Arindam Basu
arindam.basu@ntu.edu.sg
NTU Singapore

Lecture #1: Designing Low-power "Intelligent" Chips in the face of Statistical Variations of Nanoscale Devices: The Neuromorphic Solution

As CMOS technology has been scaling down over the last decade, the effect of statistical variations (or component mismatch) and their impact on circuit design have become increasingly prominent. Further, new nanoscale devices like memristors and spin-mode devices like domain wall memories have emerged as possible candidates for neuromorphic computing at energy levels lower than CMOS—however, they also suffer from issues of variability and mismatch. In this talk, I will present some of the work done by our group where we take inspiration from neuroscience and show new approaches to perform machine learning with low-energy consumption using low-resolution mismatched components. First, I will talk about "combinatoric learning" using binary or 1-bit synapses—an alternative to weight based learning in neural networks that is inspired by structural plasticity in our brains. Second, I will present an example of utilizing component mismatch to perform part of the computation—an example of algorithm-hardware co-design involving random projection algorithms like Reservoir Computing or Extreme Learning Machine. Lastly, I will show an application of such a low-power machine learner to perform intention decoding in low-power brain-machine interfaces.

Biography

Arindam Basu received the B.Tech and M.Tech degrees in Electronics and Electrical Communication Engineering from the Indian Institute of Technology, Kharagpur in 2005, the M.S. degree in Mathematics and PhD. degree in Electrical Engineering from the Georgia Institute of Technology, Atlanta in 2009 and 2010 respectively. Dr. Basu received the Prime Minister of India Gold Medal in 2005 from I.I.T Kharagpur (awarded to the top student). In the summer of 2008, he worked at Texas Instruments, Dallas and developed automatic tuning strategies for LNAs designed in 45nm and 65nm. He joined Nanyang Technological University as an Assistant professor in June 2010. He is currently an Associate Editor of IEEE Sensors journal (2015-17) and IEEE Transactions on Biomedical Circuits and Systems (2016-18). He is also Guest Editor of two Special Issues in IEEE Trans. on Biomedical Circuits and Systems for selected papers from ISCAS 2015 and BioCAS 2015 conferences.

Dr. Basu received the best student paper award at Ultrasonics symposium, 2006, best live demonstration at ISCAS 2010 and a finalist position in the best student paper contest at ISCAS 2008. He was awarded MIT Technology Review's inaugural TR35@Singapore award in 2012 for being among the top 12 innovators under the age of 35 in SE Asia, Australia and New Zealand. He is a technical committee member of the IEEE CAS societies of Biomedical Circuits and Systems, Neural Systems and Applications (Secretary Elect) and Sensory Systems. His research interests include bio-inspired neuromorphic circuits, non-linear dynamics in neural systems, low power analog IC design and programmable circuits and devices.

Jie Chen
jchen@ece.ualberta.ca
University of Alberta

Lecture #1: Designing and micro/nano-fabricating portable impedance-based point-of-care biosensors

Companion diagnostics are central to the success of personalized medicine. The portable glucose sensor is indeed the most successful example of a companion diagnostic device. They are used by millions of diabetics worldwide to monitor their health and help make decisions about their medication usage. Building from this example, the lecturer will present the power of metabolomics to develop a collection of multiplexed companion diagnostic systems on a unified platform that can be used to diagnose, monitor, or predict multiple diseases. Metabolomics is an emerging field of “omics” science. Metabolites are very sensitive to gene-environments or gene-pathogen interactions. In this talk, the lecturer will discuss their impedance-based biosensor design to measure not just one metabolite, but dozens or even hundreds at a time from human body fluids (such as blood, urine). The testing time is within 10 minutes at the cost of $1 US Dollar per metabolite test. The sensor is also able to detect metabolites at the concentration of nM. To avoid “false positive”, a competitive assay design was applied. Such a platform technology can be easily extended for environmental monitoring, food-safety checking, cancer screening and infectious disease diagnosing.

Lecture #2: Developing pulsed wave instruments for renewable biofuel and therapeutic applications

Wireless power transmission is on the rise for a variety of applications from electric vehicles to smartphone and implantable microelectronic devices (IMD). Unlike pacemakers, extreme size constraints and high power consumption prevent many IMDs such as cochlear and retinal implants from using primary batteries as their energy source. Moreover, such devices need to deliver a sizable volume of information from external artificial sensors to the nervous system while interfacing with large neural populations at high stimulus rates. Nonetheless, the skin barrier should remain intact and the temperature should be maintained well within the safe limits. In this talk I will cover the fundamentals of efficient power and wideband data transmission across inductive links. I will discuss the optimization procedure to achieve the highest possible power transmission efficiency using two, three, and four coil systems. I will review some of the latest techniques to establish wideband bidirectional communication links across the skin, and will also touch on efficient methods to convert the received AC power on the IMD to DC and stabilize it at a desired level despite coupling variations due to coil misalignments.

