Department of Electrical and Computer Engineering
National University of Singapore

PROCEEDINGS

7th NUS ECE

GRADUATE STUDENT SYMPOSIUM

8 – 9 May 2017

Venue:
Lecture Theatre 2 (LT2) & Seminar Rooms
Faculty of Engineering
National University of Singapore

SPONSORS:

MESSAGE FROM THE HEAD OF ECE DEPARTMENT

I would like to thank the ECE Graduate Student Council for organizing the 2017 ECE Graduate Student Symposium, the seventh in a series of annual symposia inaugurated in 2011. A total of 74 oral papers will be presented over two days in 11 oral sessions, 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 engage with one another through interactions throughout the event. The ability to present their work well in such a public forum is an important part of their overall education as researchers.

The symposium is supported by many parties who contributed in various ways. On behalf of the Department, I would like to thank everyone for their generous support. In particular, I thank Mr. Mark Yong, Dr. Rejeki Simanjorang, Ms. Sanna Grannas and Mr. Alex Crompton for delivering our keynote speeches. I also thank Dr. Mohammad Danesh, Dr. Senthil Raja Jayapal and Prof. Chua Soo Jin for their participation in the panel discussion.

I would also like to acknowledge the support of all our sponsors including the IEEE Singapore section, IEEE Rel/CPMT/ED society, IEEE PELS/IAS/ComSoc/Circuits and Systems societies, Plexim GmbH, and NUS ECE Department for their contributions to the symposium; and my colleagues who provided valuable advice to the students in the planning and organization of the symposium, and who will be acting as judges for the paper awards.

I wish you all a very fruitful and stimulating meeting.

John Thong

Professor and Head of Department
Department of Electrical & Computer Engineering
*National University of Singapo*re

MESSAGE FROM THE GSS COMMITEE

Thank you for being a part of this Graduate Student Symposium (GSS)-2017. We, the GSS 2017 committee, are greatly honored to welcome all the participants for our annual symposium.

The ability to make an effective presentation is a researcher's most valued skill both in academia and as well as industry. The core vision of GSS is to facilitate a platform for the graduate students to hone such skills. GSS, as its tradition goes has being providing ECE graduate students with an opportunity to present their research findings and enhance their presentation skills in a more conducive environment. Through GSS, graduate students are given constructive feedback by the ECE professors and their peers. We are proud to announce that ECE GSS started in 2011, and is running in its seventh year now.

The format of the symposium is same as previous years where every participant is encouraged to present their research findings in front of the judges and share their ideas with their peers on the site. This is followed by a Q & A session. This way, participants get the chances to practice their presentation skills and ability to think on their feet, which is very important for their PhD study and future career building. Like the previous year, we will only have oral presentations instead of both oral and poster presentations.

This year, we have three eminent keynote speakers on the first day of the conference. Firstly, we have Mr. Mark Yong, CEO of Garuda Robotics who will give us a talk on "What are you building, and who is it for?", followed by Dr. Rejeki Simanjorang from Rolls Royce Singapore on "The challenges for electrical power engineer in more electric technology". Finally, we have Ms. Sanna Grannas from the Centre for Future-ready Graduates, NUS, talking on "Career options beyond". The panel discussion titled "Where do you fit in? Discovering your career sweet spot post-graduation" will include Dr. Mohammad Danesh, Dr. Senthil Raja Jayapal, and Prof. Chua Soo Jin on the panel. On the second day, we have organized a keynote speech by Mr. Alex Crompton, Director of Entrepreneur First, Singapore, on "How to start your own deep tech company and commercialize your research".

We would like to extend our gratitude to ECE department for their support and cooperation for this event, in particular, Prof. Yung C. Liang, Deputy Head of the Department (Research & Graduate Programmes), without his advice we wouldn't have been able to pull this off, and Ms. Eunice Wong, Ms. Melissa Lam and Ms. Hemamalini for their kind guidance. Moreover, we would like to thank all the professors who helped us in judging the presentations and evaluating the research works. We would also like to express our sincerest appreciations to our fellow colleagues who volunteered to constitute and organize this symposium for their relentless and passionate call to duty that has made this event come this far. We all have enjoyed the very good experience in organizing an IEEE-like conference.

Finally, we appreciate your attendance and participation to make the sixth NUS ECE Graduate Student Symposium (GSS2017) a great success.

GSS Organizing Committee

COMMITTEE MEMBERS

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Romika Sharma
Solar Energy Research Institute of Singapore

Binita Sen
Electrical Machines and Drive Lab

Guangwei Hu
Microwave and Radio Frequency Lab

Ren Kailin
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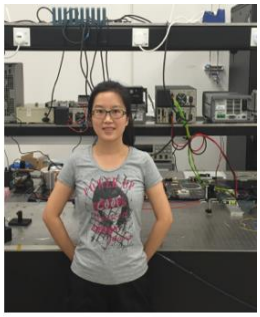

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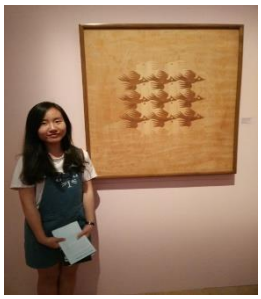


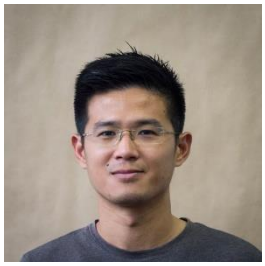
Wang Cong
Microwave Engineering Lab

Yin Tiantian
Microwave Research Lab

KEYNOTE SPEECH 1

Day 1, May 8, 2017, Time: 10:15 am – 11:15 pm, Venue: Lecture Theatre 2 (LT2)

Topic: What are you building, and who is it for?



Mr. Mark Yong
CEO and Co-Founder,
Garuda Robotics.

Abstract:
Over the last two years of deploying drones across Southeast Asia for clients in traditional industries such as agriculture, infrastructure and security, we have had to overcome challenges in user mindsets, cultures, and expectations of outcomes. I will share the key lessons learned from pushing cutting edge technology into the field, and discuss what it means for technologists looking for ways to make an impact on the world.

Biography:
Mark Yong is CEO and co-founder at Garuda Robotics, a leading developer of enterprise drone and data solutions for the agriculture, infrastructure and security sectors. He has 20 years of experience designing and building robotics systems in domains ranging from urban search and rescue to STEM education. He was previously an award-winning lecturer in the School of Computer Engineering at Nanyang Technological University, Singapore. Mark was trained in computer engineering, computer science, economics and psychology at Carnegie Mellon University (BS/MS) and the University of Michigan (MS).

KEYNOTE SPEECH 2

Day 1, May 8, 2017, Time: 11:30 am – 12:30 pm, Venue: Lecture Theatre 2 (LT2)

Topic: Challenges for Electrical Power Engineer in More Electric Technology

Dr. Rejeki Simanjorang
Singapore Advanced Technology Center,
Rolls-Royce Singapore Pte. Ltd.

Abstract:
More Electric Technology is a trend in industries today. This technology is implemented by replacing fully mechanical system with hybrid system. The hybrid system combines mechanical and electrical system together to obtain higher efficiency, more flexibility, and environmental friendly application. Power electronics which is part of electrical power engineering is playing a key role in More Electric system. The electrical power engineer has to have enough expertise in power electronics to fulfill industry needs.

This presentation will present the implementation of More Electric Technology in industries and discuss the capability that a power engineer needs to have. As some of these capabilities are not covered in engineering course, they need to be acquired through self-learning process.

Biography:
Dr. Rejeki Simanjorang (SM'16) was born in Tanah Karo, Indonesia. He received his B.Sc., M.Eng. and Dr.Eng. degrees in Electrical Engineering from University of Sumatera Utara (Indonesia, 1998), Bandung Institute of Technology (Indonesia, 2002) and Osaka University (Japan, 2008), respectively. He was a researcher in National Institute of Advanced Industrial Science and Technology (AIST) and R&D Partnership for Future Power Electronic Technology (FUPET), Japan from 2008 to 2013. Currently, he is working in Electrical Capability Group (ECG) – Applied Technology Group (ATG), Rolls-Royce Singapore. He is leading some collaboration research projects between Rolls-Royce Singapore and external partners. His main research focus on application of power converters, design of high power density converters, power electronics packaging and Electrical Health Monitoring (EHM) for power electronics system.

KEYNOTE SPEECH 3

Day 1, May 8, 2017, Time: 12:30 pm – 1:00 pm, Venue: Lecture Theatre 2 (LT2)

Topic: Career options beyond

Ms. Sanna Grannas
Careers Advisor,
Centre for Future-ready Graduates

Abstract:
The academic career path has for long been the default option for PhD degree holders, but the times are changing: due to the decreasing number of academic positions PhD students have to consider options beyond the typical career path.

The PhD students I have met for career coaching usually have two major concerns: Does a PhD degree equip me with the skills that required in the private sector? And how to showcase those skills when I'm applying for non-academic positions?

Corporate organisations do put more and more emphasis on so called soft skills, even in technical roles. In the times when machines do replace humans in a wide variety of roles, the employers do value skills that artificial intelligence and machine learning can't replace. The recruiters are in the search for candidates who can be placed in customer-interfacing roles and are able to effectively communicate with the members of their own team as well as the external parties. Similarly, team work experience is valued by more or less every employer. PhD studies do make it possible for you to gain these skills, and the skills need to be found in your resume when applying for industrial positions. That is why it is extremely important for you, a graduating PhD student, to identify the skill sets required for the roles you are interested in. Equally important it is to learn how to highlight those key skills in your resume.

Biography:
As a Careers Advisor at Centre for Future-ready Graduates Sanna is coaching postgraduate students from the STEM faculties. She is passionate about empowering students and helping them discover their strengths and interests. Sanna strives to help them to navigate through their options in career paths and guide them towards the right career decisions and development. She sets herself the challenge to be of the utmost assistance for each and every student she meets. Sanna advises students on their career preparations such as resume and cover letter writing and helps them to excel in their job interviews. After pursuing her Master's degree in Biochemistry Sanna completed another degree in Pharmacy. Before joining NUS she spent over ten years working in academic research and the private sector in both Finland and Singapore.

KEYNOTE SPEECH 4

Day 2, May 9, 2017, Time: 11:45 am – 12:45 pm, Venue: Lecture Theatre 2 (LT2)

Topic: How to start your own deep tech company and commercialize your research

Mr. Alex Crompton
Director,
Entrepreneur First, Singapore

Biography:

Alex is a programme director at Entrepreneur First, structuring the programme and helping the teams reach the EF community. Prior to joining Entrepreneur First, Alex joined worked in finance and engineering consultancy in Tokyo, having earlier started sales for a new, Oaktree Capital backed, property company in London. He runs our City to Startup meetup, and graduated from Queen's University Canada and Warwick University. Alex is interested in effective altruism, industrial applications of machine learning, and human computer interaction.

Company Profile:

Entrepreneur First is the world's leading company builder. Entrepreneur First invests in top technical individuals to help them build world-class deep technology startups from scratch in London and Singapore. Entrepreneur First helps you find your co-founder and commercialise your technology on our intensive programme to give you the best possible support in the first years of your startup's life. Since 2011, Entrepreneur First have created over 100 startups worth over $400m including Magic Pony Technology, Tractable, StackHut, Pi-Top, OpenCosmos, Status Today and Cloud NC.

PANEL DISCUSSION

Day 1, May 8, 2017, Time: 4:30 pm – 5:30 pm, Venue: Lecture Theatre 2 (LT2)

Topic: Where do you fit in? Discovering your career sweet spot post-graduation

Panel members

MOHAMMAD DANESH

CTO and Co-founder
Transcelestial Technologies Pte Ltd.

Founded in 2016, Transcelestial is a Singapore based research-led, space communications startup. Transcelestial is developing an ultra-high bandwidth space data network as a service, capable of data speeds up to 1 Tbits/sec, by using state-of-the-art research and engineering techniques in photonics and computing.

Dr. Mohammad Danesh has a PhD in Nanophotonics from the National University of Singapore. His research in Graphene Plasmonics enabled manipulation of light & matter interaction on a nanoscale level. He has performed research in photonic systems for A*STAR in the Institute of High Performance Computing, Sumitomo Electric Labs, where he worked on advanced infrared sensor arrays and FUNSOM Institute where he performed state of the art nano imaging of light and 2D materials interaction. The result of this research has been published in major photonics journals including Nature.

SENTHIL RAJA JAYAPAL

Manager, Centre for Future-ready Graduates
National University of Singapore

Dr. Senthil completed PhD in Computation and Systems Biology from the Singapore-Massachusetts Institute of Technology Alliance, National University of Singapore in 2011. Following this, he worked as a post-doctoral research fellow for 5 years at Agency for Science, Technology, and Research (A*STAR), Singapore. In addition to expertise in biomedical research, he has extensive experience in teaching and mentoring at the secondary and tertiary level in Singapore. In his current role at the Centre for Future-ready Graduates, he manages the career services at the Faculty of Science, National University of Singapore.

