

2019 IEEE SPS Summer School on Intelligent Signal and Information Processing

Xi'an, China. July 14-31, 2019

Broadband Access: from ATM to Edge Computing (18h)

Course description: A variety of bandwidth-hungry applications and services such as web & video conferencing, audio & video streaming, cloud storage, and social networking have been emerging and rolling out rapidly, thus leading to a continuous surge in bandwidth demand across networking infrastructure, notably the access portion (last-hop access). Therefore, both wireline and wireless telecommunications operators are driven to upgrade their access networks to provide broader bandwidth for their subscribers. Technological breakthroughs have been made in engineering growth in provisioning capacity of access networks in past decades. This short course covers advances of various technologies in provisioning broadband access ranging from Asynchronous Transfer Mode (ATM), passive optical networks, congestion control in heterogeneous networks, wide area network optimization, green wireline and wireless access networks, to more recent edge enabled networking and 5G implications. A brief historical development of Internet is also discoursed.

Lecturer: Professor Dr Nirwan Ansari, FIEEE, New Jersey Institute of Technology, USA



Nirwan Ansari is Distinguished Professor of Electrical and Computer Engineering at the New Jersey Institute of Technology (NJIT). He has also been a visiting (chair) professor at several universities. Professor Ansari recently authored *Green Mobile Networks: A Networking Perspective* (IEEE-Wiley, 2017) with T. Han, and co-authored two other books. He has also (co-)authored more than 550 technical publications, over 250 published in widely cited journals/magazines. He has guest-edited a number of special issues covering various emerging topics in communications and networking. He has served on the editorial/advisory board of over ten journals including as Senior Technical Editor of IEEE Communications Magazine. His current research focuses on green communications and networking, cloud computing, drone-assisted networking, and various aspects of broadband networks.

Professor Ansari was elected to serve in the IEEE Communications Society (ComSoc) Board of Governors as a member-at-large, has chaired some ComSoc technical and steering committees, has been serving in many committees such as the IEEE Fellow Committee, and has been actively organizing numerous IEEE International Conferences/Symposia/Workshops. He has frequently been delivering keynote addresses, distinguished lectures, tutorials, and invited talks. Some of his recognitions include IEEE Fellow, several Excellence in Teaching Awards, a few best paper awards, the NCE Excellence in Research Award, the ComSoc TC-CSR Distinguished Technical Achievement Award, the ComSoc AHSN TC Technical Recognition Award, the IEEE TCGCC Distinguished Technical Achievement Recognition Award, the NJ Inventors Hall of Fame Inventor of the Year Award, the Thomas Alva Edison Patent Award, Purdue University Outstanding Electrical and Computer Engineer Award, and designation as a COMSOC Distinguished Lecturer. He has also been granted 38 U.S. patents. He received a Ph.D. from Purdue University---West Lafayette, IN, an MSEE from the University of Michigan---Ann Arbor, MI, and a BSEE (summa cum laude with a perfect GPA) from NJIT---Newark, NJ.

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Fundamentals of Video Processing and Data Compression (28h)

Course description: This course provides the underlying concepts and basic techniques for signal compression of multimedia data. Main topics of this course include source models, information and entropy, lossless source coding, rate distortion theory, redundancy reduction, predictive coding, transform coding, subband coding, and optimum source coding. It also covers various international coding standards for multimedia communications.

Prerequisites: Linear System Theory including Laplace and Fourier Transforms Digital Signal Processing, Digital Image Processing Probability and Random Variables

Text Book:

- K. Sayood, Introduction to Data Compression (3rd Ed.), MK, 2006.

References:

- T. Cover and J. Thomas, Elements of Information Theory, 1991.
- P. Symes, Digital Video Compresion, 2004.
- M. Rabbani and P. Jones, Digital Image Compression Techniques, 1991.