Tutorial #1: Engineering of Nanobiotechnological Systems

Nanotechnology is a newly developed engineering field, aiming to create nanomaterials ranging 10nm to 100nm in size. Nanotechnology has presented numerous new and exciting applications across many frontiers of innovation. In particular, there are rapidly emerging new innovations in the field of biotechnology and health technology. Innovations in microfluidics, nanoparticles and DNA machinery have frequently being reported. Applications of these technologies are being adapted and applied in uses, which improve upon existing medical technologies (such as more affordable and portable diagnostic testing tools, as well as enhanced medical imaging). Furthermore, applications of these technologies are also being used to create completely new

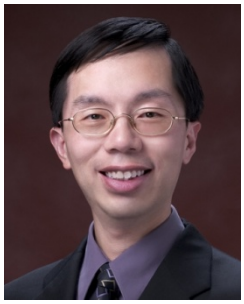
medical technologies (such as nanoparticles for cancer treatments and personalized medicine).

The core of this tutorial, nanobiotechnology, is very multidisciplinary in nature unifying a variety of topics, presented in a cohesive way that can be introduced and understood by electrical engineers. These varied topics include electromagnetics, fluid flow, thermodynamics and microfabrication. Although there are certainly textbooks which cover these topics in great detail, there are none, which integrate these diverse topics together, relate them to relevant topics in nanobiotechnology, or that give a specifically engineering-oriented view on these topics.

Biography

Dr. Jie Chen received his Bachelor degree from Fudan University, China, and his Ph.D. degree from the University of Maryland, USA. He is currently a Professor in the Faculty of Engineering at the University of Alberta, Canada. He is also a research officer at Canadian National Research Council / National Institute for Nanotechology (NINT). Dr. Chen is an IEEE Fellow. He is also a Fellow of the Engineering Institute of Canada. He received the Killam Professorship Award, one of the highest honours to a professor in Canadian Universities, for his outstanding contributions to research, teaching and community service. He has coauthored two books, 81 peer-reviewed journal papers, and 80 peer-reviewed conference proceeding papers. They were published in high impact journals, such as Physical Review Letter (impact factor: 7.728), Journal of Biomedical Nanotechnology (impact factor: 7.578), Small (impact factor: 7.514). According to the Google Scholar (http://scholar.google.ca/citations?hl=en&user=kLA9_-8AAAAJ), his H-index is 26 and i10-index is 56. His total citation is over 3,030. Dr. Chen has received numerous awards such as (i) Distinguished Lecturer of the IEEE Circuits and Systems Society; (ii) Best student paper award at IEEE/National Institutes for Health (NIH) 2007 Life Science Systems & Applications Workshop. (iii) Best Poster Award, the Conference of Biology and Synchrotron Radiation (BSR), International Union of Crystallography, Hamburg/Germany, 2013. (iv) His research on designing miniaturized pulsed wave device for intra-oral dental tissue formation was listed by “Reader’s Digest” as a major medical breakthrough in Canada in the year of 2006. He has trained 68 HQPs including 4 postdoc fellows, 18 Ph.D., and 15 M.Sc. Among the HQPs, one becomes an assistant professor at Johns Hopkins University, two entered Stanford University, one entered Yale Medical School. He also has 7 patents, and most are either in commercial use or are licensed by the other companies. He has nearly 15 years of project, administrative and management experience and has successfully helped found two spin-off companies. One was acquired by QUALCOMM in 2005, and the other produces digital HD-radios installed in most brands of automobiles and sold in Walmart and BestBuy. Since 2000 he has directed various research and business teams ranging in size from 3 to 20 members. Dr. Chen is currently the Program Leader for a NINT Program. He previously led two Alberta Health Service Projects from 2010-2012 (worth $1.1M) and has also been involved in several other multi-million dollar projects as a co-PI, such as a recent Alberta Innovates Bio-solution $5M project. Over the past 5 years he has spun off a UofA biotech company, which focuses on the pulsed wave technology for dental tissue formation and the product passed clinical phase 2 trials. The product is approved to sell worldwide. He has also organized or chaired many national and international conferences / symposiums / workshops ranging in size from 50 to 1000 participants.

His current research includes:
(i) Designing portable impedance-based point-of-care devices for detecting metabolic biomarkers, monitoring environmental toxins, sensing plant infections at an early stage, and screening pathogens for food safety.
(ii) Developing a pulsed-wave technology platform to stimulate cell growth (with applications in cell therapy, tissue engineering, mental health, and antibody production), and microorganism growth (with applications in increasing renewable biofuel/algal oil, antibiotics, omega-3, and wine/beverage production) and waste water treatment.
(iii) Using the Markov Random Field to design ultra low-power fault-tolerant nanoscale circuits.