CHUA SOO JIN

Professor, Department of Electrical and Computer Engineering,
National University of Singapore

Dr. Chua Soo Jin is a Professor of Electrical Engineering at the National University of Singapore (NUS). He was the Assistant Director of the Institute of Microelectronics (IME) when it was first formed in 1990 and established its wide industry contacts and research collaborations with the tertiary institutions during its first five formative years. In the area of research, he was Director of the Opto and Electronics Systems Cluster at the Institute of Materials Research & Engineering (IMRE) from 1997 -2006, conducting research on GaN MOCVD and OLED. Since 2006, he is the Deputy Executive Director of IMRE with responsibility for industry interactions and collaborations. His research area is in optoelectronics and has published over 400 papers in international journals and co-authored 30 patents. He has received awards for Excellent Teacher and also as Outstanding University Researcher in 1998 and 1999 respectively. His interaction with industry has been fairly extensive, providing consultancies to companies here in Singapore and in the region. His expertise in the field of Optoelectronics is well recognized and he has been engaged by companies to provide courses on specialized topics in the field.

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 six research areas- namely, Communications & Networks, Control, Intelligent Systems & Robotics, Microelectronic Technologies & Devices, Microwave & RF, Power & Energy Systems and Signal Analysis & Machine Intelligence. These works reflect the students' efforts in the state-of-the-art R & D.

PROGRAM SCHEDULE

Schedule Day 1: 8th May, 2017

Program Schedule		Track 1	Track 2	Track 3
9.30 - 10.00 AM	**Registration** (Outside LT-2)			
10.00 - 10.15 AM	**Opening Speech** (LT- 2)	Prof. Y.C. Liang (Dept. of Electrical and Computer Engineering, NUS)		
10.15 - 11.15 AM	**Keynote Speech 1** (LT -2)	Mr. Mark Yong (CEO & Co-Founder, Garuda Robotics)		
11.15 - 11.30 AM	Tea			
11.30 - 12. 30 PM	**Keynote Speech 2** (LT - 2)	Dr. Rejeki Simanjorang (Singapore Advanced Technology Centre, Rolls- Royce Singapore Pte. Ltd.)		
12.30 - 1.00 PM	**Keynote Speech 3** (LT - 2)	Ms. Sanna Grannas (Careers Advisor, Centre for Future-ready Graduates)		
1.00 - 1.45 PM	Lunch			
1.45 - 4.00 PM	**Session 1**	Communication and Networks (EA-06-02)	Signal Analysis and Machine Intelligence (EA-06-03)	Control, Intelligent Systems, Robotics (EA-06-04)
4.00 - 4.15 PM	Tea			
4:30 - 5.30 PM	**Panel Discussion** (LT - 2)	Topic: "Where do you fit in? – Discovering your career sweet spot post-graduation"		
5.30 - 6.30 PM	Heavy Snacks/Dinner			

Schedule Day 2: 9th May, 2017

Program Schedule		Track 1	Track 2	Track 3
9.30 - 11.30 AM	**Session 2**	-	Microelectronic Technologies and Devices (E1-06-04)	Control, Intelligent Systems, Robotics (E1-06-05)
11.30 - 11.45 AM	Tea			
11.45 - 12.45 AM	**Keynote Speech 4** (LT - 2)	Mr. Alex Crompton (Director, Entrepreneur First, Singapore)		
12.45 - 1.45 PM	Lunch			
1.45 - 3.45 PM	**Session 3**	Power and Energy Systems (E1-06-03)	Microelectronic Technologies and Devices (E1-06-04)	Microwave and RF (E1-06-05)
3.45 - 4.00 PM	Tea			
4.00 - 6.00 PM	**Session 4**	Power and Energy Systems (E1-06-03)	Microelectronic Technologies and Devices (E1-06-04)	Microwave and RF (E1-06-05)
7.30 - 9.00 PM	**Bowling and Mixer**			

SESSION 1

8 MAY 2017 (DAY 1)
1:45 PM to 4:00 PM

TRACK 1

COMMUNICATIONS & NETWORKS

PRESENTERS :		
1	**Ayush Kumar**	Privacy Preserving Architecture for IoT Cloud Services
2	**Ahmad Al Badawi**	Hardware Accelerated Fully Homomorphic Encryption
3	**Dong Shandong**	Strain insensitive but high thermal-sensitivity temperature sensor with a cascaded fiber interferometer
4	**Utku Tefek**	Full-Duplex SIMO Relaying for Machine-Type Communications in Cellular Networks
5	**Vignesh Sridharan**	On Multiple Controller Mapping in Software Defined Networks with Resilience Constraints
6	**Yifan Liu**	Tunable anisotropic magnetic damping of Fe2Cr1-xCoxSi half-metallic Heusler alloys

Privacy Preserving Architecture for IoT Cloud Services

PRESENTER: **Ayush Kumar**

Abstract:

With the growing number of network-connected devices owned by users, the Internet of Things (IoT) is set to become a indispensable part of our lives. To manage such a large number of devices, a central management solution is required. Cloud based solutions are a popular candidate but they give rise to many privacy concerns for the user. In this project, we study the cloud based management of IoT devices where the cloud service is not trustworthy and identify related privacy concerns. Further, we design an alternative Cloud Based Service (CBS) that addresses those privacy concerns. The proposed CBS uses three approaches to achieve privacy, namely distribution of trust over multiple parties, policy based solutions and technical solutions (for e.g. cryptography). Finally, we derive important insights from our proposed model and discuss them in detail.

Hardware Accelerated Fully Homomorphic Encryption

PRESENTER: **Ahmad Al Badawi**

Abstract:

Polynomial multiplication in Z_q[x]/[x^n + 1] has brought great attention recently thanks to new construction of cryptographic solutions based on lattice and ring-learning with errors problems. Several number theory libraries exist that can calculate this operation efficiently such as NTL and FLINT. The basic idea behind fast multiplication algorithms is the relation between multiplication and convolution which can be computed efficiently via fast Fourier transform algorithms. An interesting algorithm that cuts the transform length in half is based on the discrete Gaussian transform (DGT). DGT was first proposed to work with primes that support Gaussian integers arithmetic such as Mersenne primes. We modify the algorithm to work with arbitrary primes and show how its parameters can be found efficiently. We choose a special prime that offers efficient modulo operation to enhance the overall performance. The proposed algorithm is implemented in C++ and benchmarked against mature and highly optimized number theory libraries, namely: NTL and FLINT. Our algorithm performs better than both libraries. Speed up factors ranging from 1.01x-1.2x against NTL and 1.18x-1.55x against FLINT are achieved.

Strain insensitive but high thermal-sensitivity temperature sensor with a cascaded fiber interferometer

PRESENTER: **Dong Shandong**

Abstract:

A cascaded fiber modal interferometer (CFI) was proposed and demonstrated theoretically and experimentally. The CFI is made up of two cascaded miniaturized fiber modal interferometers (MMIs). Coupling of the CFI has been derived using transmission matrix. The CFI can be regarded as an equivalent MMI, which has been verified from FSR comparison. Experimentally, the interference length of the two MMIs are both 2cm, while the connection distance between the two MMIs is 8cm. The transmission spectrum of CFI was measured by an OSA under a wavelength resolution of 0.02nm. Conclusions have been achieved that cascading the MMIs can effectively improve its thermal sensitivity. However, the strain sensitivity has been reduced compared with that of single MMI. Experimentally, the thermal sensitivity of CFI can reach 112.9 pm/°C, and almost two times as big as that of the single MMI. In contrast, its strain sensitivity is only -0.41 pm/με, which is only 2/5 as small as that of the single MMI. Therefore, its thermal sensitivity can be effectively improved and its strain sensitivity can be effectively reduced by cascading the MMIs as a

CFI. Besides that, CFI structure keeps the advantages of MMIs, like simple and compact structure, low cost, easy to fabricate, etc.

Full-Duplex SIMO Relaying for Machine-Type Communications in Cellular Networks

PRESENTER: **Utku Tefek**

Abstract:

To address massive access in machine-type communication (MTC), we consider in-band full-duplex (IBFD) relays to aggregate MTC packets. IBFD allows devices to receive and transmit concurrently on the same frequency band, potentially doubling the spectral efficiency. On the downside, the use of IBFD raises the interference due to an increased density of simultaneously transmitting nodes. This paper deals with a key trade-off between the increased spectral efficiency and interference in utilizing IBFD uplink relays in a densely deployed MTC network. Using stochastic geometry, we develop a framework to evaluate the end-to-end outage probability and uplink data aggregation rate. The model consists of MTC devices and IBFD relay nodes that forward MTC packets to BSs over single-input-multiple-output (SIMO) channels. The BSs employ linear zero-forcing filters to cancel the interference from their associated relay nodes which may transmit simultaneously on the same frequency band. We show the somewhat surprising result that IBFD relaying does not lead to performance gains over half-duplex relays, when devices and relays are independently and homogeneously distributed in space.

On Multiple Controller Mapping in Software Defined Networks with Resilience Constraints

PRESENTER: **Vignesh Sridharan**

Abstract:

Software Defined Networking (SDN) has emerged as a promising paradigm in networking, promising flexibility and programmability in networks. The main principle of SDN is the separation of control and data plane, which is accomplished by having a central controller that manages the flow tables of the switches. To overcome the issues of scalability and resilience in single controller SDN architecture, distributed controller architectures have been proposed. This introduces the switch-controller mapping problem, which is an important issue since the mapping affects the flow setup time of new flows in the network. We propose an effective switch-controller mapping scheme for distributed controller architectures in SDN. Our scheme maps a switch to multiple controllers and distributes flow setup requests among them to minimize flow setup time, satisfying the resilience constraint which requires that a specified fraction of setup requests at each switch is not affected upon a controller failure. We develop an optimization formulation for the problem and compare our scheme against the single controller mapping scheme in which all the flow setup requests from a switch are sent to one of the controllers in the network. The results show that our scheme reduces flow setup time, provides better fairness among switches and that it is at least three times more stable against dynamic traffic fluctuations.

Tunable anisotropic magnetic damping of Fe2Cr1-xCoxSi half-metallic Heusler alloys

PRESENTER: **Yifan Liu**

Abstract:

Ferromagnetic Heusler alloys are promising candidate materials for magnetic devices due to the high Curie temperature, rich magnetic anisotropy and small damping constant. In Heusler half-metals, the Fermi level is in the band gap for one spin and in the band for the other, making the material 100% spin polarized at the Fermi level and therefore, ideal for spin based electronics. Currently, spintronics primarily focus on exploiting spin transfer torque (STT) for non-volatile memory and logic devices with reduced power consumption. The requirements, especially on the material used as the switching element are quite stringent. Crucially, reduction and control of magnetic damping is essential to engineer high-speed and small critical current density for STT switching. Here, we report a systematic investigation on the anisotropic magnetic properties of iron-based half-metallic Heusler alloy Fe2Cr1-xCoxSi (FCCS) thin films using broadband angular-resolved ferromagnetic resonance. Band structure engineering through Co doping (x) tunes the intrinsic magnetic damping over an order of magnitude namely, 1×10-2 - to 8×10-4. Notably, the damping constant for samples with high Co concentration composition are among the lowest reported for Heusler alloys. These results demonstrate the viability to tailor magnetization for Heusler alloy-based spintronics at room temperature.

TRACK 2

SIGNAL ANALYSIS AND MACHINE INTELLIGENCE

PRESENTERS :		
1	**Li Ruoteng**	Robust Optical Flow Estimation in Rainy Scenes
2	**Liang Jie Wong**	Polymetallic Nodules Abundance Estimation using Sidescan Sonar: A Quantitative Approach using Artificial Neural Network
3	**Jianxiao Wu**	Accurate nonlinear mapping between MNI152 volumetric and fsaverage surface coordinate systems
4	**Shengtao Xiao**	Recurrent 3D-2D Dual Learning for Large-pose Facial Landmark Detection
5	**Jian Zhao**	A Good Practice Towards Top Performance of Face Recognition: Transferred Deep Feature Fusion
6	**Xiaoxu Zheng**	Long-term Cooperative Tracking using Multiple Unmanned Aerial Vehicles
7	**Val Mikos**	Optimal Feature Extraction and Feature Subsets for various Machine Learning Algorithms targeting Freezing of Gait Detection
8	**Rohan Ghosh**	Spatiotemporal Feature learning and point tracking for event-based vision

Robust Optical Flow Estimation in Rainy Scenes

PRESENTER: **Li Ruoteng**

Abstract:

This paper presents a method to estimate optical flow under rainy scenes. Optical flow estimation in the rainy scenes is considered challenging due to background degradation introduced by rain streaks and rain accumulation effects in the scene. Rain accumulation effect refers to poor visibility of remote object due to the intense rainfall. Most existing optical flow methods are erroneous when applied to rain sequences because the conventional brightness constancy constraint (BCC) and gradient constancy constraint (GCC) generally break down in this situation. In this paper, our method considers the rain streaks and rain accumulation separately. Based on the fact that the RGB color channels receive raindrop radiance equally, we introduce a residue channel as a new data constraint to significantly reduce rain streaks. In the case of rain accumulation, our method proposes to separate the image into a piecewise smooth background layer and a high-frequency detail layer and enforce BCC on the background layer only. Results on both synthetic dataset and real images show that our algorithm outperforms existing methods on different types of rain sequences. To our knowledge, this is the first optical flow method dealing with rain.