Lecturer: Professor Dr Yo-Sung Ho, FIEEE, Gwangju Institute of Technology, South Korea



Yo-Sung Ho received his B.S. and M.S. degrees in electronic engineering from Seoul National University, Seoul, Korea, in 1981 and 1983, respectively, and the Ph.D. degree in electrical and computer engineering from the University of California, Santa Barbara, in 1990. He joined ETRI (Electronics and Telecommunications Research Institute), Daejeon, Korea, in 1983. From 1990 to 1993, he was with North America Philips Laboratories, Briarcliff Manor, New York, where he was involved in development of the Advanced Digital High-Definition Television (AD-HDTV) system. In 1993, he rejoined the technical staff of ETRI and was involved in development of the Korean DBS Digital Television and High-Definition Television systems. Since 1995, he has been with Gwangju Institute of Science and Technology (GIST), where he is currently Professor of School of Electrical Engineering and Computer Science. Since August 2003, he has been Director of Realistic Broadcasting Research Center at GIST in Korea. He has served as Associate Editors of IEEE Transactions on Multimedia (T-MM) and IEEE Transactions on Circuits and Systems Video Technology (T-CSVT). His research interests include Digital Image and Video Coding, Image Analysis and Image Restoration, Three dimensional Image Modeling and Representation, Advanced Source Coding Techniques, Augmented Reality (AR) and Virtual Reality (VR), Three-dimensional Television (3DTV) and Realistic Broadcasting Technologies.

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Computational Imaging Methods in Hyperspectral, Multispectral and Low-Photon Imaging Applications (10h)

Course description: You might be really pleased with the camera technology in your latest smartphone, which can recognise your face and take slow-mo video in ultra-high definition. But these technological feats are just the start of a larger revolution that is underway. The latest camera research is shifting away from increasing the number of mega-pixels towards fusing camera data with computational processing. By that, we don't mean the Photoshop style of processing where effects and filters are added to a picture, but rather a radical new approach where the incoming data may not actually look like an image at all. It only becomes an image after a series of computational steps that often involve complex mathematics and modelling how light travels through the scene or the camera. This additional layer of computational processing magically frees us from the chains of conventional imaging techniques. One day we may not even need cameras in the conventional sense any more. Instead we will use light detectors that only a few years ago we would never have considered any use for imaging. And they will be able to do incredible things, like see through fog, inside the human body and even behind walls.

In this series of lectures, the methods based on Bayesian methods that will enable future technologies will be discussed in a range of applications from single photon cameras, to hyperspectral imagers.

Lecturer: Professor Dr Steve McLaughlin, FIEEE, Heriot-Watt University, United Kingdom



Steve McLaughlin was born in Clydebank, Scotland, in 1960. He received the B.Sc. degree in electronics and electrical engineering from the University of Glasgow, Glasgow, Scotland, in 1981, and the Ph.D. degree from the University of Edinburgh, Edinburgh, Scotland, in 1990. From 1981 to 1984, he was a Development Engineer in industry involved in the design and simulation of integrated thermal imaging and fire control systems. From 1984 to 1986, he worked on the design and development of high-frequency data communication systems. In 1986, he joined the Department of Electronics and Electrical Engineering, University of Edinburgh as a research fellow, where he studied the performance of linear adaptive algorithms in high noise and nonstationary environments. In 1988, he joined the academic staff at Edinburgh, and from 1991 until 2001 he held a Royal Society University Research Fellowship to study nonlinear signal processing techniques. In 2002, he was awarded a personal Chair in Electronic Communication Systems at the University of Edinburgh. In October 2011, he joined Heriot-Watt University as a Professor of Signal Processing and Head of the School of Engineering and Physical Sciences. His research interests include the fields of adaptive signal processing and nonlinear dynamical systems theory and their applications to biomedical, energy and communication systems.

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MPEG-G: Digital Representation of Genomic Data (8h)

Course description: The advent of High-Throughput Sequencing (HTS) technologies enables the adoption of genomic information in the everyday practice of several fields and the advent of genomic medicine. As a consequence, an extraordinarily growing volume of generated data is expected. MPEG-G has been developed in response to the worldwide demand for new effective interoperable solutions in genomic information processing at the core of all kind of applications implementing the chain, from sequencing to storage and analysis.

This course will give a short introduction into Genomics, Sequencing technology and then focus on the efficient representation and storage of genomic information.

