2004 RYERSON WORKSHOP SERIES:

DISTINGUISHED LECTURES ON SIGNAL/ MULTIMEDIA PROCESSING AND COMMUNICATIONS

LECTURE 1:

Collaborative Virtual Environments: Applications, Standards and Performance Issues

PROFESSOR NICOLAS GEORGANAS, UNIVERSITY OF OTTAWA

LECTURE 2:

Toward Maximum Achievable Diversity in Space, Time, and Frequency

PROFESSOR K.J. RAY LIU, UNIVERSITY OF MARYLAND, COLLEGE PARK

LECTURE 3:

Pattern Mining in Large-Scale Image and Video Sources

PROFESSOR SHIH-FU CHANG, COLUMBIA UNIVERSITY

LECTURE 4:

Directions and New Challenges in Fourth Generation Wireless Communication Systems

PROFESSOR STEVEN BLOSTEIN, QUEEN'S UNIVERSITY

Agenda

Date: Friday October 8, 2004

09:00-10:20	**Lecture 1**
10:20-10:40	Coffee Break
10:40-12:00	**Lecture 2**
13:20-14:40	**Lecture 3**
14:40-16:00	**Lecture 4**
16:00-17:00	**Poster session / Coffee Time**

Registration

Free!!!!

Refreshments are provided.

Location: ENG LG11 (lower level), 243 Church St., Ryerson University, Toronto. www.ryerson.ca/map

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Lecture Abstracts and Biographies of the Speakers

Lecture 1 *Professor Nicolas Georganas*

Collaborative Virtual Environments: Applications, Standards and Performance Issues

Collaborative Virtual Environments (CVE) are Virtual Reality simulations running over several computer systems connected via a network and performing some collaborative task. In this talk, several CVE-related issues will be discussed and pertinent middleware standards for CVEs (DIS, SPLINE, HLA...) will be reviewed. Applications, ranging from telemedicine to defense training simulations to collaborative e-commerce, will be presented. The performance of some applications over the various middleware standards and some prototype systems will finally be discussed.

***Nicolas D. Georganas**, OOnt, FIEEE, FRSC, FCAE, FEIC is Distinguished University Professor and Canada Research Chair in Information Technology, School of Information Technology and Engineering (SITE), University of Ottawa. He received the Dipl. Ing. degree in Electrical Engineering from the National Technical University of Athens, Greece, in 1966 and the Ph.D. in Electrical Engineering (Summa cum Laude) from the University of Ottawa in 1970. Since 1970, he has been a faculty member in first the Department of Electrical and Computer Engineering and then SITE, University of Ottawa, and served as Chairman of the former from 1981 to 1984. In 1986, he was appointed Founding Dean of the Faculty of Engineering and served a seven year term.*

He has published over 350 technical papers (including 110 journal papers) and is co-author of the book "Queueing Networks- Exact Computational Algorithms: A Unified Theory by Decomposition and Aggregation", MIT Press, 1989.- He has received research grants and contracts totaling more than $52 million and has supervised more than 175 researchers, among which 100 graduate students (29 PhD, 71 Master's), 20 Post-doctoral Fellows and 16 research engineers .

In 1990, he was elected Fellow of IEEE for "leadership in university-industry research in, and performance evaluation of, multimedia communication networks and systems". In 1994, he was elected Fellow of the Engineering Institute of Canada. In 1995, he was co-recipient of the IEEE INFOCOM'95 Prize Paper Award. In 1997, he was inducted as Fellow in the Canadian Academy of Engineering and Fellow of the Royal Society of Canada. In 1998, he was selected as the University of Ottawa Researcher of the Year and also received the University 150th Anniversary Medal for Research. In 1999, he was awarded the Thomas W. Eadie Medal of the Royal Society of Canada, funded by Bell Canada, for his contributions to Canadian and International telecommunications. In 2000, he received the A.G.L. McNaughton Gold Medal and Award for 1999-2000, the highest distinction of IEEE Canada; the Julian C. Smith Medal of the Engineering Institute of Canada for 1999-2000, "in recognition of outstanding achievements in the development of Canada"; the OCRI President's Award for the creation of the National Capital Institute of Telecommunications (NCIT); the Bell Canada Forum Award from the Corporate-Higher Education Forum, the Researcher Achievement Award , from the TeleLearning Network of Centres of Excellence and a Canada Research Chair in Information Technology. In 2001, he was appointed Distinguished University Professor of the