Polymetallic Nodules Abundance Estimation using Sidescan Sonar: A Quantitative Approach using Artificial Neural Network

PRESENTER: **Liang Jie Wong**

Abstract:

There are high abundance of polymetallic nodule scattered across the vast Clarion and Clipperton Fracture Zone (CCFZ) in the Pacific Ocean. These nodules possess high potential economic value as they are rich in metals such as manganese, nickel, copper and cobalt. Quantification of nodules coverage is important for economic feasibility studies and planning of effective exploitation strategies. Traditional methods for nodule quantification are highly labour and time intensive as they rely on manual counting and measurement of polymetallic nodules collected from freefall box corer and/or through image processing of seabed photography images captured with an Autonomous Underwater Vehicle (AUV). Using sidescan sonar and geotagged photographic images collected from the CCFZ region, we propose a novel technique based on artificial neural networks (ANN) to estimate nodule abundance using texture variations from sidescan sonar data. Compared to the optical camera, the sidescan sonar provides a much larger area of coverage which in effect would drastically increase AUV survey area at a given time. Till date, this is the first known published work to make use of a data driven approach to do PMN abundance estimation using backscatter pattern from the sidescan sonar. Our network yielded a test performance of 84% accuracy, which shows that it can be used as an effective tool in estimating nodule abundance from sidescan sonar images. This approach allows faster evaluation of nodules abundance for future deep seabed sites without the need for an underwater camera.

Accurate nonlinear mapping between MNI152 volumetric and fsaverage surface coordinate systems

PRESENTER: **Jianxiao Wu**

Abstract:

Most neuroimaging studies are reported in volumetric or surface coordinate systems (or atlas spaces). Accurate mapping between MNI152 and fsaverage is important because it facilitates many applications, such as projecting fMRI results from MNI152 to fsaverage for

visualization, and projecting surface-based parcellations to MNI152 space for volumetric analysis. We implemented and compared a registration fusion (RF) approach and two common approaches using 1490 subjects from the Brain Genomics Superstruct Project. The RF approach is considered for this task for tackling registration errors present in volumetric data (in MNI152) used in actual applications. Our evaluation simulated imagined scenarios, showing that the RF approaches compared favorably in general.

Recurrent 3D-2D Dual Learning for Large-pose Facial Landmark Detection

PRESENTER: **Shengtao Xiao**

Abstract:

Despite remarkable progress of face analysis techniques, detecting landmarks on large-pose faces is still difficult due to self-occlusion, subtle landmark difference and incomplete information. To address these challenging issues, we introduce a novel recurrent 3D-2D dual learning model that alternatively performs 2D-based 3D face model refinement and 3D-to-2D projection based 2D landmark refinement to reliably reason about self-occluded landmarks, precisely capture the subtle landmark displacement and accurately detect landmarks even in presence of extremely large poses. The proposed model presents the first loop-closed learning framework that effectively exploits the informative feedback from the 3D-2D learning and its dual 2D-3D refinement tasks in a recurrent manner. Benefiting from these two mutual-boosting steps, our proposed model demonstrates appealing robustness to large poses (up to profile pose) and outstanding ability to capture fine-scale landmark displacement compared with existing 3D models. It achieves new state-of-the-art on the challenging AFLW benchmark. Moreover, our proposed model introduces a new architectural design that economically utilizes intermediate features and achieves 4Ã— faster speed than its deep learning based counterparts.

A Good Practice Towards Top Performance of Face Recognition: Transferred Deep Feature Fusion

PRESENTER: **Jian Zhao**

Abstract:

Unconstrained face recognition performance evaluations have traditionally focused on Labeled Faces in the Wild (LFW) dataset for imagery and the YouTubeFaces (YTF) dataset for videos in the last couple of years. Spectacular progress in this field has resulted in a saturation on verification and identification accuracies for those benchmark datasets. In this paper, we propose a unified learning framework named transferred deep feature fusion targeting at the new IARPA Janus Bechmark A (IJB-A) face recognition dataset released by NIST face challenge. The IJB-A dataset includes real-world unconstrained faces from 500 subjects with full pose and illumination variations which are much harder than the LFW and YTF datasets. Inspired by transfer learning, we train two advanced deep convolutional neural networks (DCNN) with two different large datasets in source domain, respectively. By exploring the complementarity of two distinct DCNNs, deep feature fusion is utilized after feature extraction in target domain. Then, template specific linear SVMs is adopted to enhance the discrimination of framework. Finally, multiple matching scores corresponding different templates are merged as the final results. This simple unified framework outperforms the state-of-the-art by a wide margin on IJB-A dataset. Based on the proposed approach, we have submitted our IJB-A results to National Institute of Standards and Technology (NIST) for official evaluation.

Long-term Cooperative Tracking using Multiple Unmanned Aerial Vehicles

PRESENTER: **Xiaoxu Zheng**

Abstract:

In this paper, we study the long-term cooperative tracking in large areas using multiple unmanned aerial vehicles (UAVs). Firstly, a hybrid tracking algorithm, which switches between a correlation filters based tracker and a cascaded detector, is developed for the robust long-term tracking using a single UAV. Then, a centralized cooperation strategy is proposed to achieve cooperative tracking using multiple UAVs. Finally, the developed algorithms are demonstrated using both a public database and a laboratory mock-up.

Optimal Feature Extraction and Feature Subsets for various Machine Learning Algorithms targeting Freezing of Gait Detection

PRESENTER: **Val Mikos**

Abstract:

The sudden inability to generate effective steps, known as freezing of gait (FoG), is a common impairment experienced by Parkinson's disease patients. Since the occurrence of FoG has been linked to falls, wearable systems which detect FoG and provide biofeedback signals in real-time as a means to warn and overcome FoG have become a central objective in Parkinson's disease therapy. Most recently, the challenge of detecting FoG has been tackled by employing machine learning algorithms which rely on various features extracted from inertial measurement units that are worn on a patient's lower limbs. The features that were extracted, however, vary among implementations and no thorough analysis of all features exists that would allow for a comparison regarding feature quality. Furthermore, certain features are extracted within a window of most recent real-time data samples, the size of which has thus far been set by empirical means rather than analytical evaluation. This work strives to amalgamate all features proposed in literature and evaluate their quality in detecting FoG as to enable a thorough discussion of all hitherto proposed features. Furthermore, an analytical approach regarding window lengths is presented which provides an optimal feature extraction procedure. Whether the extraction at optimal window lengths is significantly increasing performance is elaborated in order to underpin its importance. Finally, we summarize optimal feature subsets for various machine learning algorithms and compare them to those put forward in literature, enabling future researchers to develop machine learning algorithms with augmented accuracy.

Spatiotemporal Feature learning and point tracking for event-based vision

PRESENTER: **Rohan Ghosh**

Abstract:

Event-based sensors provide a different approach to frame based sensors for visual data acquisition, by asynchronously encoding changes in visual intensity at a high temporal resolution. Here we propose an event-based solution for extraction of feature representations, a fundamental step for most problems in computer vision. To this end, a novel, unsupervised spatiotemporal feature learning technique is proposed which learns robust local feature descriptors. The features are derived from local spike-event distributions in two dimensional space with an additional temporal component. They are computed with spatiotemporal weight matrices, which are learnt from input data using slow feature analysis. The weights estimated from this method portray properties similar to visual cortical spatiotemporal receptive fields. To evaluate this feature extraction approach, a point tracking algorithm is proposed. This algorithm was evaluated on three sets of recorded data; namely, traffic, MNIST digits and square corners, to demonstrate the robustness of our approach on various spatiotemporal patterns. Results illustrate the ability of our method to integrate spatial and

temporal information, outperforming other approaches by over 50\% in tracking accuracy. The importance of obtaining slowly changing features for 3D spatiotemporal inputs is thus demonstrated, by comparing performance with the rapidly changing counterparts. Furthermore, our method is readily adaptable for event-driven on-chip computation, requiring minimal computational overhead.

TRACK 3

CONTROL, INTELLIGENT SYSTEMS AND ROBOTICS

PRESENTERS :		
1	**Saurab Verma**	Data Assisted Modelling and Speed Control of a Robotic Fish
2	**Gao Shuhua**	Data-driven Identification and Control of Nonlinear Systems using Multiple NARMA-L2 Models
3	**Yip Chun Ming Tommy**	Effect of Different FOU Shapes on the Performance in Interval Type-2 Fuzzy PI Control Systems
4	**Josey Mathew**	Classification of Imbalanced Data by Oversampling in Kernel Space of Support Vector Machines
5	**Lau Jun Yik**	Enhanced Robust Impedance Control of a Constrained Piezoelectric Actuator-based Surgical Device
6	**Suibo Xia**	Input Allocation for Partially-Identified Redundant Control and Its Application to Precision Motion Systems

Data Assisted Modelling and Speed Control of a Robotic Fish

PRESENTER: **Saurab Verma**

Abstract:

In this paper, a novel data-assisted dynamical modelling and control approach is developed for a robotic fish speed tracking. The data assisted modelling focuses on the thrust mechanism including the structure and parameters, which are absent from the Newtonian based analytic model of the robotic motion. The thrust of robotic fish is generated through undulatory body movement interacting with surrounding water, thus is a consequence of reaction from environmental hydrodynamics. It is known, however, that hydrodynamics cannot be analytically modelled. Thus the data-assisted modelling is necessary for underwater robotic fish. Specifically in this work, data of pulse and step responses are collected from designated experimental trials, in which the pulse responses are used to determine the thrust delay terms, and step responses are used to build up the thrust nonlinearity at steady state. Discrete-time sliding mode controller (SMC) is constructed to perform speed control. The experimental results verify that SMC with data-assisted model can substantially improve the speed control performance of 2D robotic motion.

Data-driven Identification and Control of Nonlinear Systems using Multiple NARMA-L2 Models

PRESENTER: **Gao Shuhua**

Abstract:

The multiple model approach provides a powerful tool for identification and control of nonlinear systems. Among different multiple model structures, the piecewise affine (PWA) models have drawn most of the attention in the past two decades. However, there are two major issues for the PWA model based identification and control: the curse of dimensionality and the computational complexity. To resolve these two issues, we propose a novel multiple model approach. Different from PWA models in which all dimensions of the regressor space are engaged in the partitioning, the key idea of the proposed multiple model architecture is to partition only the range of the control input u(k) into several intervals and identify a local model that is linear in u(k) within each interval with neural networks. Based on the Taylor's theorem, a theoretical upper bound for the approximation error of the model structure can also be obtained. With the proposed multiple model architecture, a switching control algorithm is derived to control nonlinear systems based on the weighted one-step-ahead predictive control method and constrained optimization techniques. In addition, the upper bound for the tracking error using this switching control strategy is also analyzed rigorously. Finally, both simulation studies and experimental results demonstrate the effectiveness of the proposed multiple model architecture and switching control algorithm.

Effect of Different FOU Shapes on the Performance in Interval Type-2 Fuzzy PI Control Systems

PRESENTER: **Yip Chun Ming Tommy**

Abstract:

The control performance of type-2 fuzzy logic controller (IT2-FLCs) is heavily dependent on the choice of antecedent and consequent sets. However, there are no clear guidelines on how to choose suitable FOU shape to achieve the desired control requirements. This paper aims to explore how differences in FOU shapes affect the control performance by analysing three different types of antecedent fuzzy sets. They are the triangular top wide, triangular bottom wide and the trapezoidal fuzzy sets. Analytical structures of these controllers are derived. The analytical structures of the triangular bottom wide and trapezoidal controllers show more common features than triangular top wide controller.

Based on the characteristics of the analytical structure, it may be hypothesised that the control performances of IT2-FLCs that use triangular bottom wide and trapezoidal antecedent IT2 fuzzy sets would be more similar than an IT2-FLC constructed by triangular top wide antecedent IT2 fuzzy sets. The hypothesis is then verified by simulation results.

Classification of Imbalanced Data by Oversampling in Kernel Space of Support Vector Machines

PRESENTER: **Josey Mathew**

Abstract:

A weighted kernel-based SMOTE (WK-SMOTE) that overcomes the limitation of SMOTE for non-linear problems by oversampling in the feature space of support vector machine (SVM) classifier is proposed. The proposed oversampling algorithm along with a cost-sensitive SVM formulation is shown to improve performance when compared to other baseline methods on multiple benchmark imbalanced data sets. Additionally, a hierarchical framework is developed for multi-class imbalanced problems that have a progressive class order. The proposed WK-SMOTE and hierarchical framework are validated on a real-world industrial fault detection problem to identify deterioration in insulation of high voltage equipment.

Enhanced Robust Impedance Control of a Constrained Piezoelectric Actuator-based Surgical Device

PRESENTER: **Lau Jun Yik**

Abstract:

A robust impedance control algorithm for a semi-automated surgical device called ventilation tube applicator (VTA) was developed based on the dynamic coordination of force and position control. This paper presents an enhanced robust impedance control methodology for the VTA. The control approach is proposed for compliant manipulation in which motion and forc trajectories are controlled to achieve position and force regulation. The control methodology is formulated to accommodate parametric uncertainties, non-linearities and external disturbances in the motion system. The proposed scheme employs only a single controller to control both position and contact force of the VTA. The stability of the control approach is analysed and proven theoretically. Desirable control performances in following the desired motion and force trajectories are demonstrated through experimental studies on the VTA. An important advantage of the control methodology is that it does not require the exact system parameters in the physical realisation. The proposed control methodology is useful for the implementation of applications demanding both sensing and control of motion and force trajectories.

Input Allocation for Partially-Identified Redundant Control and Its Application to Precision Motion Systems

PRESENTER: **Suibo Xia**

Abstract:

System identification for all input channels in an input redundant system may be time-consuming and impractical. In this paper, a control allocation approach is proposed for redundant systems with generic input constraints, where only part of the input-output relationships are required to be identified. Based on the assumption that the system is controllable using only the identified baseline channels, the unidentified redundant input gain matrix is estimated online using an expectation maximization (EM) algorithm. In addition, control input allocation is carried out using quadratic programming based on

generic linear input constraints considering both strong input redundancy and weak input redundancy of the system. Unlike conventional adaptive control in multivariate systems for estimating parameters, the proposed EM algorithm does not require any prior information on the unknown input gain matrix as long as persistent excitation (PE) condition is satisfied in the redundant input channel. Simulation studies based on two typical precision motion systems: robotic welding and over-actuated motion system are provided to show that the unidentified input channels can be well estimated by an attenuating periodic PE signal. In addition, the input allocation algorithm is able to increase disturbance rejection capability and trajectory tracking performance, as compared to using only the constrained known input channels.