Yen-Kuang Chen
yen-kuang.chen@intel.com
Intel Corporation

Lecture #1: Challenges and Opportunities of circuits and systems on Internet of Things

This seminar aims to discuss the technical trends and challenges of circuits and systems on Internet of Things. Rapid advancement of networking technologies together with extreme miniaturization of computing and communication devices enable a host of new and exciting applications and services that connect the physical and the computational worlds. In the future, digital sensing, communication, and processing capabilities will be ubiquitously embedded into everyday objects, turning them into the Internet of Things (IoT). In this new paradigm, smart devices will collect data, relay the information or context to each another, and process the information collaboratively using cloud computing and similar technologies. This paradigm shift creates numerous challenges and opportunities for engineering. For example, in the future, enormous numbers of sensors will be deployed. The costs of servicing such sensors will be a major concern. It is often almost impossible to replace sensor batteries once they are in the field. Therefore, one major challenge is low power sensor design, or designs which do not require a battery change over the lifetime of the sensor. For example, if a sensor is deployed on an animal for tracking purposes, the battery of the sensor should outlive the animal. This creates a demand for energy-efficient designs. This seminar will discuss the challenges and opportunities of circuits and systems on Internet of Things.

Lecture #2: Perpetual Wireless Video Camera for Internet-of-Things

Digital sensing, processing, and communication capabilities will be ubiquitously embedded into everyday objects, turning them into an Internet of things (IoT). This is the next-generation Internet – rather than data mainly produced by humans and for humans, in the new machine-to-machine-era Internet, data are generated by machines (sensors), communicated without human involvement to other machines (servers or other computer systems) for automated processing to enable automated or human actions, driving speeds and scales unseen by the existing Internet. Distributed video cameras will play important roles in various IoT applications. To resolve the problems of high data rate, high power consumption, and large deployment cost of large-scale distributed video sensors, perpetual video cameras, where net energy consumption is almost zero, are required. Many technologies and design challenges are introduced for designing such cameras, such as energy harvesting, distributed video coding, distributed video analysis, and the associated VLSI designs. In this seminar, we will provide (1) an overview of challenges/opportunities in IoT, (2) an introduction to the rote and requirements of distributed smart cameras in IoT, (3) the analysis of power consumption of wireless video cameras, (4) an introduction of energy harvesting techniques, and (5) distributed video coding and distributed video analysis, where both the state-of-the-art works and possible future research directions will be shown.

Biography

Dr. Yen-Kuang Chen is a Principal Engineer at Intel Corporation. His research areas span from emerging applications that can utilize the true potential of internet of things to computer architecture that can embrace emerging applications. He has 50+ US patents, 20+ pending patent applications, and 85+ technical publications. He is one of the key contributors to Supplemental Streaming SIMD Extension 3 and Advanced Vector Extension in Intel microprocessors. He has served as a program committee member of 50+ international conferences on Internet of Things, multimedia, video communication, image processing, VLSI circuits and systems, parallel processing, and software optimization. He is a steering committee member of IEEE Internet of Things Journal, the past-chair of Internet of Things special interest group of IEEE Signal Processing Society, and the Editor-in-Chief of IEEE Journal on Emerging and Selected Topics in Circuits and Systems. He received his Ph.D. degree from Princeton University and is an IEEE Fellow.

Mario Di Bernardo
mario.dibernardo@unina.it
University of Naples Federico II

Lecture #1: Self-organizing control and synchronization of complex networks

Motivated by a strong interest from applications, the problem of controlling and synchronizing networks of circuits and systems has been steadily attracting increasing attention from scientists and practitioners alike. As the theory of complex networks becomes more mature, new opportunities are becoming available to steer their collective behavior in a desired manner. Specifically, new approaches inspired from Nature are emerging where the network can organize its own structural properties in order to achieve and maintain some desired behavior. This opens the exciting possibility of embedding technological networks such as power grids or road networks with the ability of organizing their own structure so that some desired properties emerge, similarly to what is observed when fish schools or flocks of birds perform complex maneuvers in the absence of a central control intelligence. In this talk, we will discuss decentralized and distributed self-organizing algorithms to control the collective behavior of complex networks. As a representative example, we will focus on the problem of reaching consensus or synchronization in a network of linear or nonlinear, possibly heterogeneous, systems (that we shall term as the “open-loop network”). We will discuss pinning control and synchronization strategies based on adaptation, contraction and evolution of the network together with novel approaches based on the theory of multiplex and multilayer networks. Applications will be discussed to networks of nonlinear circuits and power grids showing that it is possible for the network to be adapted and rewired in real time so that it can self-organize to best achieve the desired goal. All through the lecture open problems and current challenges in the area of synchronization and control of networks will be presented in the context of the existing literature to highlight some of the key open challenges and stimulate discussions.

