of the applications' tasks. The main objective is to maximize the network lifetime by sharing tasks and network resources among applications, while enhancing the overall application QoS (e.g., deadline). We also propose a heuristic two-phase winner determination protocol to solve the combinatorial reverse auction problem. Simulation results show that the proposed scheme offers efficiency and network scalability.

ETD: A Sleep Latency and Link Quality Aware Metric for Environmentally-Powered Wireless Sensor Networks

Candidate:	Supervisor/s:
Alvin C. Valera	**Soh Wee Seng, Tan Hwee Pink**

Abstract:

In environmentally-powered wireless sensor networks (EPWSN), low latency forwarding is challenging due to dynamic duty cycling, posing time-varying sleep latencies and necessitating the use of dynamic wakeup schedules. When a path needs to traverse multiple hops, determining the path that provides the least delay can be difficult because the nodes may have different duty cycles and therefore pose different sleep latencies. Existing metrics such as hop count and ETX do not consider sleep latency even though it is known to be a significant factor in the high end-to-end latency in EPWSN. To enable the selection of low latency and high reliability paths, we formulate a metric called expected transmission delay (ETD), which simultaneously considers sleep latency (due to duty cycling), and wireless link quality. We show that the metric is left-monotonic and left-isotonic, proving that its use in distributed algorithms such as the distributed Bellman-Ford will yield consistent, loop-free and optimal paths. We perform extensive simulations using real-world energy harvesting traces to evaluate the performance of the forwarding scheme.

Power-Profile-Aware Integrated Routing with Traffic Splitting in IP over WDM Networks

Candidate:	Supervisor/s:
Wu Gaofeng	**Mohan Gurusamy**

Abstract:

The energy efficiency in communication networks has drawn much attention of engineers and scientists in industry and academia worldwide due to the ever-rising energy consumption of the Internet and the corresponding environmental impact. In this paper, we focus on the power-efficient provisioning of connections in IP over WDM Networks. We adopt an integrated routing model of optical networks such that resources at the IP layer and optical layer are managed together, thereby leading to higher flexibility and better resource utilization. We divide the power consumption of an IP over WDM Network into five components, and each consumes a different amount of power. We analyze several power profiles for these components of which the difference lies in their ascending trends with the increase of the traffic load. We find that in terms of power efficiency, the convex energy profile is beneficial to traffic splitting which splits the traffic of a connection onto multiple paths. We propose an auxiliary graph which assigns the weight of a link according to its power consumption; thereby capturing the power consumption of a path conveniently.

Based on the auxiliary graph, we develop a power-profile-aware integrated routing algorithm with traffic splitting for minimizing the power consumption of a connection. Extensive performance evaluation shows that our algorithm is better than the power-profile-aware integrated routing algorithm.

Cooperation-Based Asynchronous Directional MAC for Ad Hoc Networks with Considering Minor-Lobe Interference

Candidate:	Supervisor/s:
Yu Wang	**Hari Krishna Garg, Mehul Motani**

Abstract:

Equipped with beamforming antennas, the directional transmission is capable to improve the system performance by increasing the spatial reusability. To exploit the benefit of directional transmission, efficient directional medium access control (DMAC) protocol is needed. Current DMACs rarely consider the impact of minor-lobes, thus ignoring the hidden terminal problem. In this paper, we focus on solving the hidden terminal problem for directional ad hoc networks. Existing solutions to directional hidden terminal problem rather need other equipments, which make the system more complex, or need global synchronization, which is difficult to achieve in the multihop environment. We propose Cooperation-based Asynchronous Directional MAC (CA-DMAC) which takes the cooperation to solve the hidden terminal problem and, at the same time, needs no additional equipment or global synchronization. The performance of CA-DMAC is validated in ns-2.35 simulator and the results show that CA-DMAC has good performance in terms of throughput and successful data packets transmission ratio.

On the impact of channel coding on average packet delay in a polling based multiple access system

Candidate:	Supervisor/s:
Anshoo Tandon	**Mehul Motani**

Abstract:

Delay sensitive applications such as gaming and video streaming require minimization of average packet delay, an important higher layer metric which directly affects the user experience. In this paper, we consider a polling based multiple access scheme and study the impact of channel coding on the average packet delay where the link layer employs Automatic Repeat Request (ARQ) to provide error free packet transmission. The communication model assumes that users share a common physical channel and communicate with a central server which polls them for transmission in a cyclic order. Using the expression for the average waiting time for this model we prove that compared to an uncoded system, it is sufficient for a coding scheme to reduce the average service time in order to achieve lower average packet delay. We use the bounds on the minimum distance of linear codes to choose that code for which the reduction in number of retransmissions (due to decrease in probability of packet error) outweighs the increase in packet time (due to increase in packet length by channel coding) such that the average service time is minimized. We also show that ratio of average transmit energy for the coded and uncoded system is same as the ratio of the average service time for the coded and uncoded system, respectively, and hence the percentage reduction in average service time due to channel coding translates into an equal reduction in average transmit energy. Numerical examples are provided to highlight the tradeoffs involved in the choice of an appropriate channel coding scheme.

TRACK 2

CONTROL, INTELLIGENT SYSTEMS & ROBOTICS

LOCATION: EA-06-03

PRESENTERS		
1.	Hu Jun	A Hierarchical Organized Memory Model with Spiking Neurons
2.	Mohammadreza Chamanbaz	A Sequential Randomized Algorithm for Convex Optimization in the Presence of Uncertainty
3.	Ramesh Bharath	Scalable Scene Understanding Using Saliency-Guided Object Localization
4.	Wang Xiaoqiong	Computational Load Comparison of Multiplexed MPC and Standard MPC
5.	Yu Chao	Improved System Identification with Renormalization Group

A Hierarchical Organized Memory Model with Spiking Neurons

Candidate:	Supervisor/s:
Hu Jun	**Tan Kay Chen**

Abstract:

The recent identification of neural cliques coding for memory in the hippocampus enables population coding to be the neuronal representation of memory. Moreover, these memory-coding units have been observed organizing in a hierarchical manner. Here, we present a hierarchical organized memory model with spiking neurons, which could store both auto-associative memory and episodic memory with temporal population codes. This hierarchical model is composed of three basic layers (input neuron layer, pyramidal cell layer and interneuron layer) with different functions and can be extended to more complicated networks by duplicating and connecting the basic three-layer structure. The spiking neural network with theta/gamma oscillations is able to store spatiotemporal memory items within gamma sub-cycles. Spiking-timing-dependent plasticity (STDP) contributes to the formation of both auto-associative memory and episodic memory.

A Sequential Randomized Algorithm for Convex Optimization in the Presence of Uncertainty

Candidate:	Supervisor/s:
Mohammadreza Chamanbaz	**Thomas Liew Yun Fook, Venkatakrishnan Venkataramanan, Qing-Guo Wang**

Abstract:

In this paper, we study two sequential randomized algorithms for solving any uncertain convex optimization problem. The main philosophy of the paper is to solve convex optimization problems subject to a finite number of random constraints with increasing cardinality Nk. Parallel validation sample sets of cardinality Mk are also generated to check the probabilistic feasibility of the candidate solution obtained from the optimization procedure at each step. In comparison with the well-known scenario approach, our algorithms are much less computationally expensive. In the first sequential randomized algorithm, we do not allow any validation sample to violate constraints while, in the second sequential randomized algorithm of the paper, we allow a number of validation samples to violate constraints. The effectiveness of algorithms is proved in the extensive simulations.

Scalable Scene Understanding Using Saliency-Guided Object Localization

Candidate:	Supervisor/s:
Ramesh Bharath	**A/Prof. Xiang Cheng, Prof. T. H. Lee**

Abstract:

Given an image, scene understanding is the process of segmenting and identifying the objects present, and classifying the overall scene. Several frameworks already exist to perform these tasks coherently but training of their probabilistic models is time consuming thereby limiting their scalability. This paper presents a scalable framework adopting an object-based deterministic approach. The steps taken by the algorithm are saliency detection for unsupervised object discovery, graph-cut for object segmentation and binary decision trees for scene classification. A region of interest (ROI) detector is proposed to automatically provide object location priors from saliency maps for graph-cut. We tested our system on a novel NUS/NTU dataset and compared the scene classification accuracy using different classifiers. Unlike other existing frameworks, the proposed algorithm is scalable and can easily accommodate more object and scene classes.

Computational Load Comparison of Multiplexed MPC and Standard MPC

Candidate:
Wang Xiaoqiong

Supervisor/s:
Ho Weng Khuen

Abstract:
A variant of Model Predictive Control, called Multiplexed MPC has been proposed recently. The motivation for Multiplexed MPC is to reduce real-time computational load. Experiments were carried out to compare the computational load of Multiplexed MPC and standard MPC. The experiments were carried out on a multizone thermal processing equipment commonly used in semiconductor manufacturing. The results showed that Multiplexed MPC has computational advantage over the standard MPC, for large horizon and when constraints are presence.

Improved System Identification with Renormalization Group

Candidate:
Yu Chao

Supervisor/s:
Wang Qing-Guo

Abstract:
This paper proposes an improved system identification method with Renormalization Group. Renormalization Group is applied to a fine data set to obtain a coarse data set. The least-squares algorithm is performed on the coarse data set. The theoretical analysis under certain conditions shows that the parameter estimation error could be reduced. The proposed method is illustrated with examples.

TRACK 3

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-04

PRESENTERS		
1.	Yeo Jueyuan Reuben	Tribological and corrosion performance of surface modified commercial hard disk media
2.	Maria Patricia Rouelli Garcia Sabino	Effects of lateral size and material properties on the ferromagnetic resonance response of spinwave eigen-modes in magnetic devices
3.	Meng Zhaoliang	Perpendicular magnetized CoFe/Pd multilayer films for spin-transfer torque applications
4.	Loong Li Ming	The effects of buffer layer materials on Co2FeAl0.5Si0.5 Heusler thin films

Tribological and corrosion performance of surface modified commercial hard disk media

Candidate: Yeo Jueyuan Reuben
Supervisor/s: Prof C. S. Bhatia, A/P Christina Lim, Dr Sudhiranjan Tripathy

Abstract:
Ferromagnetic metals and their alloys are used as the recording media in commercial hard disks today due to their ability to store data based on their direction of magnetization. The recording media today is protected by a diamond-like carbon (DLC) overcoat (~2-3 nm) and a layer of perfluoropolyether (PFPE) lubricant (~1-2 nm). To obtain higher areal recording densities for future hard disks, one of the requirements is to reduce the head-media spacing, which necessitates the reduction of the overcoat and lubricant thicknesses. However, without adequate protection, the media is susceptible to wear and corrosion, which could result in data loss. In this research, a new bi-level C+ ion embedment technique was developed to create an ultra-thin atomically mixed layer at the topmost surface of commercial hard disk media, which may offer similar or better wear and corrosion protection as compared to available commercial hard disks. The effect of this surface modification technique on the tribological and corrosion performance of commercial media was investigated. Our results indicate that the surface modified commercial media showed improved tribological properties as well as similar corrosion resistance when compared to as-received commercial disks. This work could potentially lead to the development of new generation ultra-thin overcoats for future hard disks.

Effects of lateral size and material properties on the ferromagnetic resonance response of spinwave eigen-modes in magnetic devices

Candidate: Maria Patricia Rouelli Garcia Sabino
Supervisor/s: Thomas Liew

Abstract:
We analyze the effects of lateral device size and magnetic material parameters on the ferromagnetic resonance (FMR) response. Results presented are directly relevant to widely used FMR experimental techniques, which is used to extract magnetic parameters from thin films that are often assumed to carry over to corresponding nanometer-sized patterned devices. We show that there can be significant variation in the FMR response with device size, and that the extent of the variation depends on the magnetic material properties. This explains, for example, why different experiments along these lines have yielded different size-dependent trends from damping measurements. Observed trends with increasing size and different material parameters are explained through the evolution of three distinct eigen-modes, demonstrating the effects of demagnetization and exchange. It is also shown that there is a crossover of dominant modes in the response signal, accompanied by conjugating edge-type eigen-modes, leading to evident effects in linewidth and damping. In some cases we observe a strong increase in apparent damping due solely to device size variations.

Perpendicular magnetized CoFe/Pd multilayer films for spin-transfer torque applications

Candidate: Meng Zhaoliang
Supervisor/s: Teo kie Leong

Abstract:
Perpendicular magnetic anisotropy (PMA) and modifiable magnetic properties have been investigated in thin CoFe/Pd multilayers with a stack structure of Ta 50Å/Pd 50Å/[CoFe 4Å/Pd t]6/Ta 20Å (t=10-20Å). The stack multilayer films were deposited on silicon dioxide substrates through DC sputtering in an ultrahigh vacuum chamber. The X-ray diffraction (XRD) analysis manifested the strong face-centered cubic (fcc) structure of Pd seed layer. In addition, full width at half maximum (FWHM) at the rocking curve (Δθ50) of the Pd fcc (111) peak, indicated a function that the fcc textures of Pd seed layer slightly improve as Pd thickness increasing. All the samples with different Pd thickness showed strong PMA, low saturation magnetization (Ms) as well as high uniaxial magnetic anisotropy (Ku) under alternating gradient magnetometer (AGM) measurement. It is demonstrated that Ms exponentially decreased from 280emu/cc to 155emu/cc, with the thickness of the Pd spacing layer increases from 10Å to 20Å. Meanwhile, Ku decreases as an inversely exponential function with Pd spacing layer thickness augment. The non-magnetic Pd spacers inserted between the CoFe magnetic layers weaken the ferromagnetic coupling, which attribute to Ms and Ku decline. It is ascribed that the PMA in the studied films is contributed by the interfacial anisotropy of the CoFe/Pd interfaces and the <111> texture of the fcc CoFe layers induced by a thick Pd seed layer. These advantages of

magnetic properties indicated that the studied CoFe/Pd multilayer films have potential to be applied in small-bit and low-energy spin-torque data storage devices.