SESSION 2

9 MAY 2017 (DAY 2)
9:30 AM to 11:30 AM

TRACK 2

MICROELECTRONIC TECHNOLOGIES AND DEVICES

PRESENTERS :		
1	**Jiefang Deng**	Voltage-controlled magnetization switching in elliptical pMTJ
2	**Luo Ziyan**	Static and Dynamic Magnetic Properties of FeMn/Pt Multilayers
3	**Wu Ying**	Ultra-low specific contact resistivity (5Ã—10-9 â„¦-cm2) for nickel stanogermanide contact on Ga-doped Ge0.96Sn0.04 substrate
4	**Zheng Xin**	Surface passivation investigation on ultra-thin atomic layer deposited aluminum oxide layers for their potential application to form tunnel layer passivated contacts
5	**Serene Wen Ling Ng**	Porous silica/TiO2 Nanocomposite for Collective Adsorption and Degradation Functionalities
6	**Ismail Can Yesilyurt**	Anomalous tunneling characteristic of Weyl semimetals with tilted energy dispersion
7	**Lulu Xiong**	The Static and Dynamic Behaviors of Width Modulated Ni80Fe20 Nanowires
8	**Jiahui Wang**	Spiked ultraflexible neural interface for decoding peripheral nerve sensory information

Voltage-controlled magnetization switching in elliptical pMTJ

PRESENTER: **Jiefang Deng**

Abstract:

Spin transfer torque (STT) based magnetic tunnel junction (MTJ) shows a better downsize scalability and a good write selectivity compared with the traditional Oersted-field based approach for magnetic random access memory (MRAM) applications. However, the large switching current density results in considerable Joule heating thus large energy consumption. Switching magnetization in perpendicular MTJ (pMTJ) via voltage controlled magnetic anisotropy (VCMA) has shown the potential to markedly reduce the switching energy. However, the requirement of an external magnetic field poses a critical bottleneck for its practical applications. In this work, we propose an elliptical-shaped pMTJ to eliminate the requirement of an external field source. We demonstrate that a 15nm thick in-plane magnetized bias layer (BL) separated by a metallic spacer of 2 nm from the free layer (FL) can be engineered within the MTJ stack to provide the 50 mT bias magnetic field for switching. By conducting macrospin simulation, we find that a fast switching in 0.38 ns with energy consumption as low as 0.3 fJ at a voltage of 1.6V is achieved. Furthermore, we study the phase diagram of switching probability, showing that a pulse duration margin of 0.15 ns is observed and low-voltage operation (~1V) is favored. Finally, the MTJ scalability is considered and it is shown that scaling down might not be appealing in terms of energy consumption for precession based VCMSA switching.

Static and Dynamic Magnetic Properties of FeMn/Pt Multilayers

PRESENTER: **Luo Ziyan**

Abstract:

Recently we have demonstrated the presence of spin-orbit toque in FeMn/Pt multilayers which, in combination with the anisotropy field, is able to rotate its magnetization consecutively from 0o to 360o without any external field. Here, we report on an investigation of static and dynamic magnetic properties of FeMn/Pt multilayers using combined techniques of magnetometry, ferromagnetic resonance, inverse spin Hall effect and spin Hall magnetoresistance measurements. The FeMn/Pt multilayer was found to exhibit ferromagnetic properties, and its temperature dependence of saturation magnetization can be fitted well using a phenomenological model by including a finite distribution in Curie temperature due to subtle thickness variations across the multilayer samples. The non-uniformity in static magnetic properties is also manifested in the ferromagnetic resonance spectra, which typically exhibit a broad resonance peak. A damping parameter of around 0.092 is derived from the frequency dependence of ferromagnetic resonance linewidth, which is comparable to the reported values for other types of Pt-based multilayers. Clear inverse spin Hall signals and spin Hall magnetoresistance have been observed in all samples below the Curie temperature, which corroborate the strong spin-orbit torque effect observed previously.

Ultra-low specific contact resistivity (5Ã—10-9 cm2) for nickel stanogermanide contact on Ga-doped Ge0.96Sn0.04 substrate

PRESENTER: **Wu Ying**

Abstract:

A heavily Ga-doped Ge0.95Sn0.05 layer was grown on Ge (100) substrate by molecular beam epitaxy (MBE), achieving an active doping concentration of 1.6Ã—1020 cm-3 without the use of ion implantation and high temperature anneal that could cause Sn precipitation or surface segregation. An advanced nano-scale transfer length method (nano-TLM) was used to extract the specific contact resistivity Ïc between nickel stanogermanide and the heavily doped p-Ge0.95Sn0.05 layer. The high active doping concentration contributes to an ultra-low Ïc of 5Ã—10-9 â„¦-cm2, which is more than 3 orders lower than the best reported data for the p-type GeSn contact.

Surface passivation investigation on ultra-thin atomic layer deposited aluminum oxide layers for their potential application to form tunnel layer passivated contacts

PRESENTER: **Zheng Xin**

Abstract:

The surface passivation performance of atomic layer deposited ultra-thin aluminium oxide layers with different thickness in the tunnel layer regime, i.e. ranging from one atomic cycle (~0.13 nm) to 11 atomic cycles (~1.5 nm) on n-type silicon wafers is studied. The effect of thickness and thermal activation on passivation performance is investigated with corona voltage metrology to measure the interface defect density Dit(E) and the total interface charge Qtot. Furthermore, the bonding configuration variation of the AlOx films under various post-deposition thermal activation conditions is analyzed by Fourier transform infrared spectroscopy. Additionally, poly(3,4-ethylenedioxythiophene) poly(styrene sulfonate) is used as capping layer on ultra-thin AlOx tunneling layers to further reduce the surface recombination current density to values as low as 42 fA/cm2. This work is a useful reference for using ultra-thin ALD AlOx layers as tunnel layers in order to form hole selective passivated contacts for silicon solar cells.

Porous silica/TiO2 Nanocomposite for Collective Adsorption and Degradation Functionalities

PRESENTER: **Serene Wen Ling Ng**

Abstract:

The performance of photocatalytic oxidation of organic compounds generally depends on two properties: VOCs adsorption abilities as well as the degradation functionalities. In this project, a hybrid system of SiO2@TiO2 was synthesized for enhanced degradation functionalities. A simple aqueous-phase method was used to synthesize different shapes of porous silica for VOC adsorption. Porous SiO2 rods of the highest surface area (1238 m2g-1) was chosen to incorporate with the TiO2 sheets for enhanced degradation. Hydrothermal TiO2 growth on SiO2 was optimized by varying the amount of materials used. The synthesized materials were characterized with scanning electron microscopy, X-ray diffraction, Energy-dispersive X-ray spectroscopy and photocatalytic performance for VOC Degradation under UV-LED illumination. The optimized SiO2rods@TiO2 sample showed enhancement of degrading up to 60 % in 120 min of degradation. Further improvement was made by loading the SiO2rods@TiO2 sample with CuO. A loading of 5 % was found to be the optimum for better degradation performance.

Anomalous tunneling characteristic of Weyl semimetals with tilted energy dispersion

PRESENTER: **Ismail Can Yesilyurt**

Abstract:

The electronic states in Weyl semimetals can be characterized as Weyl nodes in the bulk and Fermi arcs (surface states) that connect the Weyl nodes in momentum space. Unlike Dirac semimetals such as graphene, Weyl points are not located at the high symmetry k-points, thus allowing Weyl fermions to have a tilted energy dispersion. Here, we show that Weyl electrons that encounter an electrical potential barrier experience an anomalous transverse momentum shift, which originates from the coupling of the tilted energy dispersion and electrical potential gradient. In other words, incident electrons undergo anisotropic refractions and reflections at the barrier interface. Thus far, similar asymmetric deflections have been only found in the systems under magnetic or strain potentials. Therefore, our findings may pave the way for various applications in nanoelectronics due to its electrically controllable feature. Based on the above findings, we predict that the tunneling conductance of the Weyl electrons can be suppressed in a relatively wide range of applied electrical potential, which may be a solution of the major conductance modulation problem occurs in Dirac end Weyl semimetals due to the absence of backscattering. On the other hand, the asymmetric momentum shift is a chirality dependent feature, as the different type of chirality may possess tilt of opposite directions. This lifts the valley degeneracy and causes a valley polarization of the incident electrons in angle-space. We find that an electrically controllable and switchable valley filter can be achieved by using additional magnetic barrier structure.

The Static and Dynamic Behaviors of Width Modulated Ni80Fe20 Nanowires

PRESENTER: **Lulu Xiong**

Abstract:

There has been a growing interest in the static and dynamic behaviors of magnetic nanostructures with controlled modulations due to their potential application for microwave devices and domain wall logic devices. In this work, we investigated the dynamic behavior of width modulated nanowires using broadband ferromagnetic resonance spectroscopy (FMR). The structures were fabricated using DUV lithography, material deposition and lift off process. Interestingly, in contrast with homogeneous nanowires of identical structure that shows a single absorption peak, the modulated nanowires display multiple peaks, which are markedly dependent on the modulation profile. To interpret the experimental observations, we performed the static and dynamic simulations for all the nanowires using the LLG Micromagnetic Simulator. We found that the highest resonance frequency originates from the smallest width region of the modulated nanowires while the lower resonance frequencies are located in the large width region of the modulated nanowires. There is a very good agreement between the experimental results and micromagnetic simulations.

Spiked ultraflexible neural interface for decoding peripheral nerve sensory information

PRESENTER: **Jiahui Wang**

Abstract:

To record ENG and decode sensory information from peripheral nerves enables sensory feedback to tetraplegic patients. We developed a spiked ultraflexible neural (SUN) interface to record high-fidelity small-amplitude ENG signals from peripheral nerves. The novel 3D design, comprising both spike structures to access the nerve fibers intrafascicularly and an ultraflexible substrate, enables a unique conformal interface to the target nerve. With the

high signal-to-noise-ratio (SNR) provided by our electrode, we can differentiate several sensory modalities with high spatial resolution. The results suggest that our electrode can record sensory signals with good SNR from the peripheral nerves, which can be further decoded to provide sensory feedback for close-loop applications in the neural prostheses.

TRACK 3

CONTROL, INTELLIGENT SYSTEMS AND ROBOTICS

PRESENTERS :		
1	**Saurab Verma**	Motion Control of Robotic Fish under Dynamic Environmental Conditions using Adaptive Control Approach
2	**Josey Mathew**	Time-series Prognostics with Support Vector Regression
3	**Lau Jun Yik**	Enhanced Adaptive Robust Disturbance Observer-based Control of Piezoelectric Actuator-based Surgical Device
4	**Goh Sim Kuan**	Electroencephalography (EEG) artifact removal based on machine learning techniques
5	**Shanmugasivam Pillai**	Playing Hearts with Deep Reinforcement Learning
6	**Teo Jinq Horng**	A Voice Activity Detector Employing Scalable Analog-to-Digital Conversion and Machine Learning

Motion Control of Robotic Fish under Dynamic Environmental Conditions using Adaptive Control Approach

PRESENTER: **Saurab Verma**

Abstract:

In this paper, we propose a novel robust adaptive control technique to steer the direction of attack of the robotic fish swimming under influence from varying environmental conditions. Due to complex nature of robot motion hydrodynamics, it is difficult to predict the true dynamics of the system with good accuracy. Hence, a discrete-time adaptive control technique is proposed which can effectively track a reference even if the robot system's model parameters might vary over time due to physical variations in the system. Rigorous theoretical convergence analysis on the closed-loop system confirms that the reference tracking error will asymptotically be bounded within a prescribed limit. Further, the adaptive control approach is experimentally verified to produce desirable performance under significant variations in payload and drag force on the robotic fish. The latest results thus, signify that the proposed control algorithm can efficiently control the robotic fish motion in complex underwater environments.

Time-series Prognostics with Support Vector Regression

PRESENTER: **Josey Mathew**

Abstract:

Prognostics methods aim to estimate the remaining useful life (RUL) of industrial machines from time-series sensor measurements. Recent advances in technology have made it possible to collect large amounts of historical records of sensor values and corresponding maintenance logs. This trend has encouraged researchers to adapt data-driven learning algorithms to model the health state of the machine and estimate its RUL. However, the non-linear nature of real-world processes, inherent noise in sensor measurements, and the independence assumptions made by traditional learning algorithms limit their performance on real-world prognostic problems. In this work, a deep learning auto-encoding approach is proposed to firstly filter out the measurement noise. These de-noised signals are then used to train support vector regression algorithm with a novel kernel formulation. Results on benchmark and real-world prognostic problems are presented.

Enhanced Adaptive Robust Disturbance Observer-based Control of Piezoelectric Actuator-based Surgical Device

PRESENTER: **Lau Jun Yik**

Abstract:

This paper presents an enhanced adaptive robust disturbance observer-based motion tracking control methodology. This control approach is established and investigated for a semi-automated hand-held ear surgical device for the treatment of Otitis Media with effusion. The proposed control methodology is utilized for tracking a desired motion trajectory in the presence of unknown or uncertain system parameters, non-linearities including hysteresis, and disturbances in the motion system. The stability of the control approach is analyzed. The convergence of position and velocity tracking errors is proven theoretically. A precise tracking performance following desired motion trajectory is demonstrated in the experimental study. An important advantage of this control methodology is that the knowledge of exact system parameters is not required in the realization. The proposed motion tracking control methodology is attractive for the implementation of high performance piezoelectric actuator-based medical applications.