Lecture #2: From power converters to walking robots: analysis, bifurcations and control of piecewise-smooth circuits and systems

A large number of systems and devices are modeled by systems with discontinuities. This class of systems can exhibit highly nonlinear phenomena leading to complex dynamics that depends on the presence of such discontinuities. Classical examples include power converters, walking robots, systems with friction and impacts in mechanics and, even, economic and social models. This lecture will introduce the audience to the theory of discontinuity-induced bifurcations in nonlinear circuits and systems affected by switchings, saturations and any other nonlinear effect

that can be modeled as a discontinuous event at a macroscopic timescale. Border-collision bifurcations of fixed points in discrete-time maps will be discussed before introducing a systematic classification of other bifurcation phenomena in systems modeled by continuous-times models such as grazing bifurcations of limit cycles and sliding bifurcations. The theoretical derivations will be complemented by applications to switched circuits and systems, power electronic converters and vibro-impacting mechatronic devices. A combination of analytical tools will be presented to study these nonlinear phenomena that often occur in devices and circuits of practical interest. Current open problems and challenges will be highlighted both in the theory and the applications of discontinuity-induced bifurcations. In particular the challenging problem will be discussed of studying the complex dynamics of networks of nonsmooth systems interacting with each other. The lecture will be self-contained and introduce the audience step by step to the current state-of-the-art on the analysis of complex phenomena in piecewise-smooth circuits and systems.

Biography

Mario di Bernardo (SMIEEE '06, FIEEE 2012) is currently Full Professor of Automatic Control at the University of Naples Federico II, Italy. He is also Professor of Nonlinear Systems and Control at the University of Bristol, U.K and Honorary Visiting Professor at Fudan University, Shanghai, China.
On 28th February 2007 he was bestowed the title of "Cavaliere" of the Order of Merit of the Italian Republic for scientific merits from the President of Italy. In January 2012 he was elevated to the grade of Fellow of the IEEE for his contributions to the analysis, control and applications of nonlinear systems and complex networks. In 2009, He was elected President of the Italian Society for Chaos and Complexity for the term 2010-2013. He was re-elected in 2010 for the term 2014-2017. In 2006 and again in 2009 he was elected to the Board of Governors of the IEEE Circuits and Systems Society. From 2011 to 2014 he was Vice President for Financial Activities of the IEEE Circuits and Systems Society. In 2015 he served as appointed member of the Board of Governors of the IEEE Control Systems Society.
His research interests include the analysis, synchronization and control of complex network systems; the analysis and control of hybrid and piecewise-smooth dynamical systems; nonlinear dynamics, nonlinear control theory and applications to engineering and synthetic biology.
He authored or co-authored more than 220 international scientific publications including more than 110 papers in scientific journals, over 100 contributions to refereed conference proceedings, a unique research monograph on the dynamics and bifurcations of piecewise-smooth systems published by Springer-Verlag and two edited books.
According to the international database SCOPUS (December 2015) his h-index is 34 and his publications received over 4600 citations by other authors (h-index = 42, citations = 8100 according to Google Scholar, January 2016).
He serves on the Editorial Board of several international scientific journals and conferences. From 1st January 2014 till 31st December 2015 he was Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems: Regular Papers. He is Associate Editor of the IEEE Transactions on Control of Network Systems, Nonlinear Analysis: Hybrid Systems, the Conference Editorial Board of the IEEE Control System Society and the European Control Association (EUCA). He was Associate Editor of the IEEE Transactions on Circuits and Sytems I: Regular Papers from 1999 to 2002 and again from 2008 to 2010, and the IEEE Transactions on Circuits and Systems II: Brief papers from 2003 till 2008.
He is regularly invited as Plenary Speaker in Italy and abroad. Recent invitations include the Network Frontier 2015 Workshop at Northwestern University in Chicago, USA and the IEEE Conference on Applications of Nonsmooth Systems in Como, Italy in September 2014. He has been organizer and co-organizer of several scientific initiatives and events including international events at Urbino (2011 & 2013), Paris (2010), Bristol (2009), Napoli (2006), Capri (2006), Bristol (2004), Milano (2004). He received funding from several institutions including the EU, the Italian Ministry of University and Research, the UK Research Councils and Industry for a total amount of over 8M Euros.
He was selected as Distinguished Lecturer of the IEEE Circuits and Systems Society for the term 2016-2017.

Julius Georgiou
julio@ucy.ac.cy
University of Cyprus

Lecture #1: Microelectronic Systems for Improved Quality of Life

Microelectronic revolutions come in waves that are driven by necessity. Currently, the aging population is creating a need for various kinds of electronic systems to improve their quality of life. These include the restoration of lost functionality via electronic implants, better health screening technology and non-invasive monitoring in the home environment. In this talk I will present work that has been done towards addressing these needs, whether it be through the development of new required building blocks or through the development of more complex systems that combine custom built hardware and software. In particular the talk covers work done towards developing a vestibular implant for balance restoration, a single chip low-power imager for a bionic eye, a cancer screening capsule for detecting early-stage carcinomas in the small intestine and a bio-inspired acoustic scene analysis system.