The effects of buffer layer materials on Co2FeAl0.5Si0.5 Heusler thin films

Candidate:	Supervisor/s:
Loong Li Ming	**Asst. Prof. Yang Hyunsoo**

Abstract:

Co2FeAl0.5Si0.5 (CFAS) is a half-metallic Heusler compound. Such compounds are promising for spintronics applications due to their high spin polarization, which arises from their half-metallicity. The crystal structure of a Heusler compound has significant effects on its half-metallicity. Thus, the material and growth conditions of the buffer layer, which acts as the template for the growth of the Heusler thin film, play an important role in optimizing the properties of the half-metallic Heusler film. In this study, CFAS Heusler films were grown using different buffer layer materials such as Cr, Ag, Pt, and bilayer combinations of these materials on MgO single crystal substrates by a magnetron sputtering technique. The buffer layer materials were selected based on the compatibility of their lattice constants and crystal structures with CFAS. Their effects on CFAS were studied using x-ray diffraction (XRD), vibrating sample magnetometry (VSM), and time-resolved magneto-optic Kerr effect (TR-MOKE). The desired B2 crystal structure was obtained using different buffer materials, particularly Cr, the Cr/Ag bilayer, and Ag. However, the quality of crystallinity, magnetic hysteresis behavior and TR-MOKE oscillatory behavior were altered, when different buffers were used. For example, the crystal structure order parameter, magnetic coercivity, and TR-MOKE oscillation period changed, when different buffers were utilized. Thus, the buffer layer plays an important role in engineering the properties of CFAS.

TRACK 4

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-05

PRESENTERS		
1.	Huang Wen	Thermoelectric Performance of Transition-Metal Dichalcogenides
2.	Lwin Min Kyaw	Gold-free InAlN/GaN Schottky Gate HEMT on Si (111) Substrate with ZrO2 Passivation
3.	Cheng Ran	A New Liner Stressor (GeTe) featuring Stress Enhancement due to Very Large Phase-Change Induced Volume Contraction for p-Channel FinFETs
4.	Goh Kian Hui	Selective Growth of Gallium Arsenide on Germanium Fins with Different Orientations

Thermoelectric Performance of Transition-Metal Dichalcogenides

Candidate: Huang Wen
Supervisor/s: Gengchiau Liang

Abstract:
Two-dimensional semiconductor materials formed by transition-metal dichalcogenide layered structures have attracted great interests due to a wide range of important properties. Using ab-initio method and ballistic transport model, we study the electron and phonon energy dispersion relations of monolayer transition-metal dichalcogenides: MoS2, MoSe2, WS2 and WSe2, and their electron/heat transport as well as their thermoelectric properties based on ballistic transport under linear response regime with different doping types, crystal orientations and temperatures. The layer dependence is also studied for MoS2 and WSe2. Our results show that electron and phonon transport are not very sensitive to the crystal orientations because group velocity and transmission of these carriers are only slightly different for different transport directions. Furthermore, as temperature increases, first peak values of thermoelectric figure of merit (ZT1st peak) increase linearly except for monolayer n-type WSe2/MoSe2 and p-type WS2, which have higher increasing rates when temperature is high due to the electron transport contribution from an additional valley. Among these various conditions, the results show that all monolayers have similar ZT1st peak at low temperature below 100 K, and p-type monolayer MoS2 has the largest ZT1st peak at room temperature while n-type WSe2 has the largest ZT1st peak at high temperature. As the number of layer increases, ZT1st peak decreases except for bilayer n-type MoS2 which has a higher ZT1st peak than monolayer n-type MoS2 since the increase in electrical conductance outperforms the increase in thermal conductance.

Gold-free InAlN/GaN Schottky Gate HEMT on Si (111) Substrate with ZrO2 Passivation

Candidate: Lwin Min Kyaw
Supervisor/s: CHOR ENG FONG, SUDHIRANJAN TRIPATHY

Abstract:
InAlN/GaN High Electron Mobility Transistors (HEMTs) are promising candidates for high speed and high power applications owing to its high thermal stability and high Two Dimension Electron Gas (2DEG) concentration. However, cost is the challenge for InAlN/GaN HEMT to compete with other semiconductor devices. By growing InAlN/GaN HEMT structure on Si substrate for economy of scale and developing Si compatible fabrication processes to allow the making of InAlN/GaN HEMT in current Si fabrication foundries would make InAlN/GaN HEMTs more cost competitive. Traditional contacts of InAlN/GaN HEMTs are gold based, which are not welcome in Si fabrication foundries as gold is a deep level trap for Si and is very diffusive in Si, which can degrade the Si device performance. Therefore, we aim to develop non-gold based contacts for InAlN/GaN HEMTs to reduce the cost and in this paper, we report our investigations on gold-free InAlN/GaN Schottky gate HEMT on Si(111) substrate with ZrO2 passivation. The source/drain ohmic contacts are Ti/Al/Ni/W and the gate metal is Ni/W. Ti/Al/Ni/W ohmic contact property was investigated using Transmission Line Method (TLM) structure. Schottky diodes with different Ni/W thickness ratios were fabricated to investigate the Schottky barrier height (SBH) of Ni/W on InAlN/GaN under different annealing temperatures. We used InAlN/GaN HEMT structure grown on 4-inch Si(111) substrate and fabricated 2 μm gate length Ni/W Schottky gate HEMTs with Ti/Al/Ni/W source/drain contacts. The sheet resistance of the InAlN/GaN HEMT structure was 600 Ω/□ using Hall measurements. Mesa isolation of HEMTs was etched by inductively coupled plasmas using BCl3/Cl2 gases. After mesa isolation, Ti/Al/Ni/W source/drain contacts were sputter deposited, followed by annealing at 900 oC for 1 minute in vacuum. Prior to gate metal deposition, O2 plasma surface treatment was performed. The Schottky gate contact (Ni/W) was then sputtered. Finally, ZrO2, was deposited using Atomic Layer Deposition (ALD) for device passivation. Ti/Al/Ni/W on InAlN/GaN has a minimum contact resistivity (ρc) of 1.03x10-6 Ωcm2 and contact resistance of 0.35 Ωmm when annealed at the temperature of 900 oC for 1 minute in vacuum. SBH of Ni/W on InAlN/GaN increases with increasing Ni/W ratio. As the annealing temperature increases, the reverse leakage current increases while the forward bias current and SBH improves. Above 600 oC, the leakage current increases and Schottky contact degrades. The optimum annealing temperature for Ni/W Schottky gate on InAlN/GaN was 400 oC. Maximum SBH of 0.96 eV and ideality factor of 2.97 were achieved. Relatively high ideality factor are due to the domination of tunneling current through the dislocation defects in InAlN layer, as discussed in the work of Donoval [2]. Devices without passivation achieve a maximum gm of 120 mS/mm and Ron of 12 Ω/mm, while those with ZrO2 passivation attain a higher maximum gm of 160 mS/mm and a lower Ron of 10 Ω/mm. In conclusion, we have fabricated InAlN/GaN Schottky gate HEMTs grown on Si (111) substrate with non-gold based contacts

(Ti/Al/Ni/W ohmic and Ni/W Schottky) We have also demonstrated that ZrO2 passivation layer helps improve the DC characteristics of InAlN/GaN HEMT.

A New Liner Stressor (GeTe) featuring Stress Enhancement due to Very Large Phase-Change Induced Volume Contraction for p-Channel FinFETs

Candidate: **Cheng Ran**
Supervisor/s: **Yeo Yee-Chia**

Abstract:
We report the first demonstration of a novel GeTe liner stressor which exhibits very large volume contraction during phase-change, and its integration in p-channel FinFETs for strain engineering. Conformally grown GeTe liner with different thicknesses was formed on FinFETs with ultra-scaled gate length LG down to ~3 nm. When GeTe changes phase from amorphous (α-GeTe) to crystalline state (c-GeTe), GeTe liner contracts and compresses the Si source/drain region in the fin, leading to very high channel stress. Significant drive current IDsat enhancement of 69% and 106% were observed for FinFETs with 30 nm and 50 nm c-GeTe liner stressor over the control devices, respectively.

Selective Growth of Gallium Arsenide on Germanium Fins with Different Orientations

Candidate: **Goh Kian Hui**
Supervisor/s: **Yeo Yee Chia**

Abstract:
Heterogeneous integration of high-quality GaAs on Ge fins with different orientations was demonstrated for the first time using Metal Organic Chemical Vapor Deposition (MOCVD). Anti-Phase Domain (APD) formation was effectively suppressed using a substrate with 10˚ offcut. Through extensive characterization with Secondary Electron Microscope (SEM) and Transmission Electron Microscope (TEM), the evolution of GaAs facets with Ge fins rotation is successfully captured and described in a model. This enables the engineering of preferred channel surface orientation for high-mobility III-V MOSFETs.

TRACK 5

MICROWAVE & RF

LOCATION: EA-06-06

PRESENTERS		
1.	Huang Guanlong	Design of Waveguide Feed-Network For Low Sidelobe Array Antenna Application
2.	Lu Wei Jia	A Wideband Compact Broadside Coupler-based Impedance Transformer with 6:1 Bandwidth
3.	Ramanan Balakrishnan	Multiple polarization capabilities of sinuous antennas
4.	Sun Hucheng	An Adaptive Reconfigurable Rectifier for Wireless Power Transmission

Design of Waveguide Feed-Network For Low Sidelobe Array Antenna Application

Candidate:	Supervisor/s:
Huang Guanlong	**Yeo Tat Soon**

Abstract:

A corporate waveguide feed-network is proposed for low sidelobe array antenna application. Firstly, a basic in-phase but unequal-power T junction divider is designed to form a large waveguide feed-network. A 20dB Taylor N_bar=2 synthesis method is applied in the design of 4×4 corporate feed-network. All the output ports of the waveguide network can achieve the expected power ratios with good phase balance and return loss better than 24dB. Finally, an 8×8 corporate feed-network with 30dB Taylor N_bar=3 synthesis is built up and applied in a 16×16 Ku-Band slot array antenna to form a quasi-Taylor power distribution. Results show that, at typical frequency 15.0GHz, the first-sidelobe levels in E- and H-plane can achieve -28.2dB and -33.4dB, respectively, and overall sidelobe levels are lower than -27.1dB.

A Wideband Compact Broadside Coupler-based Impedance Transformer with 6:1 Bandwidth

Candidate:	Supervisor/s:
Lu Wei Jia	**Koen Mouthaan**

Abstract:

A compact broadband impedance transformer using a broadside coupler is presented. The tradeoff between good return loss and design parameters that can be realistically implemented is considered during the design. To implement the coupler and the required high impedance transmission line, a combination of stripline and microstrip is used. The circuit transforms 50 Ω to 100 Ω from 1 GHz to 6 GHz. The measured return loss is larger than 15 dB from 1.1 GHz to 6.4 GHz. In general, the measured results agree well with the simulated results.

Multiple polarization capabilities of sinuous antennas

Candidate:	Supervisor/s:
Ramanan Balakrishnan	**Koen Mouthaan**

Abstract:

Sinuous antennas are investigated for possibility of usage in situations requiring multiple polarizations. These antennas can be considered to be a variation of the traditional equiangular spiral antenna. The sinuous antenna, by virtue of its folded spiral structure, is able to exhibit multiple polarization modes. Two- and four-arm sinuous antennas in their self-complementary form also provide consistent input impedance over a wide bandwidth. It is shown that by varying the phases of the feed inputs to the antenna, different polarization modes can be obtained. Each of the modes demonstrates consistent gain, axial ratio and wide beam width at the bore sight direction over a broad frequency range. Results obtained through electromagnetic simulations will be presented together with the design parameters commonly used for sinuous antennas.

An Adaptive Reconfigurable Rectifier for Wireless Power Transmission

Candidate:	Supervisor/s:
Sun Hucheng	**Guo Yongxin**

Abstract:

A novel adaptive rectifier for wireless power transmission (WPT) applications is presented in this symposium. By utilizing a MOSFET switch, the configuration of the rectifier can automatically adapt to the input power level. Compared with traditional rectifiers, it can provide a consistent high RF-to-dc power conversion efficiency (PCE) over a significantly extended operating input power range. Measured results show that the PCE of this proposed adaptive rectifier keeps above 50% in the input power range spanning from -14 dBm up to 21 dBm. Additionally, maximum PCE of more than 75% is achieved in the input power range from 5 dBm to 15 dBm.

TRACK 6

SIGNAL PROCESSING & NEW MEDIA

LOCATION: EA-06-07

PRESENTERS		
1.	Cai Lile	Automatic Transfer Function Design Based on Histogram Segmentation and Visibility Distribution
2.	Lee Choon Meng	Motion Segmentation
3.	Rakesh Shiradkar	Reflectance based classification of ink strokes in a document
4.	MohammadReza Keshtkaran	Adaptive Power Line Interference Cancellation in Neural Recording

Automatic Transfer Function Design Based on Histogram Segmentation and Visibility Distribution

Candidate: **Cai Lile**
Supervisor/s: **Ong Sim Heng**

Abstract:
Transfer functions play a key role in volume visualization. In this paper, we present a system for automatic transfer function design based on histogram segmentation and visibility distribution. The 2D transfer function space is divided into meaningful segments by graph-based segmentation method. In order to obtain a rendered image with desired visibility distribution, the opacity of each segment is decided by an optimization process which minimized the Jensen-Shannon divergence between the observed visibility distribution and a desired visibility distribution. When tested on medical volume datasets, our method was able to clearly visualize the key structures within the volumes while requiring only minimal user intervention.

Motion Segmentation

Candidate: **Lee Choon Meng**
Supervisor/s: **Cheong Loong Fah**

Abstract:
We explore the model selection aspect of motion segmentation. Factor graph was only introduced recently to motion segmentation as an alternative for spectral clustering. The factor graph main attraction is the use of function potential as a mean for modeling cost function so as to achieve model selection. We show how factor graph with an appropriate chosen cost function can be used for model selection in motion segmentation.

Reflectance based classification of ink strokes in a document

Candidate: **Rakesh Shiradkar**
Supervisor/s: **Ong Sim Heng**

Abstract:
Classification of ink strokes is a problem of considerable interest in applications such as forensics (questioned document examination), historical manuscripts etc. We propose a novel reflectance based method of classifying different inks which can be executed using a simple hand held flashlight – camera set up (such as an iPhone). This method offers advantages of inexpensive and simple experimental conditions and non destructive analysis of the sample over the often used spectral based methods.
We first establish that reflectance profiles of inks can be used in classifying different inks due to their distinctiveness. We later demonstrate that reflectance profiles in case of hand held flashlight – camera set up can classify different inks on a flat sample document. The method is extended to the real case of a curved document achieving segmentation and classification of inks. The results show that reflectance of ink material can be a useful and promising basis for classification of ink strokes in any arbitrary document.