Electroencephalography (EEG) artifact removal based on machine learning techniques

PRESENTER: **Goh Sim Kuan**

Abstract:

Electroencephalography (EEG) data are used to design useful indicators that act as proxies for detecting humans' mental activities. However, these electrical signals are susceptible to different forms of interferences- known as artifacts- from voluntarily and involuntarily muscle movements, e.g. eye blink, ocular movement, mouth and head movements etc. that greatly obscure the information in the signal. It is pertinent to design effective artifact removal techniques (ARTs) capable of removing or reducing the impact of these artifacts. However, most ARTs have been focusing on handling a few specific types, or a single type, of EEG artifacts. EEG processing that generalizes to multiple types of artifacts remains a major challenge. In this work, we investigate a variety of eight different and typical artifacts that occur in practice and characterize the spatiotemporal-frequency of these artifacts. Machine learning techniques are then applied to clean the contaminated EEG signal. The proposed method is validated using both real and synthesized EEG, collected in the presence of multiple artifacts, and it shows superior performance in automatic artifact removal and is able to reconstruct clean EEG signals.

Playing Hearts with Deep Reinforcement Learning

PRESENTER: **Shanmugasivam Pillai**

Abstract:

Games have featured in Artificial Intelligence (AI) research since its establishment. The victory of IBM's Deep Blue in chess was considered a major milestone. In 2013, DeepMind published results on playing Atari games using deep reinforcement learning. The results were impressive, and this was followed by AlphaGo's sensational victory in 2015. Go has long been considered the hardest game for AI to beat due to its massive search space. In the advent of deep learning, we are interested to explore the capabilities of deep neural networks in other types of games. In this paper, we will investigate the performance of deep neural networks in multi-player games with hidden information.

A Voice Activity Detector Employing Scalable Analog-to-Digital Conversion and Machine Learning

PRESENTER: **Teo Jinq Horng**

Abstract:

A voice activity detector (VAD) system for energy-/quality-scalable Internet-of-Things (IoT) applications is reported. The integrator output current of a first-order continuous-time sigma-delta modulator is tuned based on the slew rate requirement determined by the selected oversampling ratio (OSR), permitting energy scalability of the system. The OSR, in turn, is selected based on energy and classification accuracy requirements. Classification is performed on 8ms audio clips by a pre-trained decision tree, which assumes a non-extreme signal-to-noise ratio (SNR) of 10dB, as SNR is difficult to obtain in real applications. It is observed that at high OSRs, reducing the OSR will result in high energy savings, while achieving similarly good classification accuracy. On the other hand, at low OSRs, reducing the OSR will not reduce energy consumption by much, but will significantly reduce classification accuracy. On the other hand, if SNR is known, the classifier can be retrained off-chip based on that information. This allows the training process to adapt the classifier to various environmental conditions. Also, the classifier can be retrained with features of samples collected by the system, allowing the training process to model non-ideal behaviour

of the system hardware. Both retraining schemes present benefits in terms of better energy-accuracy trade-off. At an OSR of 512, the proposed system consumes 180nJ per classification, which is 3x lower than state-of-the-art implementations, while achieving a comparable 10% misclassification rate at a signal-to-noise ratio (SNR) of 10dB.

SESSION 3

9 MAY 2017 (DAY 2)

1:45 PM to 3:45 PM

TRACK 1

POWER AND ENERGY SYSTEMS

PRESENTERS :		
1	**Debjani Chakraborty**	Parasitics Assisted Soft-switching and Naturally Commutated Current-fed Bidirectional Push-pull Voltage Doubler
2	**Sun Lu**	Optimum Placement of Phasor Measurement Units in Power Systems
3	**Sandeep Kolluri**	A Repetitive and Lyapunov Function-Based Circulating Current Controller for Improved Steady-State and Dynamic Performance of Modular Multilevel Converters
4	**Srinivasarao Kamala**	An Impedance Based Stability Analysis of Electrical Distribution System in the Chemical Process Industry
5	**Palak Jain**	Fault Diagnosis for Solar PV Systems Via Module-Level Power Electronics
6	**Shiva Shankaranarayanan Muthuraj**	Triple phase shift control of LLL tank based bidirectional dual active bridge converter

Parasitics Assisted Soft-switching and Naturally Commutated Current-fed Bidirectional Push-pull Voltage Doubler

PRESENTER: **Debjani Chakraborty**

Abstract:

A snubberless current-fed push-pull DC-DC voltage doubler is proposed which obtains zero voltage switching (ZVS) turn-on of low voltage current-fed devices by using the parasitic resonance between the drain-source capacitance of MOSFETs and the leakage inductance of the high frequency transformer. The secondary modulation technique helps to reduce switching losses further by obtaining zero current switching (ZCS) turn-off of primary devices and ZVS turn-on of secondary devices. This eliminates the necessity for any active-clamp circuit or passive snubbers, usually required in traditional current-fed topologies. Push-pull converter has only two primary switches with common ground to supply and results in simple and reduced gating requirement. The steady-state analysis and operation of proposed converter has been studied along with the equivalent circuits during different intervals of operation. Design of a 1kW prototype of the proposed current-fed push-pull DC-DC voltage doubler is explained. Simulation results using PSIM and experimental results of a 1 kW prototype have been demonstrated to verify the operation, proposed mathematical analysis, design, and the proposed claims.

Optimum Placement of Phasor Measurement Units in Power Systems

PRESENTER: **Sun Lu**

Abstract:

Past studies on the placement of the Phasor Measurement Units (PMUs) in the smart grid have been restricted to the considerations of the number of PMUs and measurement redundancy but not the quality of the estimated states. Variance is traditionally used as a measure of the quality of estimates. In this paper, the placements obtained after satisfying the requirements of the minimum number of PMUs, maximum measurement redundancy and observability are further distinguished on the basis of the variance of the estimated states. Hence the optimum placement i.e. the placement with the smallest variance can be selected. Both the Weighted Least Squares (WLS) and robust estimators are considered. The covariance of the state estimates from the WLS can be calculated using existing formulas. However, there is no equivalent formula for the robust estimators. A formula is derived in this paper using influence function to approximately calculate the covariance matrix of the state estimates from the robust estimators. Examples on the IEEE 30-bus system are given.

A Repetitive and Lyapunov Function-Based Circulating Current Controller for Improved Steady-State and Dynamic Performance of Modular Multilevel Converters

PRESENTER: **Sandeep Kolluri**

Abstract:

In recent years, modular multilevel converter (MMC) has attracted a lot of high voltage and high power applications, ranging from the high voltage direct current transmission (HVDC), high power variable speed drives, to offshore renewable energy integration, due to its superior properties over conventional multilevel power converter topologies. But, MMC has several complex control issues to be solved for its efficient operation. Internal circulating harmonic current is one of the potential issues in this type of converter. It distorts the originally sinusoidal arm current, also brings in additional current stress to the devices and increases the power losses in the converter, making it less efficient. If the second order

harmonic component of the circulating current is not alleviated, it can result in a series of higher even-order current harmonics. Traditional cascaded PI control structure has limited harmonic rejection capability and also suffers from the poor dynamic performance against the sudden load variations due to slower outer average voltage control loop. This paper presents a new cascaded control approach with a repetitive controller (RC) in conjunction with a Lyapunov function-based controller (LFC) to alleviate the circulating harmonic currents and to improve the dynamic performance of MMC. Model of a single phase, 5-level MMC is developed on a PLECS RT box real-time simulator for hardware-in-the-loop (HIL) testing, it operates along with the external Texas Instruments DSP controller hosting the developed control scheme. Real-time simulation results are presented to substantiate the steady-state and dynamic performance of the proposed circulating current controller.

An Impedance Based Stability Analysis of Electrical Distribution System in the Chemical Process Industry

PRESENTER: **Srinivasarao Kamala**

Abstract:

In a typical chemical processing industry, variable speed drives (VSDs) are used in vapour recovery systems and pumping operations. Approximately 80% of the electrical load in the petroleum process industry are induction motors driven by these VSDs. Although the VSDs provides excellent control performance to the system, they are prone to instability due to their constant power characteristics which lead to negative impedance. When integrating these components to the system one must consider the impedance versus frequency characteristics at the point of common coupling (PCC). Representation of electrical distribution system with power electronic converters by frequency dependent impedance equivalent is an emerging technique in stability analyses of the distribution system. The technique has been adopted for decades in DC power systems, and it has been recently adopted to map the impedances in AC systems. This work presents an impedance based stability analysis method for the petroleum processing industry loads with VSDs employed for pumping operations. The impedance of the system are measured in D-Q rotating reference frame. The simulations are carried out in the MATLAB/Simulink environment for the test system and successfully demonstrates the effectiveness of the frequency dependent impedance based stability analyses.

Fault Diagnosis for Solar PV Systems Via Module-Level Power Electronics

PRESENTER: **Palak Jain**

Abstract:

Superseding the traditional PV system where an inverter for a full string centralizes the energy conversion process, decentralized and distributed approaches are emerging to increase overall energy conversion efficiency and ease system installation, operation and maintenance. For example, direct current (dc) power optimizers and microinverters (together known as module-level power electronics, or MLPE) are proposed as a capable solution for higher energy harvesting; lower installation costs; plug-and-power operation; and enhanced flexibility, modularity, and scalability.

Since decentralized and distributed PV systems consist of large number of PV modules with their integrated switching power converters installed outdoor, they pose a huge complexity in detecting and identifying the under-performing or faulty element which could either be the PV module or the switching power converter breaching dependability.

Thus, the idea is to leverage the inherent sensing, processing, and actuation capabilities of MLPE to implement a model-based estimation approach for detecting and identifying three

types of PV system faults- (1) faults in PV modules (e.g. mismatch faults, cracks); (2) component faults in the module-level power converter (e.g. switch faults or faults in passive components); and (3) electrical sensor faults (e.g. voltage and current sensors).

Triple phase shift control of LLL tank based bidirectional dual active bridge converter

PRESENTER: **Shiva Shankaranarayanan Muthuraj**

Abstract:

Isolated bidirectional DC-DC converters (IBDCs) with high efficiency and high power density demands for complete zero voltage switching (ZVS) on all active devices for its entire operating range. This paper presents a comprehensive analysis and optimization problem formulation of a triple phase shift (TPS) controlled inductive link based voltage fed - dual active bridge (VF-DAB) converter. Limitation on natural ZVS range in terms of output power and terminal voltage variations for the TPS controlled inductive link based VF-DAB is presented. To extend the ZVS range in a TPS controlled VF-DAB converter, passive auxiliary inductors are connected in parallel (LLL tank) to the primary and secondary sides of the high frequency (HF) transformer. Analysis and subsequent numerical solutions for the TPS controlled VF-DAB with auxiliary inductors shows complete ZVS on all the MOSFETs for the entire operating range. To substantiate the soft switching performance of the TPS controlled LLL tank VF-DAB, a 1 kW experimental prototype is developed and experimental results showing complete ZVS on all MOSFETs under various voltage gains and load conditions are presented. A comparative loss breakdown for the TPS controlled LLL tank VF-DAB and the conventional inductive link VF-DAB at various operating conditions show the necessity of the additional auxiliary inductors in the conventional design for increasing optimal switching frequency of the IBDC.

TRACK 2

MICROELECTRONIC TECHNOLOGIES AND DEVICES

PRESENTERS :		
1	**Ba Myint**	Stepwise nanosphere lithography: An alternate way of fabricating complex nanostructures
2	**Kailin Ren**	Compact Physical Models for AlGaN/GaN Fin-MIS-HEMTs on Threshold Voltage and Saturation Current
3	**Wei Yang Lim**	Pseudomorphic-phase transformation of Nickel-Cobalt based ternary hierarchical 2D-1D nanostructures for enhanced electrocatalysis
4	**Alexander Toh**	The Study of the Granular-in-Gap Device using computer simulations
5	**Krishanu Dey**	Electrical and Optical characteristics of Ce doped In2O3 thin films deposited by DC magnetron sputtering
6	**Jaffar Moideen Yacob Ali**	Femtosecond and Nanosecond Laser Ablation Properties of Dielectric Layers for Solar cells
7	**Wei Wei**	pH sensing and low-frequency noise characteristics of planar PtSi Schottky ion-sensitive field effect transistor
8	**Ruize Sun**	Au-free AlGaN/GaN MIS-HEMTs with Embedded Current Sensing Structure for Power Switching Applications

Stepwise nanosphere lithography: An alternate way of fabricating complex nanostructures

PRESENTER: **Ba Myint**

Abstract:

In recent years, there has been a surge of interest in nanomaterial engineering research community due to novel and unique properties in nanostructures, with the possible applications in fields, as such, plasmonics, biomedical nanodevices, and spintronics. These nanostructure maybe fabricated by a technique called the nanosphere lithography; this technique is simple, cost effective and has a high throughput nature [1]. However, the main limitation of nanosphere lithography is the variety of achievable nanostructures. Hence, there is a need to explore a new nanosphere lithography technique.