Lecture #2: A Fluoroscopic Cancer Screening Capsule for the Small Intestine

The detection of cancer at an early stage is crucial for successful cancer therapy. An ingestible prototype capsule, which is able to detect very low concentrations of indocynine green (ICG) based fluorescent-labeling contrast agents, is presented. The capsule does not collect images but records infrared fluorescence levels, thus eliminating the need for an external receiver belt to transmit the data in real-time or the need of large onboard data storage capacity. The need for labour-intensive image analysis is also eliminated. Through ex-vivo tests with swine intestine it has been shown that the capsule is able to detect concentrations of ICG in the nanomolar and micromolar region, which is in the range required for the detection of microcancers.
Julius Georgiou (IEEE M'98-SM'08) is an Associate Professor at the University of Cyprus. He received his M.Eng degree in Electrical and Electronic Engineering and Ph.D. degree from Imperial College London in 1998 and 2003 respectively. For two years he worked as Head of Micropower Design in a technology start-up company, Toumaz Technology. In 2004 he joined the Johns Hopkins University as a Postdoctoral Fellow, before becoming a faculty member at the University of Cyprus from 2005 to date.

Biography

Prof. Julius Georgiou is a member of the IEEE Circuits and Systems Society, is the Vice-Chair of the BioCAS Technical Committee, as well as a member of the IEEE Circuits and Systems Society Analog Signal Processing Technical Committee. He served as the General Chair of the 2010 IEEE Biomedical Circuits and Systems Conference and is the Action Chair of the EU COST Action ICT-1401 on "Memristors-Devices, Models, Circuits, Systems and Applications - MemoCIS". Prof. Georgiou has been selected as an IEEE Circuits and Systems Society Distinguished Lecturer for 2016-2017. He is also is an Associate Editor of the IEEE Transactions on Biomedical Circuits and Systems and Associate Editor of the Frontiers in Neuromorphic Engineering Journal. He is a recipient of a best paper award at the IEEE ISCAS 2011 International Symposium and at the IEEE BioDevices 2008 Conference.
His research interests include Low-power analog and digital ASICs, implantable biomedical devices, bioinspired electronic systems, electronics for space, brain-computer-interfaces (BCIs), memristive devices, inertial and optical sensors and related systems.

Tsung-Yi Ho
tyho@cs.nthu.edu.tw
National Tsing Hua University

Lecture #1: The Coming of Age of Microfluidics: Connecting Algorithms and Foundations of Chip Design to Biochemistry and the Life Sciences

This seminar offers attendees an opportunity to bridge the semiconductor ICs/system industry with the biomedical and pharmaceutical industries. This talk will first describe emerging applications in biology and biochemistry that can benefit from advances in electronic “biochips”. The presenters will next describe technology platforms for accomplishing “biochemistry on a chip”, and introduce the audience to both the droplet-based "digital" microfluidics based on electrowetting actuation and flow-based “continuous” microfluidics based on microvalve technology. Next, the presenters will describe system-level synthesis includes operation scheduling and resource binding algorithms, and physical-level synthesis includes placement and routing optimizations. In this way, the audience will see how a “biochip compiler” can translate protocol descriptions provided by an end user (e.g., a chemist or a nurse at a doctor’s clinic) to a set of optimized and executable fluidic instructions that will run on the underlying microfluidic platform. The problem of mapping a small number of chip pins to a large number of array electrodes will also be covered. Finally, sensor feedback-based cyberphysical adaptation will be covered.

Lecture #2: Design Automation, Test, Error Recovery: Toward Secure, Dependable, and Adaptive Large-Scale Lab-on-Chip (LOC) Systems

The seminar offers attendees an opportunity to bridge the semiconductor ICs/system industry with the biomedical and pharmaceutical industries. The seminar will first describe emerging applications in biology and biochemistry that can benefit from advances in electronic “biochips”. Next, the presenter will describe reliability-aware system-level synthesis includes operation scheduling and resource binding algorithms, and physical-level synthesis includes placement and routing optimizations. In this way, the audience will see how a “biochip compiler” can translate protocol descriptions provided by an end user (e.g., a chemist or a nurse at a doctor’s clinic) to a set of optimized and executable fluidic instructions that will run on the underlying microfluidic platform. Testing techniques will be described to detect faults after manufacture and during field operation. A classification of defects will be presented based on data for fabricated chips. Appropriately fault models will be developed and presented to the audience. Design for testability and fault diagnosis techniques will be presented. Security vulnerabilities of microfluidic biochips by identifying potential attacks will be described. The feasibility and stealthiness of possible attacks will be evaluated. Practical and fully integrated cyberphysical error-recovery system that implemented by FPGA will be demonstrated. Finally, a number of case studies with recent applications and future challenges and several open problems in this area will also be presented.