Adaptive Power Line Interference Cancellation in Neural Recording

Candidate:	Supervisor/s:
MohammadReza Keshtkaran	**Zhi Yang**

Abstract:

This paper presents an algorithm for removing power line interference in neural recording experiments. It does not require any interference reference signal and can reliably track interference changes in frequency, phase, and amplitude. The method includes three major steps. First, it employs a robust frequency estimator to obtain the fundamental frequency of the interference. Second, a series of discrete-time oscillators are used to generate interference harmonics, where harmonic phase and amplitude are obtained using the recursive least squares (RLS) algorithm. Third, the estimated interference harmonics are removed without distorting the neural signals at the interference frequencies. The simple structure and adequate numerical behavior of the algorithm renders it suitable for real-time implementation. Extensive experiments based on both in-vivo and synthesized data have been performed, where a reliable performance has been observed.

SESSION 3

FEBRUARY 27, 2013(DAY 1)

4:00 PM to 6:00 PM

TRACK 1

COMMUNICATIONS & NETWORKS

LOCATION: EA-06-02

PRESENTERS		
1.	Yu Yi	OSNR Monitoring in High-Speed Optical Transmission Systems by Using Novel Notch Filter Effect
2.	Xu Zhuoran	Adaptive Maximum Likelihood Sequence Detection in 100-Gb/s Coherent Optical Communication Systems
3.	Le Sy Quoc	Capacity region of the symmetric linear deterministic interference channel with partial feedback
4.	Aissan Dalvandi	Joint Flow Scheduling and VM Placement for Maximizing Data Center Power Efficiency
5.	Jia Chenlong	Energy Harvesting Ad Hoc Networks: Outage Probability and Network Connectivity

OSNR Monitoring in High-Speed Optical Transmission Systems by Using Novel Notch Filter Effect

Candidate:	Supervisor/s:
Yu Yi	**Yu Changyuan**

Abstract:

In this paper, we propose an OSNR monitoring scheme by using optical notch filtering effect. The notch filtering effect is generated by the destructive branch of interferometer. A band pass filter is used to replace the delay line in delay interferometer to generate notch filtering effect. The RF power ratio between the destructive and constructive branches can be used to estimate OSNR values. The monitoring dynamic range is improved, compared with that using ODI method. Moreover, low bandwidth photo detector used in this monitoring scheme provides low cost and dispersion insensitive merits. The proposed OSNR monitoring method is demonstrated in 10-Gb/s and 40-Gb/s systems by simulation.

Adaptive Maximum Likelihood Sequence Detection in 100-Gb/s Coherent Optical Communication Systems

Candidate:	Supervisor/s:
Xu Zhuoran	**Yu Changyuan, Kam Pooi-Yuen**

Abstract:

A novel adaptive MLSD algorithm is introduced and experimentally demonstrated for a 100-Gb/s PDM-DQPSK system to automatically achieve optimal performance and reduce receiver complexity using a first-order filter for phase reference tracking.

Capacity region of the symmetric linear deterministic interference channel with partial feedback

Candidate:	Supervisor/s:
Le Sy Quoc	**Mehul Motani**

Abstract:

The linear deterministic interference channel (LDIC) with partial feedback is considered. Partial feedback for the LD-IC models a scenario in which the top l most-significant bits of the channel output of receiver j are received as feedback at transmitter j, for j = 1; 2. The rationale for studying the LD-IC with partial feedback comes from the fact that it is a good approximation to the Gaussian interference channel with output feedback corrupted by additive white Gaussian noise (commonly referred to as noisy feedback). The main contribution of this paper is to characterize the capacity region of the symmetric LD-IC with partial feedback. The main ingredient of the proof is to obtain novel upper bounds on weighted rates 2R1 + R2 and R1 + 2R2.

Joint Flow Scheduling and VM Placement for Maximizing Data Center Power Efficiency

Candidate:	Supervisor/s:
Aissan Dalvandi	**Mohan Gurusamy, Kee Chaing Chua**

Abstract:

Energy saving problem has become increasingly important in the operation of networking infrastructure, especially in data centre networks. Although several energy efficient strategies have been proposed, a comprehensive approach which considers two major components of data centre power usage _ Network, Server _ and their effects on each other has not been explored. In other words, servers as hosts of Virtual Machines (VM) which generate traffic can affect network's power that is influenced by traffic flowing through the network. Therefore, joint consideration of power of each component based on their utilization can more accurately control data centre power usage. In our work, we develop an efficient approach to maximize data centre power efficiency that schedules demands and place VM, based on the network topology, network traffic and physical server resource while satisfying as many network demands as possible. We develop an ILP formulation for the optimization problem which jointly considers VM placement and

routing while scheduling flows. We show that the problem is NP-complete, and develop a hast and scalable heuristic algorithm. Next, we compare results of our proposed heuristic and optimal results (obtained by solving the ILP problem using CPLEX) for a small data centre network with a CLOS topology. Further, we verify the effectiveness of the heuristic algorithm for large networks using simulation experiments. The simulation results demonstrate that our approach not only reduces the total power but also satisfies more network demands.

Energy Harvesting Ad Hoc Networks: Outage Probability and Network Connectivity

Candidate:	Supervisor/s:
Jia Chenlong	**Lim Teng Joon**

Abstract:

In ad hoc networks, node density lambda and node transmission range r impact the quality of one-hop transmission, as well as the connectivity of the entire network. In this paper, we study the relationship between outage probability, full-connectivity probability and (r,lambda) pairs, when nodes are distributed as a Poisson point process and have interference suppression capability characterized by a factor eta. Specifically, we derive the feasible (r,lambda) region that meets both outage probability and full-connectivity requirements. The analysis is based on combining known results on interference distribution and continuum percolation theory. We then extend the results to an ad-hoc network with energy harvesting nodes. Two kinds of energy harvesting networks are discussed. One has all nodes in the network transmitting with equal but random power Pt. The other assumes that transmission powers at nodes are independent identically distributed (iid) random variables. Our results confirm the intuition that a higher node density is required to overcome the additional randomness brought about by energy harvesting.

TRACK 2

CONTROL, INTELLIGENT SYSTEMS & ROBOTICS

LOCATION: EA-06-03

PRESENTERS		
1.	Chen Qiang	Efficient Maximum Appearance Search for Large-Scale Object Detection
2.	Gee Sen Bong	A Novel Diversity Maintenance Scheme for Evolutionary Multiobjective Optimization
3.	Vu Hoang Dung	Influence Function Analysis of Parameter Estimation with Generalized t Distribution Noise Model
4.	Yang Yue	Robust Identification of Piecewise Affine Systems from Noisy Data
5.	Yu Qiang	Temporal Coding of Local Spectrogram Features for Robust Sound Recognition

Efficient Maximum Appearance Search for Large-Scale Object Detection

Candidate:	Supervisor/s:
Chen Qiang	**Yan Shuicheng**

Abstract:

In recent years, efficiency of large-scale object detection has arisen as an important topic due to the exponential growth in the size of benchmark object detection datasets. Most current object detection methods focus on improving accuracy of large-scale object detection with efficiency being an afterthought. In this paper, we present the Efficient Maximum Appearance Search (EMAS) model which is an order of magnitude faster than the existing state-of-the-art large-scale object detection approaches, while maintaining comparable accuracy. Our EMAS model consists of representing an image as an ensemble of densely sampled feature points with the proposed Point wise Fisher Vector encoding method, so that the learnt discriminative scoring function can be applied locally. Consequently, the object detection problem is transformed into searching an image sub-area for maximum local appearance probability, thereby making EMAS an order of magnitude faster than the traditional detection methods. In addition, the proposed model is also suitable for incorporating global context at a negligible extra computational cost. EMAS can also incorporate fusion of multiple features, which greatly improves its performance in detecting multiple object categories. Our experiments show that the proposed algorithm can perform detection of 1000 object classes in less than one minute per image on the Image Net ILSVRC2012 dataset and for 107 object classes in less than 5 seconds per image for the SUN09 dataset using a single CPU.

A Novel Diversity Maintenance Scheme for Evolutionary Multiobjective Optimization

Candidate:	Supervisor/s:
Gee Sen Bong	**Tan Kay Chen**

Abstract:

Diversity and convergence are two main goals of search process in evolutionary multiobjective optimization (EMO) algorithm. In the literature, different concepts, such as clearing, crowding and weight vector approach, have been introduced into the design of the EMO algorithms in order to strike the balance between these two goals. In the presence of the local optimum, the existing diversity preservation scheme may not be able to prevent the population traps into local minimum. In this paper, we propose a new diversity maintenance scheme and embed it into the well-known decomposition-based multiobjective evolutionary algorithm (MOEA/D). The new algorithm, namely Diversity Preservation Multiobjective Evolutionary Algorithm based on Decomposition (DivPre-MOEA/D), which controls the maximum allowable diversity loss during the search process to preserve the diversity of the whole population. The proposed algorithm relaxes the dependency of the weight vector approach on approximated ideal vector to maintain the diversity of the population. In addition, the algorithm also prevents the existence of duplicated solution in the approximated Pareto front. To further enhance the searching ability of the algorithm, a hybrid recombination strategy is incorporated into DivPre-MOEA/D. The proposed algorithm is evaluated on both Walking Fish Group (WFG) and CEC-09 test suites. The experiment results show that DivPre-MOEA/D can provide better spread solutions along the Pareto front without significantly sacrificing its conver-gence properties. DivPre-MOEA/D also outperforms other major multiobjective evolutionary algorithms, in terms of inverted generational distance (IGD), in most of the test problems.

Influence Function Analysis of Parameter Estimation with Generalized t Distribution Noise Model

Candidate:	Supervisor/s:
Vu Hoang Dung	**HO WENG KHUEN**

Abstract:

Commonly made assumption of Gaussian noise is an approximation to reality. In this paper, we used the influence function in robust statistics to analyze a parameter estimator that modeled noise with the Generalized t (GT) distribution instead of the usual Gaussian noise. The analysis is extended to the case where the estimator designed with probability density function f(e) is applied to actual noise with different probability density function g(e) at different sampling instance, k, to provide a framework for analysis of outliers. By being a superset encompassing Gaussian, uniform, t and double exponential distributions, GT distribution has the flexibility to characterize data with non-Gaussian statistical properties. Equations derived are useful in determining the variance of the estimates and the

impact of outliers. These equations enable us to compute the sample size needed by the estimator to meet specified variance or to tune the estimator to limit the impact of outliers. The theory is verified through simulations and an experiment on the Chemical Mechanical Polishing of Semiconductors.

Robust Identification of Piecewise Affine Systems from Noisy Data

Candidate:	Supervisor/s:
Yang Yue	**Xiang Cheng, Lee Tong Heng**

Abstract:

In this paper, we focus on the identification of discrete-time piecewise affine (PWA) systems from noisy data. This problem consists of the estimation of both the local affine subsystems and the partition of the regression space. A twostage robust identification approach is proposed to estimate the local affine subsystems in the presence of noise. This approach includes an optimization-based initial estimation process and a least-squares-based refinement procedure. In addition, to estimate the partition of the regression space for continuous dynamic PWA systems, an intersection approach is proposed as an alternative to the widely used pattern recognition approaches. Simulation studies demonstrate the effectiveness of the twostage identification approach and the intersection approach in noisy case.

Temporal Coding of Local Spectrogram Features for Robust Sound Recognition

Candidate:	Supervisor/s:
Yu Qiang	**TAN Kay Chen**

Abstract:

There is much evidence to suggest that the human auditory system uses localized time-frequency information for the robust recognition of sounds. Despite this, conventional systems typically rely on features extracted from short windowed frames over time, covering the whole frequency spectrum. Such approaches are not inherently robust to noise, as each frame will contain a mixture of the spectral information from noise and signal. Here, we propose a novel approach based on the temporal coding of Local Spectrogram Features (LSFs), which generate spikes that are used to train a Spiking Neural Network (SNN) with temporal learning. LSFs represent robust location information in the spectrogram surrounding key points, which are detected in a signal-driven manner such that the effect of noise on the temporal coding is reduced. Our experiments demonstrate the robust performance of our approach across a variety of noise conditions, such that it is able to outperform the conventional frame-based baseline methods.

TRACK 3

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-04

PRESENTERS		
1.	Ding Junjia	Magnonic Crystals Based on Binary Ferromagnetic Nanostructure
2.	Liu Xinming	Static and Dynamic Behaviors of Fe Filled Ni80Fe20 Antidot Nanostructures
3.	Phua Wee Kee	Voltage modulated Metal-Insulator-Metal waveguide
4.	Mai Trong Thi	DYNAMICS OF WICKING ON SILICON NANOSTRUCTURED SURFACES

Magnonic Crystals Based on Binary Ferromagnetic Nanostructure

Candidate: Ding Junjia
Supervisor/s: Adekunle Adeyeye

Abstract:
There has been a growing interest in the fundamental understanding of the spin wave propagation in "magnonic crystals" (MCs) because of their potential in a wide range of applications. To fully exploit MCs in applications, the key challenge associated with the nano fabrication of tunable bi-components magnonic crystals consisting of two contrasting ferromagnetic materials must be resolved. In this work, we fabricated large area MCs consisting of one or two contrasting (Ni80Fe20/Ni80Fe20 and Ni/Ni80Fe20) ferromagnetic materials (FM) using a novel "self-aligned shadow deposition" technique. A tilt-table sample holder was specially designed and used in the shadow deposition process. A shadow area is formed on the left (right) hand side of the pattern when the material is deposited from right (left) of the sample. To create Ni/Ni80Fe20 binary structures with identical lateral dimension, the Ni and Ni80Fe20 materials were deposited on the right and left of the pattern (at ±35° away from the normal direction of the sample) sequentially, followed by the lift-off process. Two-step switching process is observed in the MOKE loop due to the distinct reversal of the Ni nanostructures (150 Oe) and Ni80Fe20 nanostructures (290 Oe) which corresponds to parallel and anti-parallel magnetization states. Two distinct absorption peaks are clearly identified in the ferromagnetic resonance measurement as a function of applied field. The higher and lower frequency mode originates from Ni80Fe20 and Ni sub-elements respectively due to the different saturated magnetization of the two materials. The stepwise change in the resonance frequency in the transition field range (190 Oe ~ 350 Oe) agrees with the two-step switching process in the MOKE results. MFM images show the parallel and anti-parallel alignment of the binary structures.