In this work, stepwise nanosphere lithography is explored. By introducing the sequences of rotational and stationary stages during material deposition, the nanostructures are overlapped one after another using sequences of deposition steps as a result creating complex nanostructure. Using this technique, the nano-rings are first created with the rotational deposition stage followed by forming nano-triangles on top of the rings with the stationary deposition stages. In the end, triangle topped rings structures are created. From both experiment and simulation results, it is demonstrated that by varying the number of stationary deposition stages, the location and number of nano-triangles formed on the rings can be controlled accurately. This flexibility in fabricating triangle topped nanorings provides advantage in controlling the properties of nanostructures for potential application in optic, magnetic and other applications.

In this presentation, the detailed process of stepwise nanosphere lithography and a range of innovative nanostructures successfully discovered by stepwise nanosphere lithography will be reported.

Compact Physical Models for AlGaN/GaN Fin-MIS-HEMTs on Threshold Voltage and Saturation Current

PRESENTER: **Kailen Ren**

Abstract:

In this work, the physical models on threshold voltage and saturation current of AlGaN/GaN Fin-gate Metal-Insulator-Semiconductor High Electron Mobility Transistors (AlGaN/GaN Fin-MIS-HEMTs) have been established and verified by TCAD simulations. The depletion effect of sidewall fin-gate electric field acting on the 2DEG channel is modeled based on the Poisson equation, and the gate bias condition causing the conduction band at the 2DEG polarization zone lifted above the Fermi level is calculated for finding the threshold voltage. The device saturation current, including the sum of 2DEG channel current and sidewall channel current, as a function of fin width has also been derived. The influences of device design parameters such as dielectric permittivity and thickness and of the gate oxide, the fin-gate dimensions, and the density of traps induced by fluorine plasma treatment on the threshold voltage and saturation current is then analyzed by the proposed model. This is the first time that theoretical models on threshold voltage and saturation current are derived to provide guidelines for the design of AlGaN/GaN Fin-MIS-HEMTs.

Pseudomorphic-phase transformation of Nickel-Cobalt based ternary hierarchical 2D-1D nanostructures for enhanced electrocatalysis

PRESENTER: **Wei Yang Lim**

Abstract:

While electrochemical water splitting is one of the most promising methods to store electrical energy in chemical bonds, facile fabrication of transition metal electrocatalyst materials with judicious chemical and structural design to facilitate high electrochemical reactivity with an in-built gas bubble release mechanism is currently lacking. Here, a facile pseudomorphic-phase transformation of a diversified ternary NiCo hierarchical structure is demonstrated. Essentially, universal template of hydroxide derivatives facilitates successive pseudomorphic-phase transformation with structural framework preservation. Direct growth of integrated 2D nanosheet-1D nanowire hierarchical features onto a conductive electrode leads to strong interfacial contact and an extended platform for electrolyte accessibility as well as provision of a discontinuous surface for low adhesion gas bubble evolution. Collectively, the as-prepared mixed transition metal and multi-dimensional structured electrode presents a uniquely advantageous electrochemical energy conversion material design.

The Study of the Granular-in-Gap Device using computer simulations

PRESENTER: **Alexander Toh**

Abstract:

Granular films are made up of magnetic nanoparticles embedded a non-magnetic material. Exhibiting magnetoresistance and superparamagnetism, granular films are currently being studied to be used as the sensing element in magnetic sensors. The Granular-in-Gap was invented to improve the sensitivity of the granular films. However, the magnetic strength in the gap of the granular-in-gaps has never been studied before; the magnetic strength in the gap has always been assumed to be near to the magnetization value of the yokes of the GIGs. This paper studies the magnetic strength in the gap using COMSOL Multiphysics. It studies the effect that the yoke-geometry has on the magnetic strength. It was found that magnetic strength in the gap was heavily dependent on the aspect ratio of the yoke's thickness to the gap-size. A practical GIG can thus be designed based on this aspect ratio.

Electrical and Optical characteristics of Ce doped In2O3 thin films deposited by DC magnetron sputtering

PRESENTER: **Krishanu Dey**

Abstract:

Transparent conducting oxides (TCO) provide high electrical conductivity when doped degenerately even close to that of metals and high transmission in the visible region of the solar spectrum. Induintinoxide (ITO) is one of the most widely used TCOs in solar cells because of its high optical transmittance in visible region, high electrical conductivity, surface uniformity and process compatibility. However, due to high carrier concentration in the conventional ITO thin films, free carrier absorption (FCA) at the near infrared limits the use in high efficiency solar cells. On the other hand, increasing the mobility has no undesirable effects and thus, it is recently the most widely used approach to minimize FCA in the NIR region while not compromising with the overall electrical conductivity.

Femtosecond and Nanosecond Laser Ablation Properties of Dielectric Layers for Solar cells

PRESENTER: **Jaffar Moideen Yacob Ali**

Abstract:

This paper reports on the ablation and micro-structuring properties of dielectric layers using a high average power femtosecond and nanosecond laser sources. The dielectrics investigated include SiNX, AlOX/SiNX stack and thermal SiO2/SiNX stack deposited on planar n-type Silicon wafer. Initially, single pulse ablation properties such as threshold fluence and energy penetration depth were determined for both laser sources. In femtosecond ablation, the presence of two different ablation regimes: gentle and strong ablation was identified. An analytical model has been developed to estimate the line width micro-machined at different pulse spacing. The modelled line width agrees quite well with the experimentally measured values for femtosecond ablation due to negligible debris deposition. As such, for line ablation using femtosecond laser, the reduction in the threshold fluence with respect to pulse overlap ratio has been estimated. These ablation properties are very useful in carrying out precise and low damage structuring of dielectrics for ablation intensive architectures such as interdigitated back contact (IBC) solar cells.

pH sensing and low-frequency noise characteristics of planar PtSi Schottky ion-sensitive field effect transistor

PRESENTER: **Wei Wei**

Abstract:

Planar platinum silicide (PtSi) Schottky ion-sensitive field effect transistors (ISFET) have been fabricated for biosensor applications to detect pH solutions. It is found that the Schottky ISFET can show a high sensitivity of 55.0 mV/pH and a resolution limit of 0.0136% of a pH shift with 1 Hz bandwidth. The obtained results suggest the practical PtSi Schottky ISFET with readily fabrication process can be one of the competitive alternatives for biochemical detection.

Au-free AlGaN/GaN MIS-HEMTs with Embedded Current Sensing Structure for Power Switching Applications

PRESENTER: **Ruize Sun**

Abstract:

AlGaN/GaN Metal-Insulator-Semiconductor High Electron Mobility Transistor (MIS-HEMT) is a promising candidate for efficient power conversion applications. In actual applications, it is beneficial for the power HEMT to have an embedded current sensing function, which helps in the circuit control function as well as overcurrent protection of device itself. In this paper, we reported the design and experimental verification of AlGaN/GaN MIS-HEMTs with embedded current sensing structure based on Au-free process technology. It shows stable current sensing ratios at various operating conditions including steady-state, transient and high temperature. The proposed structure is highly useful for making monolithic power integrated circuit on AlGaN/GaN technologies.

TRACK 3

MICROWAVE AND RF

PRESENTERS :		
1	**Chai Yan Tay**	Size Independent Wave Guiding Cloak Using Thin Gradient Metasurface
2	**Lei Jin**	Nonlinear Optical Hologram by Atomically Thin Two-Dimensional Materials
3	**Sek Meng Sow**	Electrically Small Structural Antenna Design with Beam Steering Capability on a Small Metallic Platform based on Characteristic Modes
4	**Zhongwei Jin**	Sum frequency generation based on the resonant plasmonic nanostructures
5	**Zengdi Bao**	Wireless power transfer to an implant with maximum power
6	**Menghua Jiang**	Holographic storage/projection of multiple images via pseudorandom number generation
7	**Siegfred Balon**	An Injection-Locked-based FMCW SAR Transmitter with Synthetic Bandwidth Technique

Size Independent Wave Guiding Cloak Using Thin Gradient Metasurface

PRESENTER: **Chai Yan Tay**

Abstract:

In this study, a novel two-dimensional wave guiding cloak is proposed to guide the waves around the scattering object. The wave guiding cloak is composed of three regions. Each region is designed to perform a specific task by an electrically thin layer of gradient matsurface. The first region is to trap the incident waves onto the cloak. The second region then guide the trapped waves around the object. Lastly, the third region radiate the guided waves away from the direction of incident wave. Theoretical analysis of each region is presented and as a proof of concept, the cloak is first implemented on a planar surface.

Nonlinear Optical Hologram by Atomically Thin Two-Dimensional Materials

PRESENTER: **Lei Jin**

Abstract:

The metasurface is a kind of artificial material which introduces the nanostructures on the interface and can control the light beam in a desirable manner, such as light bending, focusing, color filters, optical vortices, wave plate and hologram. These nanostructures are known as optical antenna to introduce the phase delay or modulate the intensity distribution on the interface. Recently, researchers have realized holograms by using plasmonic or all dielectric metasurface with sub-wavelength thickness ranging from several tens nanometers to hundreds nanometers. The thickness could be further decreased by changing the materials from the block materials to 2D materials. The lack of inversion symmetry in some monolayer 2D materialm, such as odd-layer transitional metal dichalcogenides, allows strong optical second harmonic generation. In this paper, the atomically thin matesurface, made by monolayer molybdenum disulfide (MoS2), is designed to realize a nonlinear optical hologram. The dyadic Green function and genetic algorithm are applied to calculate the E field distribution and the pattern of the metasurface, respectively. This design, even though derived under MoS2, can also be applied to monolayer transitional metal dichalcogenides (TMDs). This atomically thin nonlinear optical hologram can be used to optically encrypt data and improve the integration of optical devices.

Electrically Small Structural Antenna Design with Beam Steering Capability on a Small Metallic Platform based on Characteristic Modes

PRESENTER: **Sek Meng Sow**

Abstract:

This paper presents the methodology for designing a multi-feed antenna on a small metallic platform. Selecting a Small Unmanned Aerial Vehicle (SUAV), with a dimension of 0.67 of the operating wavelength- the largest dimension possible in this case- as the design platform, it proposes using Characteristic Mode (CMs) Analysis to obtain the physical insight information of the supporting CMs and their current distributions on the chosen platform. Two radiated CMs (labelled as Mode 1 and Mode 2) are identified, both featuring similar maximum current locations but different flow directions. The use of a structural antenna with four inductive coupled elements (ICEs) is also proposed.

Based on the suggested design with the respective amplitude and phase settings, this paper theorises that the identified CMs are excited with reasonably good mode purity â€“ the peak gain for Mode 1 and Mode 2 is 0.9dBi and -0.6dBi respectively. In addition, the simulation

results show that the resulting gain pattern could be steered from one CM to the other by applying different amplitude and phase settings to the feeds. To verify the simulation results, an aluminium SUAV model featuring the proposed multi-feed design is fabricated, and the individual feed element radiation patterns (IFERPs) measured in the anechoic chamber. The resulting gain pattern is obtained by linearly combining the IFERPs with specified weightage. The measured results are agreed well with the simulated results, confirming the feasibility of the design method.

Sum frequency generation based on the resonant plasmonic nanostructures

PRESENTER: **Zhongwei Jin**

Abstract:

Nowadays metal nanostructures have been widely used in many areas such as super-resolution imaging, information processing and molecular detection due to their strong local electric field enhancement by surface plasmon polaritions (SPPs). This electric field enhancement can be further boosted by resonances and advantageously exploited for amplifying nonlinear effects. Besides, the requirement for phase matching, which is conventionally of vital importance for the nonlinear effect, has been eliminated since the sizes of the metal nanostructures are much smaller than the light wavelength. Based on the resonant plasmonic nanostructures, a multitude of nonlinear processes have been explored. Among them, SFG has attracted significant attention owing to its surface-sensitive and high-controllable capability for the new frequency generation.
In this work, sum frequency generation (SFG) based on a metal-dielectric-metal plasmonic nanostructure is demonstrated. The two cross-polarized pumps (800 nm and 1500 nm) are designed to match the two resonances of this plasmonic nanostructure to make the most of the electric field enhancement. Since these two resonances are predominantly determined by the sizes of the top metallic nanostructures in the same direction, the SFG (521 nm) can be independently controlled by each pump via changing these sizes. This work not only exerts the full strength of plasmonic resonance induced field enhancement, but also offers a great degree of flexibility to control over the optical nonlinearities at the nanoscale, thereby paving a way towards using nanoplasmonics for future nonlinear information processing.

Wireless power transfer to an implant with maximum power

PRESENTER: **Zengdi Bao**

Abstract:

The issue of wirelessly charging an implant in tissue with maximum power under safety limit is addressed in this paper. A meta-lens in free space is used to focus the incident plane electromagnetic (EM) waves at the position of implant inside tissue. The implant is in the mid-field region of the meta-lens. Firstly, the problem of focusing EM waves through an interface of lossy media is analyzed. However, due to the loss caused by the tissue, the peak specific absorption ratio (SAR) appears at the interface instead of the focal point, which limit the maximum power that can be transferred safely. Assuming a surface current source located on the meta-lens aperture, and by optimizing the phase and amplitude distributions of the source, we try to make the position of peak SAR submerges into the tissue, and thus higher power can be transferred safely. The effects of operating frequency, lens size, size of the unit cell of the meta-lens, and some other factors on available maximum power than can be transferred safely are investigated in this paper. This theoretical analysis could be helpful in meta-lens design for wireless charging implants using meta-lens.