Biography

Tsung-Yi Ho received his Ph.D. in Electrical Engineering from National Taiwan University in 2005. He is a Professor with the Department of Computer Science of National Tsing Hua University, Hsinchu, Taiwan. His research interests include design automation and test for microfluidic biochips and nanometer integrated circuits. He has presented 9 tutorials and contributed 9 special sessions in ACM/IEEE conferences, all in design automation for microfluidic biochips. He has been the recipient of the Invitational Fellowship of the Japan Society for the Promotion of Science (JSPS), the Humboldt Research Fellowship by the Alexander von Humboldt Foundation, and the Hans Fischer Fellow by the Institute of Advanced Study of the Technical University of Munich. He was a recipient of the Best Paper Awards at the VLSI Test Symposium (VTS) in 2013 and IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems in 2015. He served as a Distinguished Visitor of the IEEE Computer Society for 2013-2015, the Chair of the IEEE Computer Society Tainan Chapter for 2013-2015, and the Chair of the ACM SIGDA Taiwan Chapter for 2014-2015. Currently he serves as an ACM Distinguished Speaker, a Distinguished Lecturer of the IEEE CAS Society, and Associate Editor of the ACM Journal on Emerging Technologies in Computing Systems, IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, and IEEE Transactions on Very Large Scale Integration Systems, Guest Editor of IEEE Design & Test of Computers, and the Technical Program Committees of major conferences, including DAC, ICCAD, DATE, ASP-DAC, ISPD, ICCD, etc.

Ebroul Izquierdo
ebroul.izquierdo@qmul.ac.uk
Queen Mary, University of London

Lecture #1: Face Recognition in the Wild

Automated face recognition is one of the oldest and probably best understood tasks in computer vision. Due to the plethora of applications, it is also the basis for a fast evolving technology drawing attention from researchers and practitioners in several fields including forensics, biometrics, visual information retrieval, automated surveillance and internet driven social networking. Despite its maturity, face recognition algorithms fail badly when the image capturing conditions are not ideal. Furthermore, in most critical applications it requires extremely high accuracy under very adverse conditions including significant variations in image quality, scale, orientation, noise and distortions induced by other faces or objects in the same image. This makes an already difficult problem even harder.

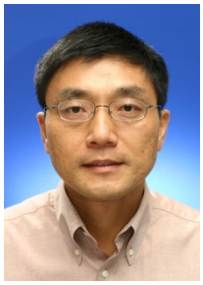
In this talk important aspects of face recognition and few crucial applications will be presented. Starting with key open technical challenges, some important generic aspects of face recognition will be discussed. The state of the art in face recognition technology will be then outlined. The talk will subsequently refer to essential mathematical and statistical methods used to achieve highly accurate face recognition, as well as, the advantages and disadvantages of available algorithmic solutions. The usefulness of face recognition, as a tool to help forensic investigators when mining the vast amounts of data in crime solving, will be presented. Furthermore, examples of recent technological developments in two specific application scenarios will be presented. The first one relates to the recognition of people across a social networks and consumer photo collection by exploiting contextual information extracted from social semantics. The second refers to recent theoretical developments that promise to deliver a quantum leap in the accuracy of face extraction and recognition under very adverse conditions.

Lecture #2: Visual Information Retrieval: From Machine Vision to Human Computation

The performance of any visual information retrieval rest in the accuracy of algorithms for image understanding. Here the main challenge is to overcome the disparity between low-level image features and the richness of semantics in user interpretations of digital images: The semantic Gap. This talk illustrates important technological developments that have contributed to narrowing the semantic gap over the last few years. It will also outline remaining critical challenges in automatic image understanding. Specific successful models to tackle these challenges will be shown in the context of key cutting-edge visual information retrieval applications.

Biography

Ebroul Izquierdo, PhD, MSc, CEng, FIET, SMIEEE, MBMVA, is Chair of Multimedia and Computer Vision and head of the Multimedia and Vision Group in the school of Electronic Engineering and Computer Science at Queen Mary, University of London. Prof. Izquierdo is a IET Chartered Engineer, a member of the Visual Signal Processing and Communications Technical Committee of the IEEE Circuits and Systems Society and member of the Multimedia Signal Processing technical committee of the IEEE. He has been associated editor of the IEEE Transactions on Circuits and Systems for Video Technology (from 2002 to 2010), the IEEE Transactions on Multimedia (from 2010 to 2015). He is member of the editorial board of the EURASIP Journal on Image and Video processing (from 2004 to date) and several other international journals in the field.
Prof. Izquierdo has been member of the organizing committee of several conferences and workshops in the field of image and video processing including The IEEE International Conference on Image Processing (ICIP), The IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), The IEEE International Symposium on Circuits and Systems (ISCAS), The IEEE Visual Communications and Image Processing Conference (VCIP) and The IEEE International Conference on Multimedia & Expo (ICME). He has chaired special sessions and workshops in ICIP, ICASSP, ISCAS, VCIP and ICME.
Prof. Izquierdo has graduated over 30 PhD researchers. He holds several patents in the area of multimedia signal processing and has published over 500 technical papers including books and chapters in books.