Lecturer: Professor Dr.-Ing. Jörn Ostermann, FIEEE, Leibniz Universität Hannover, Germany



Jörn Ostermann studied Electrical Engineering and Communications Engineering at the University of Hannover and Imperial College London, respectively. He received Dipl.-Ing. and Dr.-Ing. from the University of Hannover in 1988 and 1994, respectively. From 1988 till 1994, he worked as a Research Assistant at the Institut für Theoretische Nachrichtentechnik conducting research in low bit-rate and object-based analysis-synthesis video coding. In 1994 and 1995 he worked in the Visual Communications Research Department at AT&T Bell Labs on video coding. He was a member of Image Processing and Technology Research within AT&T Labs - Research from 1996 to 2003. Since 2003 he is Full Professor and Head of the Institut für Informationsverarbeitung at Leibniz Universität Hannover, Germany. From 2007 until 2011, he served as head of the Laboratory for Information Technology.

From 1993 to 1994, he chaired the European COST 211 sim group coordinating research in low bitrate video coding. Within MPEG-4, he organized the evaluation of video tools to start defining the standard. He chaired the Adhoc Group on Coding of Arbitrarily-shaped Objects in MPEG-4 Video. Since 2008, he is the Chair of the Requirements Group of MPEG (ISO/IEC JTC1 SC29 WG11). From 2011 to 2013, he served as Dean of the Faculty of Electrical Engineering and Computer Science at LUH.

Jörn was a scholar of the German National Foundation. In 1998, he received the AT&T Standards Recognition Award and the ISO award. He is a Fellow of the IEEE (class of 2005) and member of the IEEE Technical Committee on Multimedia Signal Processing and past chair of the IEEE CAS Visual Signal Processing and Communications (VSPC) Technical Committee. Joern served as a Distinguished Lecturer of the IEEE CAS Society (2002/2003). He published more than 200 research papers and book chapters. He is coauthor of a graduate level text book on video communications. He is named as inventor on more than 30 patents.

His current research interests are data compression, computer vision, machine learning, 3D modeling, face animation, and computer-human interfaces.

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Short description of the course “Speech processing and AI” (8h)

Course description: This course covers fundamentals and key technologies of speech processing, mainly focusing on automatic speech recognition, especially on the recent progress of DNN (deep neural network)-based methods. Capability, current limitation and future perspectives of AI (artificial intelligence) technology are also discussed.

1. Human speech production and speech analysis (1 hour)
2. Speech coding and speech synthesis (1 hour)
3. Automatic speech recognition (ASR) (4 hours)
 - 3.1 History of ASR research
 - 3.2 Acoustic modeling
 - 3.3 Language modeling
 - 3.4 DNN-based methods
 - 3.5 Speaker recognition
4. Current and future AI (2 hours)

Lecturer: Emeritus Professor Dr Furui Sadaoki, FIEEE, Tokyo Institute of Technology, Japan



Sadaoki Furui Received the B.S., M.S., and Ph.D. degrees from the University of Tokyo, Japan in 1968, 1970, and 1978, respectively. After joining the Nippon Telegraph and Telephone Corporation (NTT) Labs in 1970, he has worked on speech analysis, speech recognition, speaker recognition, speech synthesis, speech perception, and multimodal human-computer interaction. From 1978 to 1979, he was a visiting researcher at AT&T Bell Laboratories, Murray Hill, New Jersey. He was a Research Fellow and the Director of Furui Research Laboratory at NTT Labs. He became a Professor at Tokyo Institute of Technology in 1997. He was Dean of Graduate School of Information Science and Engineering, and Director of University Library. He was given the title of Professor Emeritus and became Professor at Academy for Global Leadership in 2011. He is now serving as President of Toyota Technological Institute at Chicago (TTI-C). He has authored or coauthored over 1,000 published papers and books. He was elected a Fellow of the IEEE, the Acoustical Society of America (ASA), the Institute of Electronics, Information and Communication Engineers of Japan (IEICE) and the International Speech Communication Association (ISCA). He received the Paper Award and the Achievement Award from the IEEE SP Society, the IEICE, and the Acoustical Society of Japan (ASJ). He received the ISCA Medal for Scientific Achievement, and the IEEE James L. Flanagan Speech and Audio Processing Award. He received the NHK (Japan Broadcasting Corporation) Broadcast Cultural Award and the Okawa Prize. He also received the Achievement Award from the Minister of Science and Technology and the Minister of Education, Japan, and the Purple Ribbon Medal from Japanese Emperor. He was accredited as Person of Cultural Merit by the Japanese Government in 2016.