Holographic storage/projection of multiple images via pseudorandom number generation

PRESENTER: **Menghua Jiang**

Abstract:

Holography is the storage of all information about light, both amplitude and phase on a two-dimensional medium. The storage/projection of multiple images in a single hologram faces challenges due to signal crosstalk among the images. Drawing inspiration from random phase encryption, the proposed method introduces a rotating random phase mask whose rotation process is analogous to that of pseudorandom number generation. Preliminary simulation results are demonstrated for storage/projection of multiple images, and orbital angular momentum demultiplexing. Up to 20 images can be simultaneously be stored in a single hologram.

An Injection-Locked-based FMCW SAR Transmitter with Synthetic Bandwidth Technique

PRESENTER: **Siegfred Balon**

Abstract:

Frequency-modulated continuous wave (FMCW) radars are used in various high-resolution ranging and imaging applications. However, obtaining wideband FMCW chirp signals while maintaining its frequency linearity is not straightforward in transmitter design. The use of direct digital synthesis (DDS) has been popular due to its frequency linearity. However, DDS is limited in producing high frequency and wideband chirps. An injection-locked-based FMCW transmitter using a synthetic bandwidth technique is proposed to extend the bandwidth of DDS-generated chirps while maintaining its linear phase and frequency characteristics.

A wideband chirp is synthesized by combining the up-converted narrowband chirp with different adjacent carrier frequencies. This is achieved by mixing a narrowband direct digital synthesis (DDS) chirp with a fast-switching subharmonic injection-locked oscillator (SHILO). The use of SHILO allows fast-switching at sub-10 ns and provides good phase noise performance not attainable by phase-locked loops. The key idea is demonstrated at 4 GHz by generating two sub-band chirps with about 300 MHz bandwidth each, achieving a synthetic bandwidth of 600 MHz. The measured impulse response shows a resolution of 25 cm with a sidelobe level of -25 dBc and very accurate range estimates with accuracy of Â±0.5 cm. The capability of the transmitter in synthetic aperture radar (SAR) imaging is also demonstrated in an indoor setup. A good SAR image was obtained in a single-corner-reflector setup using the Range-Doppler algorithm (RDA).

SESSION 4

9 MAY 2017 (DAY 2)
4:00 PM to 6:00 PM

TRACK 1

POWER AND ENERGY SYSTEMS

PRESENTERS :		
1	**Sunil Kumar Dube**	A Comprehensive Loss Analysis And Selection Of A Single Phase Boost Rectifier For Low Power And High Frequency Application
2	**Salish Maharjan**	Impact of Power Ramping of PV generator on voltage instability in distribution network: A case study.
3	**Lan Dongdong**	Isolated Matrix Current Source Rectifier in Discontinuous Conduction Mode
4	**Ravi Kiran Surapanenei**	A High Voltage Gain Coupled Inductor Based Microinverter
5	**Cikai Ye**	A long lifetime multi-channel LED driver in street lighting application
6	**Debjani Chakraborty**	A ZVS Semi-Bridgeless Dual Boost PFC AC-DC Converter

A Comprehensive Loss Analysis And Selection Of A Single Phase Boost Rectifier For Low Power And High Frequency Application

PRESENTER: **Sunil Kumar Dube**

Abstract:

In the past literature, different single phase Power Factor Corrected (PFC) boost topologies are compared in terms of efficiency and power factor for high power applications in the range of hundreds of watt to kilowatt. Efficiency as high as 97-98% are achieved at hundreds of watt and kilowatt power range. But percentage loss distribution across the various circuit components changes as we go for power level below 100W. At this power level, switching loss of devices becomes dominant over the conduction loss of devices and core loss of magnetic components. In this paper a comprehensive analysis of five potential topologies for single phase boost rectifier: conventional boost, bridgeless boost, dual boost, totem-pole boost and totem-pole interleaved boost are discussed for low power application such as LCD, laptop and mobile charger. The selected topologies are compared for peak power of 65W using efficiency and universal input voltage variations (80-265V) as the design parameters. The comparison is done for 1 MHz switching frequency operating at both CCM and DCM. According to IEC 61000-3-2 standard, there is no specific limit defined for the Total Harmonic Distortion (THD) and Power Factor (PF) at a power level below 75W for class D appliances (i.e. personal computer, tablet, laptop power supplies). As in this work, the peak power is 65W where THD and PF has no stringent requirement, we will use the term single phase boost rectifier in the following discussion of the paper instead of the conventional term PFC boost rectifier.} From the analysis and performance comparison among the selected topologies, the best suited topology for the power level of 65W at 1 MHz frequency of operation is evaluated.

Impact of Power Ramping of PV generator on voltage instability in distribution network: A case study.

PRESENTER: **Salish Maharjan**

Abstract:

Studies on photovoltaic (PV) power ramp rate in Singapore reveal that it can be reach up to 50 % of its rated capacity in just 20 seconds. At higher PV penetration in a distribution grid, the magnitude of active power fluctuation due such ramping could cause large voltage dips on nodes and induce instability. The grid compensates the active and reactive power imbalances through a load tap changing (LTC) transformer in a conventional grid. However, rate of active power imbalance due to PV variability is faster than from load variability. As a result, the delay setting of LTC transformer, which is typically from 10 to 30 second for 11kV distribution, could cause voltage instability before it reacts to the regulate the voltage. Previous research on low voltage residential grid has shown that there could be short-term voltage instability due to delay in LTC response and the study was mainly focused on single-phase air-conditioning loads. However, the magnitude of this problem would be more pronounced at primary distribution system where residential, commercial and industrial load are connected and bulk PV integration is possible. In this paper, the voltage instability is explored in 11KV United Kingdom General Distribution System (UKGDS) considering residential, commercial and industrial feeder at various PV penetration levels. Moreover, the voltage instability due to various load composition are investigated, as the load response to supply voltage is also a major cause of voltage instability. The simulation results shows that voltage dips could cross the security limits and induce instability due to short term PV ramping. The severity is more pronounced at higher composition of dynamic load, which is likely to be observed in commercial and industrial feeder.

Isolated Matrix Current Source Rectifier in Discontinuous Conduction Mode

PRESENTER: **Lan Dongdong**

Abstract:

The current type rectifier is a buck type rectifier, and it has advantages such as wide output voltage range, high power density, unity power factor and suitable for variable frequency applications. However, most of them are working in continuous conduction mode where the output current is assumed to be a DC value. In some cases, like a small output inductance and working at low load, the dc link current will become discontinuous, and distortion can be observed in input current. A three-phase isolated matrix current source rectifier is designed to work in discontinuous conduction mode (DCM). High frequency transformer is used to provide galvanic isolation. A novel symmetric space vector modulation scheme is adopted. Two loop control based on exact linearization is applied to control input power factor and output voltage. Unity power factor correction and low THD is achieved, the proposed design is verified by simulation and experiment.

A High Voltage Gain Coupled Inductor Based Microinverter

PRESENTER: **Ravi Kiran Surapanenei**

Abstract:

Microinverters require high voltage gain capability for interfacing low voltage photovoltaic (PV) module to single-phase grid. A two-stage inverter is proposed in this paper, with the first boost stage consisting of coupled inductor added with a voltage multiplier to achieve the required high gain at high efficiency and to track Maximum Power Point (MPP) over wide input voltage range, while the second stage is a traditional pulse width modulated (PWM) grid-tied inverter. Among the coupled inductor topologies, adding an additional clamp circuit is a common solution to handle the voltage spike caused due to leakage inductance. In the proposed converter, the resonance between coupled inductor and voltage multiplier is used to address the issue of voltage spike thereby reducing both component count and device voltage stress. Detailed analysis and design procedure of the proposed converter is presented in this paper. Experimental results of a 250 W microinverter are presented to validate the proposed converter.

A long lifetime multi-channel LED driver in street lighting application

PRESENTER: **Cikai Ye**

Abstract:

A long-lifetime multi-channel LED driver consisting of front-end AC-DC boost Power Factor Correction (PFC) converter followed by a DC-DC power conversion stage with dimming capability for LED based street light is proposed in this paper. This LED driver uses a patented DC side auxiliary decoupling circuit at the output of the AC-DC Converter for mitigating twice the input ac line frequency power-ripple. This patented power-ripple storage circuit comprises of an inductor for providing ripple energy storage which results in longer lifetime of the input Boost PFC converter. At the DC-DC power conversion end, a half-bridge non-resonant converter with symmetrical quadrupler rectifier output is implemented to convert available DC power to multiple current regulated DC outputs for LED loads. The proposed DC-DC converter possesses an inherent protection against LED failures due to its topology for both electrically open and short circuit conditions of the LED loads thus leading to superior reliability and lifetime of the LED loads. Moreover the DC-DC converter achieves complete soft switching of all semiconductor devices and additional stability during PWM dimming operation which enables greater reliability of the DC-DC

LED driver. In this paper the proposed patented driver for street lighting is analyzed and validated on a 150W test setup.

A ZVS Semi-Bridgeless Dual Boost PFC AC-DC Converter

PRESENTER: **Debjani Chakraborty**

Abstract:

A semi-bridgeless boost PFC ac-dc converter is employed to convert universal ac input varying from 85 VRMS- 230 VRMS to fixed and regulated 400 V output dc voltage. The converter is operated at 500kHz in CCM, using two-loop average current control, with Si Super-junction MOSFETs. The switching network forms a H-bridge thus making it bidirectional. The top switches are for synchronous rectification. A passive auxiliary circuit is used to facilitate ZVS turn-on of bottom switches (boost devices) in positive and negative ac half line cycles. The advantage of this topology along with the proposed auxiliary circuit for soft-switching is that only one leg of the H-Bridge operates every half line cycle thus optimizing on the converter losses. The steady-state analysis and operation of proposed converter has been studied along with the equivalent circuits during different intervals of operation during ac input half line cycle. Design of a 500W prototype of the proposed converter is explained along with some simulation results using PSIM to validate the proposed claims.

TRACK 2

MICROELECTRONIC TECHNOLOGIES AND DEVICES

PRESENTERS :		
1	**Romika Sharma**	Optimization of firing temperature and belt speed to reduce LID in multicrystalline silicon solar cells
2	**Amit Singh Rajput**	"Smart PL"(Photoluminescence) Imaging Technique for Solar Cell Characterisation
3	**Colin Peeris**	Carbon Nanotube ring cathode for electron beam projection lithography
4	**Mengji Chen**	Efficient THz emitter based on FIM/NM heterostructures
5	**Shengqiang Xu**	Silicon-on-insulator (SOI) and Germanium-on-insulator (GeOI) Grating Coupler Operating at 2 Î¼m wavelength for Telecommunication: Simulation and Experimental demonstration
6	**Eric Cheung**	Low-drive Voltage Optical Modulators in Multi-layer Lithium Niobate
7	**Chang Tian**	Magnetization Dynamics in Multilayer Rhomboid-shaped Nanomagnets

Optimization of firing temperature and belt speed to reduce LID in multicrystalline silicon solar cells

PRESENTER: **Romika Sharma**

Abstract:

Light-induced degradation (LID) significantly affects the performance of multicrystalline silicon (multi-Si) solar cells. Recently, it has been reported that reducing the metallization peak firing temperature results in reduced LID. In this study, we investigate solar cell samples fired at different temperatures in the range of 620°C to 850°C to study the impact of the firing temperature on LID. It is observed that samples fired at lower temperature (~620°C) have negligible LID as compared to samples fired at higher temperature (800°C and 850°C).However, decreasing the firing temperature lowers the effective carrier lifetime and the cell efficiency. Hence, further experiments are carried out to study LID as a function of the firing belt speed. Optimization of the firing temperature and belt speed is done to reduce the impact of LID without compromising on cell efficiency.

"Smart PL"(Photoluminescence) Imaging Technique for Solar Cell Characterisation

PRESENTER: **Amit Singh Rajput**

Abstract:

We propose a non-destructive measurement technique to determine the variation of series resistance (RS), contact resistance, presence of cracks and defects in solar cells. In this method we use the confined concentrated light beam using array of high power LEDs to generate electron-hole pairs in one part of the solar cell, thus injecting photocurrent which travels to the dark areas. This radiative recombination results in luminescence emission which is collected using Si-CCD camera. We examine the use of this configuration to obtain series resistance images, detect micro cracks and deduce metallization contact resistance.

Carbon Nanotube ring cathode for electron beam projection lithography

PRESENTER: **Colin Peeris**

Abstract:

Carbon Nanotubes (CNTs) have proven to be an excellent candidate for Field Emission (FE) applications due to their high aspect ratios and electrical conductivity. Research has shown that CNTs are able to produce high emission currents under relatively low applied electric fields. They have also proven to be robust and capable of operating in poor vacuum condition. In this work, CNT rings cathodes are fabricated and studied. The ring cathodes are defined using laser writing of iron catalyst onto a silicon substrate and grown using Plasma Enhanced Chemical Vapour Deposition (PECVD). These cathodes are characterised in an electron-beam projection column setup that is used to study the emission patterns produced from the ring cathodes. The column comprises the CNTs as the cathode, an extraction anode, and an acceleration anode. The column is also fitted with an Einzel Lens that is used to focus the electron beam and therefore produce sharp focused emission patterns onto a YAG scintillator located after the Einzel Lens. From the image formed on the scintillator, the electron emission pattern produced from the ring cathode can be closely studied. Potential applications for this study include maskless lithography where emission patterns from cathodes are demagnified and projected onto samples where they can be used to define features. Future work would also include using CNT cathodes of various other shapes to form emission patterns.