Static and Dynamic Behaviors of Fe Filled Ni80Fe20 Antidot Nanostructures

Candidate: Liu Xinming
Supervisor/s: Adekunle Olusola Adeyeye

Abstract:
Magnonic crystals (MCs) have received considerable attention recently due to their potential in a wide range of applications such as microwave resonators, filters and spin logic devices [1]. In this work, we present a systematic investigation of the static and dynamic behaviors of Fe filled Ni80Fe20 antidot nanostructures representing a 2-D MC. The structures were fabricated using a novel process we recently developed [2]. A representative SEM image of the Ni80Fe20(25 nm)/Fe(25 nm) structure is shown in Fig. 1(a). For controlled experiments, reference Fe(25 nm) dots array and Ni80Fe20(25 nm) antidot array were also fabricated during the same processing steps.
Shown in Fig. 1(b) is M-H loop of the Ni80Fe20/Fe structure. We observed a distinct three-step switching corresponding to vortex core formation of the Fe dots at Hs1, magnetization reversal of the Ni80Fe20 antidots at Hs2 and vortex core annihilation of Fe dots at Hs3. Interestingly, all the three switching fields show a significant decrease compared to the reference Fe dots and Ni80Fe20 antidots, as indicated by the dashed lines due to the strong mutual magnetostatic coupling between the Fe and Ni80Fe20 elements. Shown in Fig. 1(c) are ferromagnetic resonance (FMR) absorption spectra of the Ni80Fe20/Fe structure. Again we observed a drastic modification of the FMR mode profiles when compared with reference Fe dots and Ni80Fe20 antidots. Our experimental results are in qualitative agreement with both the static and dynamic micromagnetic simulations.
Reference:
[1] G. Duerr, M. Madami, S. Neusser, S. Tacchi, G. Gubbiotti, G. Carlotti, and D. Grundler, Appl. Phys. Lett. 99, 202502 (2011).
[2] X. M. Liu, J. Ding, and A. O. Adeyeye, Appl. Phys. Lett. 100, 242411 (2012).

Voltage modulated Metal-Insulator-Metal waveguide

Candidate:
Phua Wee Kee

Supervisor/s:
Daniel Shawn Pickard

Abstract:
We propose a novel approach to modulate waveguide modes in a Metal-Insulator-Metal (MIM) structure, that is, replacing the solid-state insulator with a vacuum and applying a voltage bias at the sides of the structure. The voltage bias will induce a Fowler-Nordheim (FN) tunneling current in the vacuum gap, which in turn changes the permittivity of the vacuum gap. We find that the permittivity of the vacuum gap is tunable by varying the gap separation and the voltage bias. Such a tunable permittivity enables an active modulation mechanism and it is possible to achieve better wave-guiding performance than conventional solid-state dielectrics. These findings will pave the way for the replacement of wave guiding mediums to achieve the best possible plasmonic or conventional photonics modes desired.

DYNAMICS OF WICKING ON SILICON NANOSTRUCTURED SURFACES

Candidate:
Mai Trong Thi

Supervisor/s:
Choi Wee Kiong

Abstract:
We present a theoretical and experimental study on the dynamics of capillary rise of liquid (or wicking) on different silicon nanostructured surfaces. By balancing the driving capillary forces in the rough surface and viscous dissipation forces caused by the nanostructures, we are able to come up with an equation to predict the wicking process without use of extensive empirical values. The model is validated against experimental observations of the wetting of silicon nanostructured surfaces with different geometries synthesized by interference lithography and metal-assisted chemical etching (IL-MACE) techniques. Excellent agreement between theoretical and experimental results was achieved.

TRACK 4

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-05

PRESENTERS		
1.	Meng Lei	Single Contact Electron Beam Induced Current Imaging on Solar Cells
2.	Teo Yu Han	Visible light-driven photocatalytic water splitting
3.	Naomi Nandakumar	Investigation of the origin of fixed charge in Al2O3 films using EELS
4.	Guo Li	Fabrication of Nickel nanowires using anodic alumina template on ITO/glass substrate for electrochromic applications

Single Contact Electron Beam Induced Current Imaging on Solar Cells

Candidate: **Meng Lei**
Supervisor/s: **Charanjit S. Bhatia, Jacob C. H. Phang**

Abstract:
Single contact electron beam induced current (SCEBIC), which is capable of imaging the unconnected junctions, was developed to overcome the contact limitation of the conventional electron beam induced current (EBIC) method. It shows an enormous potential of SCEBIC as a contactless imaging technique for semiconductor devices. This technique is however still limited for failure analysis on small-junction devices such as multi-level ICs, and applications of SCEBIC on solar cells remain unexplored. It is because that the time-dependent SCEBIC transient signals are highly sensitive to the junction and parasitic capacitance of the devices and this capacitance effect is yet well understood. Therefore, it is crucial to test the possibilities of the SCEBIC measurements on solar cells, whose junction areas are much larger than those of the ICs. In addition, as only one electrical contact is required by SCEBIC, which could be applied on partially processed solar cells prior to the metallization process, it is able to isolate the origin of the defects by checking the current map of the cells from each fabrication process after the formation of the p-n junctions. Another advantage of SCEBIC could be the imaging capability of multiple junctions in a multi-junction solar cell by applying only one electrical contact to the cell and characterizing the inaccessible device regions.

Visible light-driven photocatalytic water splitting

Candidate: **Teo Yu Han**
Supervisor/s: **Ho Ghim Wei**

Abstract:
Research in the generation of H2 and O2 gasses through the photocatalytic reduction of water has been steadily attracting the attention of various stakeholders. Photocatalyst such as pure TiO2 and Ta2O5 have been well studied. Unfortunately, the large intrinsic bandgap of the two materials only allows the generation of electron-hole pairs under ultraviolet (UV) light. Efforts have been taken to increase the absorbance of such photocatalyst to within the visible light range. Ta2O5 can be doped with nitrogen to produce TaON with an absorption edge at 500 nm. However, the conventional method of synthesizing TaON is through the ammonolysis of Ta2O5 under the NH3 gas flow at high temperature for several hours. In this work, we synthesized the TaON photocatalyst by using urea as the nitrogen source with much shorter in situ calcination duration. Such synthesis method avoids the use of hazardous NH3 gas and long hours of energy-intensive, high-temperature annealing. The resulting TaON synthesized via urea route has a bright yellow hue with an enhanced absorbance in the UV-Visible region as well as improved photocatalytic efficiency. The effect of pre- and post-calcination upon the photocatalytic performance of the TaON was also investigated. Apart from TaON, TiO2 could also be modified with noble metals such as Ag and Au nanoparticles in order to utilize the surface plasmon resonance (SPR) effect. Such effect enables the modified TiO2 photocatalyst to respond to visible light depending on the size or morphology of the noble metals. In this paper, the effects of noble metal loading amount and its morphology on the photocatalytic efficiency of the modified TiO2 were investigated.

Investigation of the origin of fixed charge in Al2O3 films using EELS

Candidate:	Supervisor/s:
Naomi Nandakumar	**Armin ABERLE, Bram HOEX**

Abstract:

Recombination losses at the crystalline Si (c-Si) surfaces have become increasingly important in the field of silicon solar cells and hence surface passivation to restrict recombination is critical to increasing solar cell efficiencies. Aluminum Oxide or Al2O3 films have been seen to demonstrate excellent passivation properties on p-type and n-type surfaces and this is attributed to a large built-in negative charge and a low interface defect density. Al2O3 is popularly deposited by atomic layer deposition or ALD. ALD is primarily of two types - thermal ALD which uses H2O and trimethylaluminum (TMA) and plasma ALD which uses an oxygen plasma along with TMA. In this study, the origin of the negative charge due to structural changes in Al2O3 films is investigated using electron energy loss spectroscopy (EELS) for films deposited by both thermal and plasma ALD. An increased fraction of tetrahedrally co-ordinated Al-atoms is observed near the interface for samples that gave higher lifetimes indicative of better passivation properties. This has been attributed to an increase in the net negative charge as a result of the tetrahedral coordination. Further, SiOx is identified at the interface between Si and Al2O3. Free oxygen is also seen in the samples due to electron stimulated degradation of the Al2O3 film during measurement.

Fabrication of Nickel nanowires using anodic alumina template on ITO/glass substrate for electrochromic applications

Candidate:	Supervisor/s:
Guo Li	**Chim Wai Kin**

Abstract:

The use of a nanoporous anodic aluminum oxide (AAO) template is an inexpensive and relatively easy approach to produce ordered nanostructures. Without the use of membrane transfer techniques, the growth of AAO on different substrates remains an important advancement in the large scale and practical usage of AAO. While the fabrication of AAO on substrates such as Si wafers has been shown to be relatively routine, the inability to stabilize Al anodization on indium doped tin oxide (ITO)/glass substrates is a key stumbling block that limits the use of the AAO template-assisted method of nanostructure fabrication for photonic applications. The ability to fabricate AAO on transparent conductor substrates will open up a range of applications in electrochromic, photovoltaic or other photonic devices. In this talk, we report a method of growing stable AAO on ITO/glass substrates using a thin titanium layer as an adhesion layer between the ITO/glass substrate and a deposited aluminium layer. A cathodic polarization process in potassium chloride solution is applied to reduce the thickness of the oxide layer at the bottom of the AAO template. We show that it is possible to fabricate AAO templates on ITO/glass substrates and demonstrate the nanostructural growth of nickel (Ni) nanowires (NWs) on ITO/glass substrates. The Ni NWs are electrochemically deposited in the AAO template, which further demonstrates the stability of the AAO template and the retainment of the conductivity of the ITO in the entire process.

TRACK 6

SIGNAL PROCESSING & NEW MEDIA

LOCATION: EA-06-07

PRESENTERS		
1.	**Wu Zhe**	**Utilize Intensity Profile in Shadow Removal**
2.	**Yunghans Irawan**	**Just Shoot Me: User Study on Visual Interactive Questioning Using Smartphone Camerane Camera**
3.	**Seetha Krishnan**	**Representation of olfactory ques in the zebrafish habenula**
4.	**Xu Mengdi**	**Touch Saliency**

Utilize Intensity Profile in Shadow Removal

Candidate:	Supervisor/s:
Wu Zhe	**Tan Ping**

Abstract:
Shadow has been a concern for photometric stereo. Detection and removal of shadow will greatly improve the robustness and accuracy of many photometric stereo algorithms. In the presentation, I will introduce the fact that the intensity profile of a surface point usually lies in a low dimensional linear subspace and show how we made use of such observation to help detect and remove shadow in our lighting related projects.

Just Shoot Me: User Study on Visual Interactive Questioning Using Smartphone Camerane Camera

Candidate:	Supervisor/s:
Yunghans Irawan	**Steven Zhou Zhiying**

Abstract:
Visual interactive questioning is a special case of interactive questioning using image as the main component of the question and the audience is expected to pick a part of the provided image as the answer. We propose the use of smart phone camera as audience response system. In this paper we present our findings based on the result of our pilot experiment conducted to study the performance of smart phone camera audience response system compared against text based audience response system. We also study the overhead of smart phone camera compared with conventional pointing device such as touch screen.

Representation of olfactory ques in the zebrafish habenula

Candidate:	Supervisor/s:
Seetha Krishnan	**Shih-Cheng Yen, Suresh Jesuthasan**

Abstract:
The habenula consists of an evolutionarily conserved set of nuclei that regulate monoaminergic neurons. In lower vertebrates, the medial habenula receives innervation from sensory regions but the significance of this is unclear. Here, we address the role of the habenula in olfaction by imaging neural activity in intact larval zebrafish expressing GCaMP3 throughout the habenula. Activity in more than 500 neurons per fish was recorded each second using an EMCCD camera and fast focusing, enabling three-dimensional maps of odor-evoked activity to be created. Various odorants including food extract, skin extract, bile acids and chondroitin sulfate activate the medial subnucleus of the dorsal right habenula. The response duration and intensity increased with the amount of odorant. In contrast, the amino acids leucine and lysine trigger a weaker response, with signals originating in the lateral habenula. Thus, the habenula may regulate midbrain neuromodulator release based on the quantity and type of odor.

Touch Saliency

Candidate:
Xu Mengdi

Supervisor/s:
Yan Shuicheng

Abstract:

In this work, we propose a new concept of touch saliency, and attempt to answer the question of whether the underlying image saliency map may be implicitly derived from the accumulative touch behaviors (or more specifically speaking, zoom-in and panning manipulations) when many users browse the image on smart mobile devices with multi-touch display of small size. The touch saliency maps are collected for the images of the recently released NUSEF dataset, and the preliminary comparison study demonstrates: 1) the touch saliency map is highly correlated with human eye fixation map for the same stimuli, yet compared to the latter, the touch data collection is much more flexible and requires no cooperation from users; and 2) the touch saliency is also well predictable by popular saliency detection algorithms. This study opens a new research direction of multimedia analysis by harnessing human touch information on increasingly popular multi-touch smart mobile devices.

SESSION 4

FEBRUARY 28, 2013(DAY 2)

9:00 AM to 11:00 AM

TRACK 1

INTEGRATED CIRCUITS & EMBEDDED SYSTEMS

LOCATION: EA-06-02

PRESENTERS		
1.	Ang Zhi Ping	High Speed Video Processing Using Fine-Grained Processing on FPGA Platform
2.	Anup Kumar Das	Communication and Migration Energy Aware Design Space Exploration for Multicore Systems with Intermittent Faults
3.	Anup Kumar Das	Energy-Aware Task Mapping and Scheduling for Reliable Embedded Computing Systems
4.	Liu Xiayun	A 900MHz ISM band QPSK/16-QAM Energy-Efficient Transmitter for Biomedical Application

High Speed Video Processing Using Fine-Grained Processing on FPGA Platform

Candidate:	Supervisor/s:
Ang Zhi Ping	**Akash Kumar**

Abstract:

High speed video capture is used in several scientific and engineering fields which investigate physical phenomena that are too fast for human perception. In order to achieve real time image processing at a high frame rate without frame dropping, hardware-based processing is required. Commercially available image sensors have built-in real-time processing that are largely unsophisticated (i.e. colour space conversion), whereas current research often propose ASIC solutions that are expensive to fabricate. Therefore, a reconfigurable hardware platform, which can be easily integrated as a modular component to a larger system, is explored in this research. The paper shall advance an FPGA-based pixel array processor which performs Laplacian filtering, used for edge detection in images, on a 128 by 128 pixel grayscale at a high frame rate of 10000 frames per second. The hardware architecture is comprised of primitive pixel processors that use bit-serial arithmetic to compute. Each of the processors is connected in a 2-dimensional mesh topology to form the overall array processor. The architecture also features the novel use of partial reconfiguration to pass inputs into and pull the processed results out of the array. The array processor is realised on the Virtex-6 ML605 Evaluation Kit using a MicroBlaze system. It has been found that the array processor requires a single configurable logic block, and is able to achieve the target frame rate at a low operating frequency of 0.31 MHz. A working implementation of a 40 by 40 pixel array has been realized on the ML605.