Weisi Lin
wslin@ntu.edu.sg
NTU Singapore

Lecture #1: Just-Noticeable Difference (JND) Formulation: Turning Limitations of Human Senses into System Advantages

As a result of the evolution, the human has developed unique characteristics in perception of viewing, hearing, smelling, touching and tasting. Just Noticeable Difference (JND) refers to the minimal amount of “X” that must be changed for the difference to be sensed by the human, where X can be any signal, derived quantity from signals such as emotion and user-experience, or even technical specifications such as resolution, asynchrony, accuracy, etc. “Perception is reality”, so JND plays an important role both explicitly and implicitly throughout our work and life, from sound to smell and from engineering to marketing (e.g., advertisement, logo management, personalization, and recommendation). The scientific measurement and formulation for JND are

the prerequisite for user-centric designs and for turning human perceptual sensitivities into many system advantages. In this seminar, a holistic view will be first presented on JND research and practice, followed by an in-depth case study in visual signals. JND modeling for visual signals has attracted much research interests so far, while those for audio, haptics, olfaction, gestation and other forms of signals are expected to intensify. In essence, factors to influence JND also include utility, culture and personality, as will be highlighted.

Tutorial #1: Perception-driven Visual Signal Modeling, Evaluation and Processing

There are at least three good reasons to make machines that process visual signals (image, video, graphics, animation, screen content, and their combinations) perceive as humans do: 1) Most visual signals we manipulate are for human consumption; 2) Human perception is effective and efficient so machines that emulate human functioning have technical advantages; 3) There is an increasing need for harmonious human-machine interaction (in the near future we may have to deal with robots acting as salespersons or care-givers). So far, we have been able to build machines that perform significantly better and quicker than our body parts like arms and legs. However, when it comes to modeling human perception, the odyssey proves to be much more difficult. In this tutorial, the major problems and research progress in perceptual signal processing will be introduced. The basic computational models (e.g., visual attention, just-noticeable difference, and perceptual signal quality metrics) will be discussed with the latest research and development highlighted. Afterward, different perceptually-inspired signal processing techniques will be presented for signal acquisition, enhancement, communication, retrieval/search, adaptation and understanding. Much of the materials will be drawn upon my substantial experience in related academic and industrial projects. The last part of the tutorial discusses future research and development possibilities, including those enabled by the emerging big data and cloud media.

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    - 2.2 Just-noticeable Difference (JND)
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3. Modelling Methodology
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    - 3.2 Embedded Modules & Standalone Systems
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5. Concluding Remarks and Possible Future Work
    - 5.1 Modelling Advancement; Extension of Scope and Applications
    - 5.2 Possibilities Enabled by Emerging Big-Data and Cloud-Media

Biography

Weisi Lin obtained his PhD from King's College, London Univ., in 1993, and is an active researcher in image processing, video compression, quality metrics and perceptual modeling of visual signals, and multimedia communication. He served as the head of the Visual Processing Lab and the Acting Manager of the Media Processing Department in Institute for Infocomm Research (I2R), Singapore. He is currently an Associate Professor, School of Computer

Engineering, Nanyang Technological University. He published 150 international journal papers, 220+ conference papers, 2 authored books, 3 edited books, 9 book chapters and 7 patents, and successfully delivered R&D projects with $6m funding as the PI. He has been elected as a Distinguished Lecturer for Asia-Pacific Signal and Information Processing Association (2012-13), and given keynote/invited/tutorial/panel talks to over 20 international conferences. He is an AE for IEEE Trans. on Image Processing, IEEE Trans. Circuits and Systems for Video Technology, IEEE Signal Processing Letters and Journal of Visual Communication and Image Representation, and a past AE for IEEE Trans. on Multimedia. He has been elected as a Fellow of IEEE and IET. He believes that good theory is practical, and has kept a balance of academic research and industrial deployment (and business development) throughout his working life.

Shih-Chii Liu
shih@ini.uzh.ch
University of Zurich and ETH Zurich

Lecture #1: Event-Based Auditory Processing with Spiking Silicon Cochleas and Deep Networks

Audio processing based on conventional regular sampling, process audio frames unnecessarily even when the frames carry no information. They also require high sampling rates for auditory scene parsing where source localization and separation are essential. Event-based neuromorphic audio sensors and processing algorithms offer a potential solution to these applications for IoT, mobile, and always-on applications by asynchronously sampling and processing the audio input in a data driven way. This talk covers the latest audio sensing systems including a new sub milliwatt binaural silicon cochlea, event-based algorithms that process the outputs of these cochlea sensors, and example system applications such as auditory localization using a factor of 40 less computing power than conventional Nyquist-rate systems. The talk also covers event-driven deep networks that use the output of the cochleas and the impact of bit precision of such networks on their performance.