Efficient THz emitter based on FIM/NM heterostructures

PRESENTER: **Mengji Chen**

Abstract:

Terahertz (0.1-10 THz) spectroscopy is a powerful characterization method that can be applied to material composition analysis, which is important for biological, medical and chemical applications. Therefore, it is of great interest in developing efficient THz sources. So far, THz wave emission has been observed from various methods, such as optical rectification from electro-optical (EO) crystal, transient electrical currents in semiconductor antennas and air plasmas induced by a focus femtosecond laser. Interestingly, recent studies have shown a high performance THz sources with nonmagnetic (NM) and ferromagnetic (FM) metallic bilayers. However, there have been no reports involved in high performance THz generation based on ferrimagnetic (FIM)/NM heterostrcutures. In this work, we report a THz emitter with high performance based on ferrimagnetic (CoxGd1-x)/NM heterostructures where x is the composition of Cobalt. The spin currents are first induced in the FIM layer by a femtosecond laser beam and then transient charge currents are generated in NM layer due to the inverse spin Hall effect (ISHE), leading to THz emission. The THz intensity decreases linearly as Co composition decreases and the sign of the THz signal changes after the compensation point. Our results suggest that the THz emission is dominant by the Co component in ferrimagnetic layer and an adjustable THz emitter can be achieved by changing the ferrimagnets composition. The new FIM/NM based THz emitter is believed to be much more stable than the emitter with FM/NM heterostructures, due to antiferromagnetic ordering between Co and Gd.

Silicon-on-insulator (SOI) and Germanium-on-insulator (GeOI) Grating Coupler Operating at 2 μm wavelength for Telecommunication: Simulation and Experimental demonstration

PRESENTER: **Shengqiang Xu**

Abstract:

Integrated Si photonics have been developed in the near-infrared (NIR) range to satisfy the optical communication demands. Extending the telecommunication window to wavelength λ of ~2 μm could solve issues related to increase in volume of data transmission. Low-loss hollow-core photonic band-gap fibers and thulium doped fiber amplifiers (TDFAs) with high gain and low noise were demonstrated recently, paving the way for telecommunications in the 2 μm range. SOI substrates have been adopted as a standard platform in Si photonics. Therefore, research on SOI-based passive components for λ of 2 μm is important. Grating coupler, a powerful tool for coupling light from fiber to nanophotonic waveguides, has been developed in 1550 nm range for telecommunications and in the longer wavelength regime (peak wavelength of 2.1 μm and beyond) for sensing and nonlinear optics application. However, there is no report on optimization of grating couplers at 2 μm for telecommunications. Recently, Ge has attracted much attention due to its better optical properties over Si, such as high refractive index, stronger free-carrier effect, and so on. Novel Ge waveguide platform on GeOI has been raised for MIR integrated photonics. Accordingly, GeOI grating coupler operating at 2 μm and beyond deserves to be investigated.

Low-drive Voltage Optical Modulators in Multi-layer Lithium Niobate

PRESENTER: **Eric Cheung**

Abstract:

Waveguide optical modulators are important building blocks towards integrated photonics. Lithium niobate (LiNbO3/LN), in particular, is the gold standard electro-optic material used for modulation applications due to its variety of optical electronic properties such as transparency and high electro optical coefficient. However modulators based on LN are often bulky and require long interaction length for modulation. The electrodes placement is also often in hundreds of microns range which requires higher driving voltage for modulation to take place. Based on smart-cut technology, Lithium niobate on insulator (LNOI) is a wafer processing technique developed that enables better confinement of light in fabricated waveguides on single crystal LN. Electrodes can also be placed closer to the waveguide structures within the range of a few microns due to the thin single crystal film. LNOI thus enables application of reduction in driving voltage; however current electrodes such as copper induces losses when it is placed closed to the waveguide structures. In this paper, I propose a new method of reducing driving voltage based on electrode material and placement. This design involves a slot like waveguide structures that confines light within the waveguide in nanometer scale and enables direct contact of electrodes to waveguides. This will hence reduce the distance between electrodes and reduces threshold voltage for more efficient modulation of light propagating in the waveguides.

Magnetization Dynamics in Multilayer Rhomboid-shaped Nanomagnets

PRESENTER: **Chang Tian**

Abstract:

Information processing based on nanomagnetic networks is of great interest due to their nonvolatility, ultrahigh density, unlimited endurance, and thermal robustness.1 Nanomagnet based devices rely on controlling the magnetic ground states for device operations. The control of the ferromagnetic (FM) and antiferromagnetic (AFM) ground states of the rhomboid-shaped nanomagnets (RNMs) was achieved by the geometrical design of the nanomagnets.2 However, a relatively small frequency difference (Î”f < 0.5 GHz) was obtained for the two ground magnetic states (FM and AFM) in single layer RNMs. A larger frequency difference is desirable for unambiguous identification of the modes in device operation.

In this work, a systematic investigation is presented for the magnetization dynamics in trilayer RNMs using micro-focused Brillouin light scattering (ÂµBLS) spectroscopy. The multilayer structures consist of two permalloy (Ni80Fe20) layers separated by a nonmagnetic Cr spacer layer. By varying the Cr thickness between 5 and 15 nm, the dipolar coupling can be effectively controlled, modifying the corresponding magnetic ground state and the magnetization dynamics as a function of initialization field orientation. Distinct frequency difference of ~ 2 GHz in dynamic responses between the FM and AFM ground states were achieved. The field evolution of the multilayer structures was also investigated. Micromagnetic simulations validate our experimental observations. This method would provide potential implications for low-power magnonic devices based on reconfigurable microwave properties.

TRACK 3

MICROWAVE AND RF

PRESENTERS :		
1	**Tiantian Yin**	Phase retrieval of complex-valued object based on phase modulation
2	**Zengdi Bao**	A Novel Single-Layer Tri-Band Inverted F Antenna for Conformal-Capsule Applications
3	**Zhongwei Jin**	Genetic Algorithm based Lattice Optics Design
4	**Srien Sithara Sayed Nasser**	Metasurface based low profile base station antenna
5	**Guangwei Hu**	Functional Metalens for simultaneous generation and focusing of cylindrical vector beams
6	**Sek Meng Sow**	Wideband Thin Wire Dipole Design based on Characterisitic Modes

Phase retrieval of complex-valued object based on phase modulation

PRESENTER: **Tiantian Yin**

Abstract:

Coherent diffractive imaging (CDI) is a technique used for 2D or 3D reconstruction of a noncrystalline specimen or a nanocrystal in nanometirc scale resolution from the measured far-field intensity patterns. Due the loss of phase in CDI measurements, phase retrieval problem is of great interests. Hybrid input-output (HIO) method has been the most popular phase retrieval algorithms. Many variants of HIO algorithm have been developed over the years, stagnation remains as a problem. Wirtinger flow (WF) algorithm has then been proposed to guarantee convergence theoretically. However, it suffers from slow convergence rate and high sample complexity. Although many works have been down to reduce the sample complexity of WF algorithm, it is still of great needs to improve further. Recently, constraint conjugate gradient Wirtinger flow (CCG-WF) algorithm applied with phase modulation has been proposed to reconstruct the high-quality complex object from noisy diffraction patterns CDI. CCG-WF outperforms the HIO and oversampling smoothness (OSS) algorithms which represent the state-of-the-art phase retrieval algorithm in terms of accuracy, convergence rate, and sample complexity. In the presentation, HIO as well as OSS algorithm will be reviewed comprehensively. Then, the presentation will give an intensive introduction to the paper presenting CCG-WF. The pros and cons of the algorithm will be analyzed in the presentation.

A Novel Single-Layer Tri-Band Inverted F Antenna for Conformal-Capsule Applications

PRESENTER: **Zengdi Bao**

Abstract:

A novel tri-band conformal capsule antenna with simple configuration is proposed in this paper. It evolves from a conventional inverted F antenna (IFA), which is single-band. In publications, additional resonances are usually introduced to an IFA by modifying the "F" structure, which makes the antenna complicated and bulky. In contrast, we obtain additional resonances by tactically modifying the geometry of the IFA ground and shifting the feeding position. By doing this, the IFA covers the MedRadio band (401 MHz - 406 MHz) and two ISM bands (902 MHz - 928 MHz and 2.4 GHz - 2.5GHz). Meanwhile its configuration remains single-layer and simple, which is very desirable because the antenna then can be made conformal to the shell of a capsule easily. Besides, the impedance match of the proposed tri-band IFA is relatively insensitive to the variations of the surrounding environment, which is also very desirable given that the capsule will travel in the digestive system and experience different environments in practical scenarios. Moreover, the proposed antenna continues to maintain a stable impedance match when a battery is added inside the capsule or when there is a change in the battery size and/or its position. The operating mechanism of the proposed tri-band IFA is discussed and parametric studies are carried out to investigate the characteristics of the proposed antenna, whose results may be helpful for capsule antenna designs in the future.

Genetic Algorithm based Lattice Optics Design

PRESENTER: **Zhongwei Jin**

Abstract:

Metasurfaces that can control light based on subwavelength structures have received huge attention among researchers during the recent decades. These ultrathin architectures are made up by arranged subwavelength units of nanostructures according to the required phase profiles based on the analytical solutions. The Genetic algorithm (GA) is a classical optimization method which mimics the process of biological evolution process and can converge to the global optimal solution within limited generations. By using this brute-force method, lattice optical designs with aperiodically arranged subwavelength nanostructures can realize multi-objective functions in a single design.

In this work, a modified genetic algorithm is implemented to realize several kinds of subwavelength optical designs, such as the Fresnel zone plate and multi-focusing in 3D space. It can be shown that by using this algorithm, we can produce a large variety of far-field profiles in 3D. And by using an improved fitness function, the balancing between multi-objective functions can be achieved. Thus, it opens opportunities for a single configuration metasurface to concentrate light into different locations without physical modulation of phase profile. In the future, we hope this work can also be extended to more applications such as integrated optical devices, aberration-free lenses, holograms, and high-resolution, 3D imaging.

Metasurface based low profile base station antenna

PRESENTER: **Srien Sithara Sayed Nasser**

Abstract:

The proposed antenna integrates a ±45 degree polarized crossed dipole with a metasurface to realize low profile and wideband performance. The metasurface comprises symmetric unit cells arranged periodically and characterized by the effective susceptibility parameters. These electrically small inclusions produce changes in the amplitude and phase of the electromagnetic waves incident on it. This property is utilized to realize in-phase reflection of the waves with a reduced profile. In addition, the TE surface wave resonance of the finite surface is used to obtain a wide bandwidth. The mechanism to control the dispersion of the TE surface wave is explored in this work. The antenna with an overall profile of 0.113λ (λ is the wavelength in free-space at the lower operating frequency) displays realized boresight gain higher than 8 dBi in the frequency range 1.69 - 2.71 GHz, which accounts to a bandwidth of 46.36 % with $|S_{11}| \leq$ -14 dB. The isolation of the antenna is greater than -27 dB.

Functional Metalens for simultaneous generation and focusing of cylindrical vector beams

PRESENTER: **Guangwei Hu**

Abstract:

Recently, metasurface, 2-dimensional equivalent metamaterials, has provided unprecedented tools to control the light properties, such as polarization, amplitude, phase, the spin angular momentum, orbital angular moment and etc. One of most promising practical application of metasurface is metalens, where metasurface can impart the focusing phase front to the transmitted light. This focusing phase is usually presented by locally rotating the anisotropic element resided in the unit cell, and this can bring the Pancharatnam-Berry phase to the cross-polarization of light with respect to incident circular polarization. However, the resolution is limited by the intrinsic property of focusing circular polarized light. For example, focusing the cylindrical vector beams can give a better resolution than

circularly polarized light.

In this paper, we theoretically propose a highly efficient functional metalens that can generate the cylindrical vector beams with the focusing wavefront from the incident linearly polarized light in visible range. Using the Jones' matrix, the rigorous theoretical conditions to fulfil the double functions of the designed metalens are fully investigated. The finite-differential time-domain method is used to calculate the performance of unit cell and the vector Sommerfeld theory is utilized in the simulation of the metalens. The result shows that full width at half maximum can be smaller than λ/2 with the focusing efficiency more than 70%. This work can help the miniaturization of optical microscopic device and the design of multifunctional meta-devices.

Wideband Thin Wire Dipole Design based on Characterisitic Modes

PRESENTER: **Sek Meng Sow**

Abstract:

Traditionally, a thin wire λ/2 dipole operates at its fundamental mode has an impedance bandwidth lower than 10% and realized peak gain around 2dBi; the radiation pattern of this type of antenna should resemble a "donut" shape. This dipole could also be regarded as a multi-band antenna, if excited at the higher order modes, it should be able to perform with relatively good antenna gains at the expense of radiation pattern stability. This paper presents a methodology for designing a multi-feed thin wire dipole with wider radiation pattern stability bandwidth. A Characteristic Modes (CMs) Analysis is conducted on a 100mm (~λ/2 at 1.5GHz) long straight thin wire from 1.0GHz to 4.0GHz and two CMs (Mode 1 and Mode 2) are identified with the resonant frequency at 1.41GHz and 2.93GHz respectively. The locations of the excitation feeds are progressively determined individually, which is different from the traditional CM based antenna design. Hence a total of three feed locations are identified and used in the proposed design. This multi-feed design shows that the simulated realized peak gain improved by 2 to 4dB from 2.0GHz to 3.5GHz as compared to the single-feed design; its radiation pattern is stable from 1.5GHz to 3.5GHz. In conclusion, a multi-feed excited thin wire dipole shows better performance in radiation pattern stability bandwidth.