Communication and Migration Energy Aware Design Space Exploration for Multicore Systems with Intermittent Faults

Candidate:	Supervisor/s:
Anup Kumar Das	**Akash Kumar, Bharadwaj Veeravalli**

Abstract:

Shrinking transistor geometries, aggressive voltage scaling and higher operating frequencies have negatively impacted the dependability of embedded multicore systems. Most existing research works on fault-tolerance have focused on transient and permanent faults of cores. Intermittent faults are a separate class of defects resulting from on-chip temperature, pressure and voltage variations and lasting for a few cycles to several seconds or more. Operations of cores impacted by intermittent faults are suspended during these cycles but come back alive when conditions become favorable. This paper proposes a technique to model the availability of multiprocessor systems-on-chip (MPSoCs) with intermittent and reparable device defects. This model is based on Markov chain with stochastic fault distribution and can be applied even for permanent faults. Based on this model, a design space pruning technique is proposed to select a set of task mappings (with variable resource usage), which minimizes the task communication energy while satisfying the MPSoC availability constraint. Moreover, task migration overhead is also minimized, which is an important consideration for frequently occurring intermittent and temperature related faults, where prolonged system downtime during task re-mapping is not desired. Experiments conducted with real-life and synthetic application task graphs demonstrate that the proposed technique minimizes communication energy by 30% and reduces migration overhead by 50% as compared to the existing approaches.

Energy-Aware Task Mapping and Scheduling for Reliable Embedded Computing Systems

Candidate:	Supervisor/s:
Anup Kumar Das	**Akash Kumar, Bharadwaj Veeravalli**

Abstract:

Task mapping and scheduling is critical in achieving the performance requirement of heterogeneous embedded multiprocessors. The NP-hard nature of this problem has drawn significant attention among research community to solve the general unrestricted problem as well as its criteria-driven restricted counterpart. A well-studied optimization criteria for application task mapping and scheduling is energy minimization. However, another area of growing concern for modern multiprocessor systems is the increase in the failure probability of one or more component processors. This is especially critical for applications where performance degradation (throughput, for example) directly impacts the quality of service requirement. The key problem to address in this respect is to remap the tasks such that the performance requirement is not violated while keeping the energy consumption at minimum. This paper proposes a design-time (offline) multi-criterion optimization technique to statically determine the mapping of applications on embedded multiprocessor systems for all processor fault-scenarios. A scheduling technique is then proposed based on self-timed execution to minimize the schedule storage and construction overhead at run-time. Experiments conducted with synthetic and real applications from streaming and non-streaming domain on heterogeneous MPSoCs demonstrate that the proposed technique minimizes the overall energy by 22\% and the design space exploration time by 5x while satisfying the throughput requirement for all processor fault-scenarios. For scalable throughput applications, the proposed technique achieves 30% better throughput per unit energy as compared to the existing techniques. Additionally, the self-timed execution based scheduling technique minimizes the schedule construction time by 95% and storage overhead by 92%.

A 900MHz ISM band QPSK/16-QAM Energy-Efficient Transmitter for Biomedical Application

Candidate:	Supervisor/s:
Liu Xiayun	**HENG CHUN HUAT**

Abstract:

The demand of low power, high data rate transmitter is growing rapidly, especially in the biomedical applications such as neural recording and wireless capsule endoscopy. Conventional transmitters adopt OOK or FSK to simplify the system, thus suffering from low data rate of a few Mbps. Recently, advanced modulation schemes such as QPSK/O-QPSK are reported. However, their bandwidth efficiency is still not high enough. This paper reports a first QPSK/16-QAM (rectangular) direct modulation TX for the biomedical application. It employs sub-harmonic injection-locking ring oscillator (ILO). The simple ILO provides comparable phase noise performance as well as eliminates long settling time and stability issue in conventional PLL. Without power hungry DACs and mixers, the proposed TX facilitates high bandwidth efficiency modulation while maintaining low power consumption. On-chip SRRC filtering for baseband waveform is implemented to lower the sideband of the output spectrum. The transmitter operates at 900-925MHz ISM band considering the trade-off between propagation in a human body and antenna efficiency.

TRACK 2

CONTROL, INTELLIGENT SYSTEMS & ROBOTICS

LOCATION: EA-06-03

PRESENTERS		
1.	Teong Beng Koay	Energy efficient path planning in coastal waters
2.	Ang Zong Yao Kevin	Power line detection on an Urban Unmanned Aerial Vehicle
3.	Li Kun	Platform Design and Mathematical Modeling of an Ultra-light Micro Aerial Vehicle
4.	Andras Gabor Kupcsik	Data-Efficient Contextual Policy Search for Robot Movement Skills
5.	Elham Saadatian	Translating the meaning of infant's cries

Energy efficient path planning in coastal waters

Candidate: Teong Beng Koay
Supervisor/s: Mandar Anil Chitre

Abstract:
Autonomous underwater vehicles (AUVs) have increasingly being used for scientific surveillance and exploration of vast open ocean due to its lower operational cost compared to vessel based expeditions. However, their operational efficiency is largely limited by their endurance, which in turn dictated by the propulsion needs and the finite amount of energy that they carry. This limitation is amplified in operations near coastal waters where partially propelled, low-power systems risk running aground and collision. Here, more power hungry vehicles with full propulsion capability is needed to safely navigate between complex geographical obstacles and among shipping vessels. To increase the endurance of such systems, we turn to energy efficient path planning that minimizes the propulsions needed to travel between any two points by taking advantage of the local water current structures. We employed an A* search to achieve this objective using with a number of heuristics to estimate their travel costs. Simulations have been setup to test these heuristics in scenarios that closely resemble the real world operations. The simulation uses an ocean hydrodynamic model for local waters as inputs to the heuristics, it takes into account geographical obstacles such as island and man-made structures in the area, as well as realistic operational limit of STARFISH AUV that has been widely used in local waters. This presentation shows simulation results from the different heuristics that have been tested over 40 randomly generated source-destination points. Assuming the current is temporally static and given that the minimum vehicle speed is limited to 2.5 knots, the energy savings of current aware paths could range from a few percentage to 50% when compared to the energy needed to travel the shortest path. The simulation also shown that the energy savings are more if the average vehicle speed is kept closer to the water current speed. If the vehicle is allowed to drift with the current and only propelled whenever needed to get into favorable currents, the typical energy savings could range from 40% to 90%. Though, the traveling time will be much more compared to those actively propelled paths, and the time variation is sensitive to the current conditions. The result from temporally varying current will also be discussed.

Power line detection on an Urban Unmanned Aerial Vehicle

Candidate: Ang Zong Yao Kevin
Supervisor/s: Ben M. Chen

Abstract:
This presentation introduces some of the work done by the NUS Unmanned Aerial Vehicle Team in the field of urban navigation and obstacle avoidance. There will be a brief showcase of our advanced autonomous UAV, QuadLion, and it capabilities before a look into the possible outdoor navigation setups. The QuadLion utilizes stereo vision for obstacle avoidance and the GPS and IMU for localization in an urban environment. However, in urban environments there exist obstacles that are potentially hazardous for a low flying UAV. “Wire strikes” are the number one cause of fatal helicopter accidents. The operational safety of UAVs in their environment is frequently overlooked but this is essential for mission completion. Detection of power lines will be primarily achieved by using vision processing. Through the understanding of how power lines appear in images, we could design mask filters specifically for the detection of power lines. It is the implementation of a series of gradient mask operators, image inverse thresholding, line-thickness filtering and segmentation that will result in the detection of power lines in images. Hough transform could correct discontinuities in the power lines detected to present a clearer image of the power lines and also form as a prediction on how far the power lines might extend. The presentation then concludes with the future plan of fusing the stereo depth map and power line detection to achieve obstacle avoidance and navigation in outdoor environments.

Platform Design and Mathematical Modeling of an Ultra-light Micro Aerial Vehicle

Candidate: Li Kun
Supervisor/s: Chen Benmei, Lee Tongheng

Abstract:
Micro and nano unmanned aerial vehicles are an emerging class of aircraft uniquely suitable to perform short-range urban surveillance and covert missions. In recent years, research interest has arisen with these centimeter-scale size air vehicles based on rotary wing, fixed wing or flapping wing. In this paper, a micro quad-rotor aircraft with approximated 15 centimeters size and 10 grams total mass that can fly 10 minutes is developed. Aspects of system development of this micro quad-rotor aerial vehicle are discussed with respect to design of the mechanical structure and electrical system. Mechanical structure is determined based on the weight budget, propulsion system efficiency as well as structural analysis. Mechanical parts are designed and analyzed with Solidworks and manufactured by 3D printing technique. Development of the electrical system includes integration of CPU, IMU and communications with commercial off-the-shelf electrical components. A mathematical model of the quad-rotor with regard to kinematics and rigid body dynamics is derived based on the quad-copter working principle. Verification of the linearized model is then conducted with the model extracted from the real flight data.

Data-Efficient Contextual Policy Search for Robot Movement Skills

Candidate: Andras Gabor Kupcsik
Supervisor/s: Loh Ai Poh, Prahlad Vadakkepat

Abstract:
In robotics, low-level controllers are typically used to make the robot solve a specific task. However, to generalize a low-level controller to multiple contexts, an upper-level policy is needed. For example, the controller can encode a throwing movement while the context defines the target coordinates to hit. A common approach to learn such upper-level policies is to use policy search. However, most current approaches are model-free and require a high number of interactions of the robot with its environment. We propose a new model based algorithm that is well-suited for learning such upper-level policies and, therefore, allows to generalize movement skills to multiple contexts. Our approach is based on learned probabilistic forward models and information-theoretic policy search. We show on two complex simulated robotic tasks and on a real robot experiment that the proposed learning framework speeds up the learning process up to several orders of magnitude in comparison to existing methods.

Translating the meaning of infant's cries

Candidate: Elham Saadatian
Supervisor/s: Prof. Ryohei Nakatsu

Abstract:
Cry is the language of the baby. Parents of the newborn babies often have difficulty understanding what baby tries to communicate to them thorough the cry language. There are studies that prove the internal status of the baby is reflected on the baby cry. This study attempts to receive the cry signals in real-time and translate their meanings to parents. Signal processing and machine learning algorithms are applied to classify the cry signals to their corresponding classes. The algorithm is developed and system is implemented with up to 97% of accuracy.

TRACK 3

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-04

PRESENTERS		
1.	Yang Jing	Magnetic-electric interference in metal-dielectric-metal oligomers
2.	Wang Hao	Development of stretchable membrane based nanofilter using patterned array of vertically grown carbon nanotubes
3.	Xiang Zhuolin	Development of Vertical SU-8 Microtubes Integrated with Dissolvable Tips for Transdermal Drug Delivery
4.	Kwadwo Konadu Ansah-Antwi	High quality semipolar GaN epilayer grown on spatially exposed Si(111) surfaces on a Si(100) substrate

Magnetic-electric interference in metal-dielectric-metal oligomers

Candidate:	Supervisor/s:
Yang Jing	**Prof. Hong Minghui, Dr. Teng Jinghua**

Abstract:
The existence of magnetic resonance in designed Metal-Dielectric-Metal (MDM) oligomers is investigated. Via angling the incident light it is found that in the MDM oligomers, not only the E-component of incident field drives plasmon oscillations, but the H-component also plays an important role to excite magnetic plasmons. These magnetic plasmons give rise to a magnetic resonance in addition to classical Fano Resonance (FR). Importantly, unlike regular MDM structures which exhibit separate magnetic and electric resonances, the MDM oligomers possess the capability to exhibit both magnetic and electric resonances in the same wavelength window with proper metallic and dielectric thicknesses. It leads to the appearance of an additional FR as a result of interference between magnetic-electric plasmonic resonances rather than electric-electric resonances with a clear proof of remarkable absorption enhancement. The unique capability of MDM oligomers exhibiting both electric and magneto-electric FRs can realize many potential applications of FR.

Development of stretchable membrane based nanofilter using patterned array of vertically grown carbon nanotubes

Candidate:	Supervisor/s:
Wang Hao	**Chengkuo Lee**

Abstract:
A unique process, which utilizes a membrane based vertically grown carbon nanotubes (CNTs) as sorting nanofilters for mass transport study, is presented here. By using ss-DNA and Haemagglutinin as testing molecules of different dimensions, the mass transport function of the CNTs membrane is investigated by driving them through the membrane with pressure and electric field assists.

Development of Vertical SU-8 Microtubes Integrated with Dissolvable Tips for Transdermal Drug Delivery

Candidate:	Supervisor/s:
Xiang Zhuolin	**Lee Chengkuo**

Abstract:
Polymer microneedles have drawn much attention in transdermal drug delivery resulting from their flexibility and biocompatibility. Traditional fabrication approach deploys various kinds of molds to create sharp tips at the end of needles for the penetration purpose. This approach is usually time-consuming and expensive. In this study, we developed an innovative fabrication process to make biocompatible SU-8 microtubes integrated with biodissolvable maltose tips as novel microneedles for transdermal drug delivery application. These microneedles can easily penetrate the skin's outer barrier of stratum corneum (SC) layer. After the maltose tips dissolved by body fluid, drugs can be delivered via microtubes. The drug delivery device of mironeedles array with 1000 μm pitch spacing between adjacent microneedles is proved to be able to penetrate porcine cadaver skins successfully. After 9 minutes of penetration, all the maltose tips have been dissolved by the fluid in the tissue. Drugs can be further delivered via these open SU-8 microtubes.