Lecture #2: Silicon Cochlea Design and Processing Hardware

Event-based neuromorphic sensors such as the silicon cochlea sample the world asynchronously by responding only to changes in the input stimuli. This is in contrast to the regular sampling method used by many conventional sensor systems resulting in unnecessary processing of audio frames even when the frames carry no information.
The first hour will cover the evolution of silicon cochlea designs, including design details of current sub-milliwatt cochleas. The second hour will cover algorithms and deep neural networks that process the sensor outputs in solving real-time auditory scene processing for localization and classification of auditory sources. The third hour will cover the hardware digital FPGA implementations of event-driven deep networks for auditory processing.
The tutorial will include hands-on participation in hardware demonstrations of the cochlea and applications.

Biography

Shih-Chii Liu co-leads the Sensors group at the Institute of Neuroinformatics, University of Zurich and ETH Zurich. She received the B. S. degree in electrical engineering from MIT and the Ph.D. degree in the Computation and Neural Systems program from the California Institute of Technology.
She worked at various companies including Gould American Microsystems, LSI Logic, and Rockwell International Research Labs. Her research interests include low-power neuromorphic

auditory sensors and processors; and VLSI event-driven bio-inspired processing circuits, deep networks, and event-driven algorithms.
Dr. Liu is past Chair of the IEEE CAS Sensory Systems and Neural Systems and Applications Technical Committees. She is current Chair of the IEEE Swiss CAS/ED Society and an associate editor of the IEEE Transactions of Biomedical Circuits and Systems and Neural Networks journal.

Lexing Xie
lexing.xie@anu.edu.au
Australian National University

Lecture #1: An Anatomy of Social Media Popularity

How did a video go viral? Or will it go viral, and when? These are some of the most intriguing yet difficult questions in social media analysis. This talk will first provide a broad overview of recent research in understanding the predicting popularity, driven by larger amounts of online data and more understanding of human perception and psychology. I will then cover a few recent results from my group on understanding and predicting popularity, especially for YouTube videos. I will start by describing a unique longitudinal measurement study on video popularity history, and introduce popularity phases, a novel way to describe the evolution of popularity over time. I will then discuss a physics-inspired stochastic model that connects exogenous stimuli and endogenous responses to explain and forecast popularity. With such novel representation and new models, we can correlate video content type to popularity patterns, make better predictions, describe the endo-exo factors driving popularity, and forecast the effects of promotion campaigns.

Lecture #2: Understanding of Images and Language with Knowledge and Styles

Building an artificial agent that can see and read has been one of the long-standing challenges in artificial intelligence. Recent progress in a few areas has changed the landscape of these problems. Statistical language models made leaps and bounds into analyzing and synthesizing realistic language. Non-trivial amounts of labeled visual data, coupled with efficient and effective feature learning approaches has made visual recognition closer to reality. Finally, massive amounts of structured and semi-structured data that directly or indirectly encode human knowledge became widely available, turning the knowledge representation problems into a computational grand challenge with feasible solutions in sight. This talk will start with an overview of the related research topics under rapid development, language modeling and visual recognition, data-driven construction of knowledge graphs, large-scale machine learning. We will then cover a few topics under active development in the Computational Media lab and elsewhere: the fusion of commonsense, lexical, and encyclopedia knowledges, approaches for efficient learning of knowledge graphs, synthesizing image descriptions with naturalistic properties such as human cognition and style, beyond encoding factual knowledge.

Biography

Lexing Xie is Associate Professor in the Research School of Computer Science at the Australian National University, she leads the ANU Computational Media lab (http://cm.cecs.anu.edu.au), and is also affiliated with the machine learning research group at NICTA. She was research staff member at IBM T.J. Watson Research Center in New York from 2005 to 2010, and adjunct assistant professor at Columbia University 2007-2009. She received B.S. from Tsinghua University, Beijing, China, and M.S. and Ph.D. degrees from Columbia University, all in Electrical Engineering. Her research interests are in machine learning, multimedia, social media. Of particular recent interest are stochastic time series models, neural

network for sequences, and active learning, applied to diverse problems such as multimedia knowledge graphs, modeling popularity in social media, social recommendation. Lexing's research has received six best student paper and best paper awards between 2002 and 2015, and a Grand Challenge Multimodal Prize at ACM Multimedia 2012. She currently serves an associate editor of ACM Trans. MM, ACM TiiS and PeerJ Computer Science. Her service roles include the program and organizing committees of major multimedia, machine learning, web and social media conferences.