High quality semipolar GaN epilayer grown on spatially exposed Si(111) surfaces on a Si(100) substrate

Candidate:	Supervisor/s:
KwaDwo Konadu Ansah-Antwi	**Prof Chua Soo Jin**

Abstract:

The importance of III-nitride materials in the areas of optoelectronics and microelectronics cannot be overemphasized. Several devices have been demonstrated and commercialized including light emitting diodes (LEDs), laser diodes (LDs) photoconductors, solar cells and field effect transistors (FETs) based on the III-nitride materials system. GaN has been of most interest to researchers and industry players at large among the other III-nitrides including AlN and InN. In spite of the advances made in the growth of GaN based materials for device fabrication, the issue of spontaneous and piezoelectric polarizations characteristic of polar (0001)GaN planar materials have been deleterious to device performance. These drawbacks are overcome by fabricating devices on non-polar and semi-polar GaN surfaces. However, unlike c-plane GaN surface, growth of GaN on (10-11), (11-22) and (10-10) planes are plagued by high prismatic and basal fault dislocation density. Although GaN lattice prefers to grow on Si(111) surface, the use of Si(100) oriented substrate as a platform to grow high quality GaN based films will pave the way for the ultimate integration of Si CMOS devices with GaN based optical devices. In this work, (10-11)GaN oriented epilayer is grown on Si(111) facets that are exposed within 3-5 µm wide trenches patterned on Si(100) substrate. The magnitude of strain in the GaN epi-film is qualified independently with µ-Raman spectroscopy, µ-photoluminescence (PL) and high-resolution x-ray diffraction (HRXRD) techniques.

TRACK 4

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-05

PRESENTERS		
1.	Huang Jian	Enhanced Photoluminescence by Surface Plasmon Excitation in Gold Capped InGaAs Quantum Disk Array
2.	Tang Jie	Determination of the electron and hole effective mass from n-type and p-type ZnO thin film by Terahertz Time Domain Spectroscopy
3.	Gaurav Gupta	Role of Acoustic Phonons in Resistance of Bi2Se3 Topological Insulators
4.	Chen Yiguo	Controlling resonance in plasmonic nanoantenna arrays by phase change materials

Enhanced Photoluminescence by Surface Plasmon Excitation in Gold Capped InGaAs Quantum Disk Array

Candidate:	Supervisor/s:
Huang Jian	**Xiang Ning**

Abstract:

We report the surface plasmon enhanced photoemission of an InGaAs quantum disk array covered with gold caps. A 2-dimensional array of gold nano-particles is fabricated via interference holography with a certain designed period above an InGaAs quantum well layer. A chemical solution etch is then used to make InGaAs quantum nanodisks under the gold mask caps. Different depths and diameters of quantum nanodisks are studied by varying the etching time. A tunable shift of spectral response in absorption is observed, which is attributed to the surface plasmon resonance and is also a function of etching time. A three-fold enhancement in light emission is observed when the absorption wavelength is close to the emission wavelength of the quantum disks. Finite-difference time-domain (FDTD) simulation results agree with the tunable shift and confirm the surface plasmon excitation around the gold particles. The photoemission of InGaAs quantum disks is enhanced due to the occurrence of coupling between the surface plasmon resonance wavelength and the quantum disk's emission wavelength. This work provides a convenient method of tuning surface plasmon resonance to couple with quantum disk and to enhance its photoemission.

Determination of the electron and hole effective mass from n-type and p-type ZnO thin film by Terahertz Time Domain Spectroscopy

Candidate:	Supervisor/s:
Tang Jie	**Chua Soo Jin**

Abstract:

Zinc oxide (ZnO), is an attractive semiconductor with a wide range of properties for multi-functional applications, such as solar cells, varistors, LEDs, nanogenerators, chemical and gas sensors and spintronic devices due to its large bandgap (3.37eV) with high transparency in visible range, light emitting properties with large exciton binding energy (60meV), high electrical conductivity, large piezoelectric coefficient and promising magnetic properties. In order to fully realize the potential of ZnO for these applications, great efforts have been put into the study of fundamental electronic and optoelectronic properties since 1940s. However, the carrier transport properties and conductivities are still lacking, especially that of p-type ZnO due to the numerous difficulties in obtaining stable and reliable p-type ZnO. To understand the transport phenomena and calculate the optical gain in semiconductors, the effective mass, which is one of the fundamental quantities in semiconductor physics is crucial. Precise mass information is essential to the rational design of functional devices. Terahertz time domain spectroscopy (THz-TDS), a recent developed advancing contactless optical characterization method, can give insightful information on the physical properties of semiconductor materials without the need of Kramers-Kronig analysis as the carrier scattering rates of semiconductors lies in the terahertz frequency range. In conventional THz-TDS characterization methodology, the value of effective mass is assumed to be known by ignoring the dependence on the carrier density as THz-TDS alone with only amplitude and phase information is not sufficient to determine effective mass independently. In this work, we present a new approach to extract the electron and hole effective mass of ZnO from THz-TDS (from 0.1 to 3 THz) and Hall effect measurement without any additional assumptions. The p-type and n-type ZnO films with different carrier concentrations are prepared by aqueous solution method [1, 2]. The obtained values of effective mass have a good agreement with Drude model and other reported results.

References

[1] Xuan Sang Nguyen, Chuan Beng Tay, Eugene A. Fitzgerald, and Soo Jin Chua, small, 8, 1204 (2012).

[2] Chuan Beng Tay, Soo Jin Chua, Kian Ping Loh, J. Phys. Chem. C, 114, 9981 (2010).

Role of Acoustic Phonons in Resistance of Bi2Se3 Topological Insulators

Candidate: Gaurav Gupta
Supervisor/s: Liang Gengchiau, Mansoor Bin Abdul Jalil

Abstract:
Three-dimensional (3D) topological insulators (TI) have bulk band gap and odd numbered [1, 2] Dirac cones resulting in topological surface states (TSS) with electron's spin locked to its momentum vector [3] due to strong spin-orbit coupling [2, 4]. This property is considered useful for advancing towards spintronic [5, 6] and quantum computing applications [2, 6]. Bi2Se3, with relatively large bulk bandgap (~0.3eV) among different TI materials, has been shown to be a 3D topological insulator [3]. Due to time reversal symmetry in topological insulators, non-magnetic impurities cannot beget backscattering of electrons flowing on 3D-TI surface [1]. However, acoustic phonons can still backscatter electrons in samples longer than the mean free path (m.f.p) by slowly turning around the electrons via modulation of their momentum vector as electrons move forward across the sample. Including the other complicated mechanisms, such as thermal activation, and Fermi-level position, competing to dominate transport behaviors, the various experimental measurements concluded with different transport characteristics of 3D Bi2Se3 TI. For examples, some experiments have shown metallic behavior for Bi2Se3 TI, whereas few have also shown insulating trends in line with theoretical expectation [7]. Moreover, strength of electron-phonon coupling (strong vs weak) on Bi2Se3 surface states is disputed based on theoretical arguments, ARPES and helium scattering experiments. Therefore, in this work, we aim to unveil this puzzle using a quantum transport approach coupled with acoustic phonon scattering. We examine the experimental data for resistance measurement across temperature for Bi2Se3 TI, and clarify the effect and strength of acoustic phonon scattering on electron transport through topological surface of Bi2Se3 slab for low doping density by evaluating acoustic phonon effect on resistance. The current flow and resistance of Bi2Se3 TI samples are studied as the temperature varies from 50K to 200K at the different Fermi-levels (Ef) for 12 Quintuple Layer (1 QL ~ 9.4nm) thick (13 physical layers), infinitely wide (periodic) and 29nm long Bi2Se3 slab under 50mV bias (VDS) (low-field transport) across the samples. The selected thickness is sufficient to neglect the Dirac band opening and inter-surface coupling, and channel is longer than mean free path (~20nm [8]) for acoustic scattering. Henceforth, we found that for ballistic transport, Bi2Se3 TI arrays insulating trend even for Ef in bulk bands. However, interaction with acoustic phonons reproduces and explains experimentally observed both the insulating and metallic trends. For fermi-level close to Dirac-point (very low carrier doping), despite of acoustic phonons insulating trend is observed. However, at higher doping, phonon scattering overrides thermal activation to result in metallic trend. To the best of our knowledge, this is the first study to capture ballistic and acoustic transport through individual layers of Bi2Se3 TI slab simultaneously, and predict effective current contribution by topological surface to explain contrasting experimental observations.

References: [1] L. Fu, C. Kane, and E. Mele, Physical Review Letters 98 (2007). [2] M. Hasan, and C. Kane, Reviews of Modern Physics 82 (2010). [3] D. Hsieh et al., Nature 460 (2009). [4] D. Hsieh et al., Physical Review Letters 107 (2011). [5] D. Pesin, and A. H. MacDonald, Nature materials 11 (2012). [6] J. E. Moore, Nature 464 (2010). [7] B. Skinner, T. Chen, and B. Shklovskii, Physical Review Letters 109 (2012). [8] N. P. Butch et al., Physical Review B 81 (2010).

Controlling resonance in plasmonic nanoantenna arrays by phase change materials

Candidate: Chen Yiguo
Supervisor/s: Hong Minghui, Stefan Maier, Boris Lukiyanchuk

Abstract:
Plasmonic nanoantenna arrays exhibit remarkable optical properties from the excitation of localized surface plasmon resonances. To solve the limitation of the fixed working bandwidth of such structures, here we investigate tunable metamaterials using phase change materials. Through the hybridized configuration, resonance of a plasmonic structure can be easily tuned without geometric modification. Using the unique refractive index of the phase change material, diffractive coupling between LSPRs of the nanoantennas and photonic modes of the array can be enhanced to achieve high-Q resonance. The effects of the thickness of the phase change material on the resonance's position and quality factors are also studied. This work can lead to tunable metadevices in optical modulations, switching and sensing.

TRACK 5

POWER & ENERGY SYSTEMS

LOCATION: EA-06-06

PRESENTERS		
1.	Chia Meng Hwee	Applications of Matrix Pencil Method on Power System Signals
2.	Jeevan Adhikari	Harnessing High Altitude Wind Energy Using Light Gas Filled Blimp For Off Grid Power Generation
3.	Li Yuling	Influence of Gate Drive on Pulsed Current Collapse Recovery in AlGaN/GaN Power HEMTs
4.	Pan Xuewei	Novel Interleaved Bidirectional Snubberless Soft-switching Current-fed Full-bridge Voltage Doubler for Fuel Cell Vehicles
5.	Shu Zhen	Optimal Sizing of Energy Storage System for Wind Power Plants

Applications of Matrix Pencil Method on Power System Signals

Candidate:	Supervisor/s:
Chia Meng Hwee	**Ashwin M Khambadkone**

Abstract:

Matrix Pencil Method (MPM) is a high-resolution spectral analysis technique that can decompose a signal into a sum of damped complex exponentials. This method is highly suitable for the analysis of power system signals as they can often be approximated with damped or undamped sinusoids. Compared to Fast Fourier Transform (FFT) techniques, MPM has the added advantages of higher frequency resolution given lesser number of samples and also of the capability of estimating the damping factor. The proliferation of power electronic inverters and distributed generation at the distribution grid level increases electrical phenomena at the fundamental and higher frequencies, for example, increase in harmonic voltages and currents. This in turn has led to a need for faster and better signal analysis techniques. In this presentation, we shall examine the application of MPM on power system signals. We shall highlight the superiority of MPM over certain classes of power system signals, its limitations and its applications in terms of analysis of electrical phenomena. The presentation shall be divided into 3 sections. In section 1, the basic mathematical construct of MPM shall be explained. Section 2 shall focus on the analysis of MPM as a signal processing method in comparison with FFT in terms of frequency resolution and accuracy. Section 3 shall demonstrate the applications of MPM on power signals.

Harnessing High Altitude Wind Energy Using Light Gas Filled Blimp For Off Grid Power Generation

Candidate:	Supervisor/s:
Jeevan Adhikari	**Prof. S.K Panda**

Abstract:

Wind energy has become one of the best alternative sources of clean energy in recent decades. Higher capital investment, low capacity factor and low area power density are major drawbacks of convectional wind energy harvesting system. High altitude based wind energy harvesting provides electrical power at low cost and higher capacity factor without any major constructional requirements. This paper presents a simple concept to harvest high altitude wind energy using air borne electric generators supported by light gas filled blimp for off-grid power supply. Blimp is an aerostat that remains stationary at high altitude around 1000 m aligning itself along the direction of air flow. It is filled with light gas like helium and hydrogen. Control of blimp and generation of power are independent of each other. Blimp can be controlled laterally and longitudinally to face the direction of wind flow. These generators at high altitude extract kinetic energy from high speed streamline wind taking the buoyancy provided by blimp. Using suitable power electronic converters, extracted electrical power is sent to the ground using tether. Blimp is tethered to ground and same tether is used for electricity transmission as well. This paper presents discussions on major components used for harvesting high altitude wind power and proposed simple & light weight power electronic converter to transmit the power to the ground station. A light weight power electronic converter is designed with minimum number of active devices and simulated using PSIM-9. Simulation results obtained have proved the efficient power transmission using the proposed converter to ground based off-grid power station. However, there are many challenges in harvesting high altitude wind energy using light gas filled blimp but it provides clean energy at low cost and high capacity factor unlike conventional wind energy. Blimp uses light gases like Hydrogen and Helium for it buoyancy those are expensive. In addition, hydrogen is sensitive to spark and Helium is limited element is the earth. Moreover, control of aerostat at gutsy high altitude to align to extract high energy is also challenging. Despite all these challenges, high altitude wind power can be one of the best supplements to fulfil high clean energy demand in this decade for on-grid, off-grid and emergency power requirements.

Influence of Gate Drive on Pulsed Current Collapse Recovery in AlGaN/GaN Power HEMTs

Candidate:	Supervisor/s:
Li Yuling	**Yung C. Liang, Samudra,G S**

Abstract:

The slow recovery in pulsed drain current in AlGaN/GaN power HEMTs caused by high voltage stress during off-state becomes an important research topic in power electronic switching applications. To further investigate this phenomenon, the influence of gate drive towards the drain current recovery is investigated in this paper. The gate drive current can influence the de-trapping process along the AlGaN device surface, which then in turn affects the 2DEG conductivity for the on-state current recovery. The effect is analysed through the physical model and 2D T-CAD Sentaurus simulations, and verified by the experimental measurement. This proposed work is able to assist engineers in gate drive design for AlGaN/GaN power HEMT devices for fast pulsed current recovery in high-frequency switching.

Novel Interleaved Bidirectional Snubberless Soft-switching Current-fed Full-bridge Voltage Doubler for Fuel Cell Vehicles

Candidate:	Supervisor/s:
Pan Xuewei	**Akshay Kumar Rathore**

Abstract:

A novel secondary modulation based naturallyclamped soft-switching bidirectional current-fed full-bridge isolated dc/dc converter is proposed. This proposed secondary modulation technique clamps the voltage across the primary side devices naturally with zero current commutation and therefore eliminates the necessity for active-clamp circuit or passive snubbers required to absorb device turn-off voltage spike in conventional current-fed topologies. Switching losses are reduced significantly owing to zero-current switching (ZCS) of primary side devices and zero-voltage switching (ZVS) of secondary side devices. Soft-switching and voltage-clamping is inherent and is achieved at variation in load and input voltage. The voltage across primary side devices is independent of duty cycle with varying input voltage and output power and clamped at rather low reflected output voltage enabling the use of semiconductor devices of low voltage rating, which have low onstate resistance. Therefore, the conduction loss of primary side, a considerable part of total loss, is significantly reduced and higher efficiency can be achieved to obtain a compact and higher power density system. These merits make the converter promising for fuel cell vehicles application, front-end dc/dc power conversion for fuel cell inverters and energy storage. Steady state operation, analysis, and design have been explained. Simulation results using PSIM 9.0.4 are presented to verify the accuracy of the proposed analysis and design. A 250 W laboratory prototype of the converter is built and tested to demonstrate the converter performance. Experimental results clearly confirm the claimed soft-switching of all semiconductor devices, natural clamping and zero current commutation of primary side devices.

Optimal Sizing of Energy Storage System for Wind Power Plants

Candidate:	Supervisor/s:
Shu Zhen	**Panida JIRUTITIJAROEN**

Abstract:

This work proposes a stochastic programming approach to the solution of sizing problem of energy storage system applied to grid-connected wind power plants. The objective is to maximize expected daily profit though time shifting of renewable energy production. The problem is formulated considering stochastic behaviors of renewable power as well as electricity prices. We apply stochastic programming framework with Sample Average Approximation (SAA). We conduct a case study using data from the Electric Council Reliability Council of Texas (ERCOT). It is shown that considerable profit can be achieved with a suitable energy storage size.

SESSION 5

FEBRUARY 28, 2013(DAY 2)

12:00 PM to 2:00 PM

TRACK 2

INTEGRATED CIRCUITS & EMBEDDED SYSTEMS

LOCATION: EA-06-03

PRESENTERS		
1.	Mahmood Khayatzadeh	A 0.7-V 17.4-uW 3-Lead Wireless ECG SoC
2.	Ng Kian Ann	A low input capacitance and compact neural recording amplifier with a Cin/Gain ratio of 20fF.V/V.
3.	Pan Rui	A Prototype Wireless Body Area Network for Healthcare Applications
4.	Zhang Zhe	Energy harvesting techniques for low power SOCs

A 0.7-V 17.4-uW 3-Lead Wireless ECG SoC

Candidate:	Supervisor/s:
Mahmood Khayatzadeh	**Prof. Yong Lian**

Abstract:

This paper presents the first fully integrated sub-1V 3-lead wireless ECG System-on-Chip (SoC) for wireless body sensor network applications. The SoC includes an ECG front-end, a driven-right-leg circuit, a custom designed MCU, two banks of 16kb SRAM, and a MICS band transceiver. The measurement results show the SoC consumes 17.4µ and 74.8µW, respectively, in heart rate detection and raw data acquisition modes under sampling rate of 500Hz. This makes it one of the best ECG SoCs among state-of-the-art biomedical chips.

A low input capacitance and compact neural recording amplifier with a Cin/Gain ratio of 20fF.V/V.

Candidate:	Supervisor/s:
Ng Kian Ann	**A/Prof Xu Yong Ping**

Abstract:

This paper reports a low input capacitance and compact neural recording amplifier. By adding a clamped T-capacitor network to an amplifier's feedback path, the proposed amplifier can achieve same mid-band gain with less input capacitance, consuming a smaller silicon area and yet higher input impedance. Fabricated in 0.35µm CMOS, the amplifier achieves 38.1-dB mid-band gain with 1.6pF input capacitance, and hence has a Cin/Gain ratio of 20fF.V/V. It achieves the lowest Cin/Gain ratio to date. It occupies merely 0.056mm2, has an input referred noise of 6.72µVrms over 8.4-kHz bandwidth, NEF of 4, and consumes 6µW. In-vivo recordings from an animal experiment are also demonstrated.

A Prototype Wireless Body Area Network for Healthcare Applications

Candidate:	Supervisor/s:
Pan Rui	**A.P. Xu Yong Ping**

Abstract:

Wireless Body Area Network (WBAN) is specifically designed for applications that require wireless communications on or around human body to monitor some vital physiological signals for healthcare applications. Such a system is often battery powered and thus required to be energy efficient. In this work, a prototype wireless network is designed and implemented with FPGA. A sensor node in the network is able to acquire useful signals periodically and transmit the data to an off-body base station wirelessly. The sensor network can accommodate up to 100 nodes. A MAC protocol is thus required to regulate the network traffic. IEEE 802.15.4 standard is the most widely adopted protocol for this purpose, but researchers have shown that it is not suitable for WBAN applications in terms of energy efficiency. Besides, most existing systems use a MCU to implement the MAC protocol, which often takes large chip area and power consuming. In this work, we present a TDMA MAC protocol with customized MAC frame design in attempt to minimize the power consumed by RF transceiver. With the proposed protocol, sensor nodes transmit data in their assigned time slots, which eliminates idle listening and collision, and saves the energy. Physiological signal sampling frequency and network information, such as beacon interval, base station ID and transmission slot duration are tunable via beacon frame broadcast by the base station. The system is tested with 3 nodes, commercial transceivers and ECG sensing front-end. The results show that the network protocol is functioning correctly, and the base station can correctly recover sampled data for post processing.

Energy harvesting techniques for low power SOCs

Candidate:	Supervisor/s:
Zhang Zhe	**Prof. Lian Yong, Dr. Koen Mouthaan**

Abstract:

This paper gives an overview of various energy harvesting techniques which could power the low-power biomedical circuits and wireless sensor network (WSN). Energy harvesting sources include solar energy, vibration, temperature gradient, piezoelectric, RF energy, etc. Different circuit techniques are applied to harvest different sources of energy. Keys issues in circuit design include designing power efficient rectifiers and DC-DC converters, designing energy harvesting system which harvest different sources of energy simultaneously, and designing low power circuits which is fully functional utilizing the limited harvested energy. This paper also investigates the feasibility of harvesting the ambient RF energy to power the SOC system.

TRACK 3

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-04

PRESENTERS		
1.	Liu Yi	Ti/Al Ohmic Contacts on n-GaN by Two-Step Annealing
2.	Wang Yue	Graphene Nanostructure Imaging and Fabrication with Focused He+ Beam
3.	GU JING	Application of the Helium Ion Microscope to biological sciences
4.	Qian You	The effects of interlayer mismatch on electronic properties of bilayer armchair graphene nanoribbons
5.	Lim Fang Jeng	Influence of novel fluorosurfactant modified PEDOT:PSS hole transport layer on the performance of inverted organic solar cells

Ti/Al Ohmic Contacts on n-GaN by Two-Step Annealing

Candidate: Liu Yi
Supervisor/s: Chor Eng Fong, Patrick Lo

Abstract:
Many experiments have been carried out to investigate the Ti/Al based ohmic contacts on GaN. Typically, Ti/Al covered by a diffusion barrier layer such as Ni and followed by a gold (Au) capping layer on the top is used in the GaN based devices for optoelectronic and power device applications. In order to obtain a low specific contact resistivity, the traditional ohmic contact scheme uses Au as a capping layer which is helpful to reduce the sheet resistance and to prevent contact degradation resulting from the oxidation. However, the surface morphology of the usual Au based ohmic contacts become worse due to the formation of Al–Au alloy phases caused by melting of the alloy at low temperature (525 oC) [1]. This Al-Au alloy phase raises concerns about reproducibility or reliability issues. At present, GaN based epi-layer on 6-inch Si wafers are available in the market, so the overall cost of making GaN-on-Si devices can further be reduced by carrying out the processing in existing silicon fabrication facilities. Hence, as an initiative of Au-free ohmic contacts, Ti/Al bilayer ohmic contacts on n-GaN are being investigated. However, the contact resistivity of Ti/Al ohmic contact is not low enough compared to conventional Au-based ohmic contacts due to the fact that Ti/Al contact oxidizes easily, its surface roughness becomes worse during high temperature annealing process since the melting point of Al is ~660 oC. Recently, TiAl3 has been reported as a reasonably good capping layer for the Ti/Al contacts [2]. Indeed, TiAl3 is in equilibrium with Al and is stable at high temperature. In addition, TiAl3 can be a good capping layer due to the formation of a very thin but continuous protective Al2O3 layer at the surface.
In this study, a two-step annealing process is being utilized for the Ti/Al bilayer contact in order to obtain a top TiAl3 layer at a relatively low temperature (600 oC) followed by high temperature annealing to ensure lower contact resistivity. Should the transformation to TiAl3 layer be successful, the need for the deposition of a capping layer for the Ti/Al contact is eliminated. Two-step annealing has shown to be an effective method to obtaining good surface morphology for Ti/Al contacts, which require high annealing temperature (> 750 oC) to form low contact resistivity ohmic contact. Different thickness ratios between Ti and Al have been investigated. It has been confirmed that the first-step annealing at 600 oC has led to the formation of the stable TiAl3. Our results show that the 30/120 nm Ti/Al contact presents a good tradeoff between surface roughness and specific contact resistivity, with a minimum contact resistivity of 4.87□10-6 Ω·cm2 and a RMS roughness < 10 nm obtained.

References
[1] Z. Dong, J. Wang, et al, Microelectron. Reliab., 52, 434(2012).
[2] C. M. Pelto, et al, J. Appl. Phys., 92, 4283(2002).

Graphene Nanostructure Imaging and Fabrication with Focused He+ Beam

Candidate: Wang Yue
Supervisor/s: Dr. Daniel S. Pickard

Abstract:
Graphene nanopatterning has attracted tremendous amount of interest among researchers recently because of its unique properties in the nanoscale range. Electron beam lithography combined with reactive ion etching, unzipping from carbon nanotube (CNT) and chemical methods have been widely used to fabricate graphene nanostructures such as graphene nanoribbons (GNRs). GNRs exhibit the bandgap opening property and the the size of the energy gap inversely depends on the ribbon width. However, conventional lithography can only reliably pattern ~ 20 nm-wide ribbons limited by lithography resolution, and the chemical methods result in irregular shaped and distributed flakes poorly suited for device applications. In this work, we demonstrate a resist free top-down fabrication approach, which enables controlled tailoring of graphene in sub-10 nm features using the helium ion microscope (HeIM). With the edge resolution of ~0.25 nm and high spatial resolution with tremendous surface contrast, HeIM is attractive for imaging graphene structures. Even more compelling is the ability to directly modify graphene through surface sputtering, enabling direct pattern transfer for the fabrication graphene devices. This ability to directly pattern graphene structures promises great utility in the fabrication of sub-10nm graphene devices. More importantly, the method is based on focused He+ ions direct sputtering, which enables resist-free, direct pattering of graphene structure with sub-10 nm resolution for both supported and suspended graphene with good precision and control using the pattern generator.

Application of the Helium Ion Microscope to biological sciences

Candidate:	Supervisor/s:
GU JING	**Dr. Daniel S Pickard**

Abstract:

The Helium Ion Microscope (HIM) is a new imaging technology based on a high brightness (> 4X109A/cm2sr[1]) and stable Gas Field Ion Source (GFIS), which exhibits a low energy spread (< 1eV) and small virtual source size (<0.3nm). It gains a high spatial resolution (0.25nm[2]) because of the shallow escape depth (<1nm) of the secondary electrons generated by a high energy (30keV) of incident helium ion beam. The investigations of biological specimens with HIM have gained significant traction over alternative techniques. The utility of this instrument in addressing topics of the biological science is due in part to the HIM's high spatial resolution. In addition, it is also able to image the non-conductive samples without needs of metal coating and a background gas, both of which introduce more risk of artifacts thus degrade surface details and image resolution. With the HIM, sample neutralization is achieved by an integrated electron flood gun, which impinges a focused electron beam onto the ion scanning field. The positive charges introduced by helium ion are then balanced by the negative-charged electron beam, without degradation of resolution or loss of surface contrast. It has been reported that the HIM reveals rich surface details of wide range of biological samples[3], which have not been achieved by other techniques. However, as all imaging techniques utilizing charged particles, a vacuum environment is necessary thus makes the biological sample preparation much more elaborated: the specimens need to be completed dried by chemical altered or dehydrated, which inevitably presents an obstacle to obtain reliable and faithful image by changing of specimen morphology and introducing artifacts. We overcome this limitation by applying cryogenic specimen preparation technique. Instead of chemical dehydration, the biological specimen is prepared cryogenically so that the aqueous environment is maintains by vitreous ice formation, so that the specimen structure is kept to nearly the native state. We have recently installed a cryo-stage in the HIM which allows cryogenic sectioning and imaging of hydrated specimens in the vacuum environment at cryogenic temperature (-150℃). Experiment details involving the preparation procedure, freezing technique effect and ion and electron beam influences for cryogenic specimens will be discussed in the presentation.

The effects of interlayer mismatch on electronic properties of bilayer armchair graphene nanoribbons

Candidate:	Supervisor/s:
Qian You	**Lee Chengkuo, Liang Gengchiau**

Abstract:

We investigate the impact of interlayer mismatch on the electronic properties of bilayer graphene nanoribbons (BGNRs) with armchair-edges in terms of the total energy and electronic structures by first principle calculations. Simulation results show that in-plane misalignments require little energy and a large variation in the energy bandgap (EG) can be observed. Based on the resulting atomic configurations due to the misalignments, the details of the observed relationship between bandgap and the lattice mismatch are investigated. It is observed that in general, misalignment in the transverse direction results in a decrease in the interaction between the two layers, giving rise to a larger EG. On the other hand, misalignment in the longitudinal direction, i.e. along the edges, leads to an oscillation in EG due to the periodic change of the GNR stacking order. A combination of these movements results in a complex variation of EG, which introduces great uncertainty in electronic devices. However, such a phenomenon could also be used in various kinds of nanoelectromechanical systems as it provides a large change in electronic properties with a small movement.

Influence of novel fluorosurfactant modified PEDOT:PSS hole transport layer on the performance of inverted organic solar cells

Candidate:	Supervisor/s:
Lim Fang Jeng	**Ho Ghim Wei**

Abstract:

Long-term stability of organic solar cells with conventional device architecture in ambient conditions is a major concern when compared to devices with an inverted configuration. The removal of the interface between the ITO and the acidic PEDOT:PSS layer along with the substitution of the low work function metal cathode in the inverted configuration renders high stability in these devices. However, one of the main technical issues involving the fabrication of such device architecture is the wettability of the hydrophilic PEDOT:PSS onto the photoactive layer such as P3HT:PCBM which is hydrophobic in nature. This large surface energy differences will render high surface tension between the layers, resulting in poor adhesion and spreading during coating. To overcome this inherent difficulty, we have used a novel fluorosurfactant, Capstone® Dupont™ FS-31 (CFS-31) for the first time as a substitute to the conventional Zonyl FS-300 as an additive to PEDOT:PSS. Additionally, the new fluorosurfactant also provides fourfold advantage to the device. Firstly, a sufficiently wide and easily controllable surfactant concentration for a maximum device performance of 3.1% (P3HT:PCBM model system) using solution processed TiOx electron transport layer was obtained. Secondly, a smooth and uniform PEDOT:PSS layer was coated onto the P3HT:PCBM blend layer by addition of CFS-31 alone without any further treatments. Thirdly, addition of CFS-31 does not alter the optimal device parameters such as thickness of TiOx. Fourthly, it also provides an attractive advantage of forming better energy level alignment that result in an initially improving and stable device performance in ambient conditions for more than 300 hours without any encapsulation. The enhancement effect of the new fluorosurfactant is attributed to the enhanced phase segregation without significant blockage on the PEDOT conduction pathway.

TRACK 4

MICROELECTRONIC TECHNOLOGIES & DEVICES

LOCATION: EA-06-05

PRESENTERS		
1.	LEONG WEI SUN	Low-Contact-Resistance Contacts to Graphene via Metal-Mediated Etching
2.	Low Kain Lu	Electronic Band Structure and Effective Mass Parameters of Ge1-xSnx Alloys
3.	Shubham Duttagupta	Progress with industrially-feasible surface passivation of moderately and heavily-doped Czochralski silicon using plasma silicon nitride
4.	Tung Kar Hoo Patrick	Photoluminescence of self-assembly GaAs quantum rings grown by droplet epitaxy

Low-Contact-Resistance Contacts to Graphene via Metal-Mediated Etching

Candidate:	Supervisor/s:
LEONG WEI SUN	**John Thong Thiam Leong**

Abstract:

The performance of graphene electronic devices is often limited by poor metal-graphene contacts (Novoselov, 2012). From ab initio quantum mechanical studies, end-contacted metal-graphene contacts have been shown to provide much lower contact resistance compared to that of side-contacted contacts by up to a few orders of magnitude (Matsuda, 2010). In addition, an experimental study demonstrated that the current crowding takes place at the edge of the contact metal with graphene (Nagashio, 2010). However, the end-contacted configuration is limited by the amount of exposed graphene edges in contact with the metal. Conventional metallization schemes place the metal electrode on top of the graphene channel resulting in a side-contacted configuration, except for a small amount of edge coverage. In this work, we incorporated a metal-mediated etching technique (Wang, 2012) into the fabrication graphene device fabrication process. This etching technique creates a number of etched edges on graphene surface to allow the extensive formation of end-contacted metal-graphene contacts. Exfoliated graphene was first patterned into desired geometry followed by deposition of a thin metal film at the source/drain graphene regions. The prepared sample was then annealed in a hydrogen ambience. This causes the metal film to ball up due to surface tension and etches the graphene surface progressively. The etching is found to initiate from the graphene edges and extend along the natural crystallographic orientation of graphene. Most of the etch pits observed are triangular or germinal hexagonal in shape. The sample preparation was followed by forming electrical contacts onto graphene via conventional means such as electron-beam lithography and thermal evaporation. For comparison purposes, a few-layer graphene was patterned into two equivalent strips. Two small cobalt pads (3nm thick) were deposited at the end of one of the graphene strip. We then annealed the sample in hydrogen and patterned electrical leads to these contacts. Electrical measurements were carried out under ambient conditions. It was found that the two-point resistance of the graphene device with cobalt-etched-graphene contacts is 5 times lower than that of the untreated graphene device. Since nickel-graphene contact appears to provide the lowest contact resistance, we also fabricated a 4-point single layer graphene (SLG) device with nickel-etched-graphene contacts. The contact resistance measured under ambient conditions is 250Ωμm2, which to the best of our knowledge, is the lowest reported value for exfoliated SLG devices, with all previous reported ambient values above 700Ωμm2 (Venugopal, 2010; Nagashio, 2011; Xia, 2011). We then explore different duration and temperature for the etching process and thickness of metal film to be deposited to the source/drain graphene regions for etching. This is to obtain the optimized conditions for the metal-assisted etching approach proposed in this work. The lowest contact resistance we obtained so far is ~70Ωμm2 from a bilayer graphene device. In summary, the findings suggest that the metal-mediated etching technique could be a promising method to obtain low-contact-resistance metal contacts to graphene.

Electronic Band Structure and Effective Mass Parameters of Ge1-xSnx Alloys

Candidate:	Supervisor/s:
Low Kain Lu	**Dr. Yeo Yee-Chia**

Abstract:

This work investigates the electronic band structures of bulk Ge1-xSnx alloys using the Empirical Pseudopotential Method (EPM) for Sn composition x varying from 0 to 0.2. The adjustable form factors of EPM were tuned in order to reproduce the band features that agree well with the reported experimental data. Based on the adjusted pseudopotential form factors, the band structures of Ge1-xSnx alloys were calculated along high symmetry lines in the Brillouin zone. The effective masses at the band edges were extracted by using a parabolic line fit. The bowing parameters of hole and electron effective masses were then derived by fitting the effective mass at different Sn compositions by a quadratic polynomial. The hole and electron effective mass were examined for bulk Ge1-xSnx alloys along specific directions or orientations on various crystal planes.

Progress with industrially-feasible surface passivation of moderately and heavily-doped Czochralski silicon using plasma silicon nitride

Candidate:	Supervisor/s:
Shubham Duttagupta	**Prof. Armin G. ABERLE**

Abstract:

In regards to surface passivation, dynamically deposited (i.e. moving substrate) plasma SiNx films using industrial inline reactors have so far only achieved a modest level of surface passivation, although such SiNx films are widely used in silicon wafer solar cell manufacturing. Further reduction of surface recombination velocities using an industrial inline PECVD reactor is becoming very important for realizing industrial high-efficiency silicon wafer solar cells as the industry adapts increasingly thinner substrates. In this work, we present extremely low upper-limit effective surface recombination velocities (Seff.max) of 2 and 8 cm/s, respectively, obtained on moderately doped (4-5 Ω.cm, 160 µm) large-area (15.6 cm2) n-type and p-type Czochralski silicon wafers using silicon nitride (SiNx) films dynamically deposited in a commercially available industrial inline plasma-enhanced chemical vapour deposition (PECVD) reactor. Such low Seff.max values were previously only attainable for SiNx films deposited statically in lab reactors. SiNx films with optimised antireflective properties provide excellent Seff.max of 5 cm/s after high-temperature (> 800 °C) firing. Contactless corona-voltage measurements reveal that these SiNx films contain a relatively high positive charge of (4-8) × 1012 cm-2 combined with a relatively low interface defect density of ~5 × 1011 eV-1cm-2. The positive fixed charge density is particularly beneficial for the passivation of highly doped n-type c-Si because the minority carriers (i.e., the holes) are effectively shielded from the c-Si surface ("field-effect passivation"). These SiNx films demonstrated very low saturation current densities (J0e) of 15 and 170 fA/cm2 obtained for 180 and 20 Ω/sq obtained on planar phosphorus-diffused n+ emitters after an industrial firing. For textured surfaces J0e values are 1.2 to 2.2 times larger compared to their planar counterparts. These values are comparable to the best published laboratory results; although, in this case the films were deposited in a fully industrial reactor and using industrial process conditions, thus can be immediately transferred to industries/factories.

Photoluminescence of self-assembly GaAs quantum rings grown by droplet epitaxy

Candidate:	Supervisor/s:
Tung Kar Hoo Patrick	**Dr. Xiang Ning**

Abstract:

The fabrication of GaAs quantum rings by droplet epitaxy process on lattice matched AlGaAs surface using molecular-beam epitaxy (MBE) will be presented. Droplet epitaxy is a fabrication method allowing the formation of low dimensional nanostructures on lattice matched materials. During droplet epitaxy, Ga is first introduced first in the absence of As and it forms metallic droplets on the surface from Volmer-Weber growth mode. Subsequently, As is introduced and the Ga droplets were crystallised to form GaAs quantum rings. GaAs quantum rings forms into two distinct sizes from Ga droplet etching properties. Photoluminescence (PL) was used to observe optical emission from the GaAs quantum rings. The PL emission of the bi-modal GaAs quantum rings will be presented and discussed.

TRACK 5

POWER & ENERGY SYSTEMS

LOCATION: EA-06-06

PRESENTERS		
1.	Bhuneshwar Prasad	Energy-Efficient Optimal Thrust Allocation for Spherical Underwater Robot
2.	Gu Chaojun	Impacts of Communication Failure on Power System Operations
3.	Krishnanand Kaippilly Radhakrishnan	A Real-Time Fast Discrete S-Transform for Cross-Differential Protection of Shunt-Compensated Power Systems
4.	Quan Hao	Construction of Neural Network-Based Prediction Intervals for Short-Term Electrical Load Forecasting
5.	Yu Yinquan	Vibration Study and Classification of Rotor Faults in PM Synchronous Motor

Energy-Efficient Optimal Thrust Allocation for Spherical Underwater Robot

Candidate: Bhuneshwar Prasad
Supervisor/s: A/P S.K PANDA

Abstract:
In this paper, a spherical underwater robot uses optimal thrust allocator to determine the magnitude and the direction of thrust required for each water-jetted bilge pump thruster to create force and moment equilibrium. However, in order to ensure safe operation of the underwater robot it is equipped with redundant thruster configuration and therefore is over-actuated. Therefore, the choice of a particular solution for thrust allocation is found using an optimization process. In this work, the thrust allocation problem is formulated as an optimization problem, with an objective to minimize the total power consumption of the spherical underwater robot. The power consumption of underwater robot depends on the thrust generated by each bilge pump. The relationship between the power consumption and the thrust of the bilge pump is established using experimental data. The formulated optimal thrust allocation problem is solved using Mincon (Sequential Quadratic Programming) and SA (Simulated Annealing) optimization algorithm. The percentage savings in total power consumption for thruster system using the SA method ascompared to Mincon method is 50.6 %.

Impacts of Communication Failure on Power System Operations

Candidate: Gu Chaojun
Supervisor/s: Panida Jirutitijaroen

Abstract:
Communication technology serves important functions in the power system energy management system (EMS). Recent studies found that cyber-attack and terrorist attack can cause failure of power system communication which affects EMS in various ways. This paper analyzes two impacts of communication failure on EMS, namely, system observability and system control. The first impact on system observability is studied using DC state estimation to identify unobservable states when loss of communication occurs at various locations. The second impact on system control is studied using DC OPF to find the loss of load caused by communication failure. Simulation studies on the two analyses are conducted on IEEE 14 bus and IEEE 30 bus systems. Results show that certain substations are more critical for system observability. Optimal upgrade strategy is provided in this paper to improve system observability. It is also shown that failure of communication will cause extra loss of load. By protecting certain substations, the system can expect less loss of load. It is concluded that communication system is crucial to the power system operation. This paper also gives suggestion to optimally improve communication systems.

A Real-Time Fast Discrete S-Transform for Cross-Differential Protection of Shunt-Compensated Power Systems

Candidate: Krishnanand Kaippilly Radhakrishnan
Supervisor/s: Assoc. Prof. Sanjib Kumar Panda

Abstract:
This paper presents a cross-differential protection scheme for power transmission systems inclusive of a STATCOM. The measurement of the energy of the prominent frequency components of the current signals is done using a computationally fast version of the discrete S Transform suitable for power system signal analysis. The energy thus obtained is used for cross-differential purposes. The practical implementation of the new fast discrete S-transform is performed on the TMS320C6713 digital signal processor for verification of real-time operation of the algorithm. The computational load of the processor to perform in the online mode is reduced by a cross-differential check using a cumulative difference technique. The analysis and results obtained from the extensive experimentations show feasibility and speed of the new approach.

Construction of Neural Network-Based Prediction Intervals for Short-Term Electrical Load Forecasting

Candidate:	Supervisor/s:
Quan Hao	Dipti Srinivasan

Abstract:

Short-term load forecasting (STLF) is of great importance for control and scheduling of electrical power systems. The uncertainty of power systems increases due to the random nature of climate and the penetration of the renewable energies such as wind and solar power. Traditional methods for generating point forecasts of load demands cannot properly handle uncertainties in datasets. To quantify these potential uncertainties associated with forecasts, this paper implements a neural network (NN)-based method for construction of prediction intervals (PIs). A newly proposed method, called lower upper bound estimation (LUBE), is applied to develop PIs using NN models. The primary multi-objective problem is firstly transformed into a constrained single-objective problem. This new problem formulation is more close to the original problem and has fewer parameters than the cost function. Particle swarm optimization (PSO) integrated with the mutation operator is used to solve the problem. Two case studies from Singapore and New South Wales (Australia) historical load datasets are used to validate the PSO-based LUBE method. Demonstrated results show that the proposed method can construct high quality PIs for load forecasting applications.

Vibration Study and Classification of Rotor Faults in PM Synchronous Motor

Candidate:	Supervisor/s:
Yu Yinquan	Abdullah Al Mamun, BI CHAO

Abstract:

Both radial and axial direction Repeatable Run-Out (RRO) and None repeatable Run-Out (NRRO) of spindle motor in HDD is a big concern in high TPI requirement. Besides the reasonable spindle motor structure design which studied, the fabrication tolerance of spindle motor parts should be controlled in order to minimum RRO and NRRO. As it is known, the vibration of spindle motor is mainly caused by unreasonable Unbalance Magnet Pull (UMP). Different motor parts faults (tolerance is out of the control) will generate different types of UMP which should be generate different vibration signals pattern. Though studying different vibration signals and acoustic noise pattern, the types of UMP faults should be detected and classified. Then, the related out of tolerance controlled parts can be known. Researchers have studied vibration and acoustic signals in recent years. In this paper, the 12 slots and 5 pole-pairs PM surface mounting Synchronous motor is modified as M1 to do experimental study. This paper can be a guideline of design high performance motor, it also can be the reference of general motor fault diagnosis.