University of Ottawa and he also received the Order of Ontario, the province's highest and most prestigious honour. In 2002, he received the Killam Prize for Engineering, Canada's most distinguished award for outstanding career achievements. In 2003, he was honoured with the Queen Elisabeth II Golden Jubilee Medal. In 2004, he became Founding Editor-in-Chief of the ACM Transactions on Multimedia Computing, Communications and Applications (TOMCCAP), and received an Honorary Doctorate from the Technical University Darmstadt, Germany.

Lecture 2 *Professor K. J. Ray Liu*

Toward Maximum Achievable Diversity in Space, Time, and Frequency

The idea of using multiple transmit and receive antennas in future wireless communication systems to accommodate high data rate has attracted considerable attentions recently. A challenging problem is to develop new coding and modulation methods to exploit all of the diversities available in space, time and frequency domains. In case of frequency non-selective fading channels for narrowband transmission, diversities are available only in space and time domains. The coding approach that is developed for this scenario is termed as space-time (ST) code. First, we will briefly review some of existing space-time block codes (STBCs) that can guarantee full diversity in space and time domains. Then, we will focus on the STBCs from orthogonal or block-orthogonal designs. These codes not only achieve full diversity, but also have a very simple maximum-likelihood (ML) decoding algorithm. Finally, we will talk how to combine orthogonal or block-orthogonal designs with sphere packing to further increase the coding advantage.

In case of frequency selective fading channels for broadband wireless communications, there is additional frequency diversity due to the multi-path fading. A mature technique to mitigate the frequency selectivity is to use OFDM. We will discuss space-frequency (SF) and space-time-frequency (STF) coding strategies for MIMO-OFDM systems. The basic idea of SF coding is to encode the source data stream over the transmit antennas and the OFDM tones, but restricting the codewords within one OFDM block period. The problem is how to design SF codes to achieve the spatial and frequency diversities available in MIMO frequency selective channels. First, we will briefly review previous works on SF coding. Then, we will introduce a systematic design method to construct full-diversity SF codes by taking advantage of the existing ST codes and discuss an approach to design SF block codes that can guarantee full-rate full-diversity transmission in MIMO-OFDM systems. Finally, if coding delay is allowed, we will discuss how to obtain a STF code that reaches the maximum achievable diversity in space, time, and frequency.

Professor K. J. Ray Liu *received the B.S. degree from the National Taiwan University in 1983, and the Ph.D. degree from UCLA in 1990, both in electrical engineering. He is a Professor and Director of Communications and Signal Processing Laboratories of Electrical and Computer Engineering Department and Institute for Systems Research of University of Maryland, College Park. His research contributions encompass broad aspects of wireless communications and networking; information security; multimedia communications and signal processing; signal processing algorithms and architectures; and bioinformatics, in which he has published over 300 refereed papers. Dr. Liu is*

the recipient of numerous honors and awards including IEEE Signal Processing Society 2004 Distinguished Lecturer, the 1994 National Science Foundation Young Investigator Award, the IEEE Signal Processing Society's 1993 Senior Award (Best Paper Award), IEEE 50th Vehicular Technology Conference Best Paper Award, Amsterdam, 1999, and EURASIP 2004 Meritorious Service Award. He also received the George Corcoran Award in 1994 for outstanding contributions to electrical engineering education and the Outstanding Systems Engineering Faculty Award in 1996 in recognition of outstanding contributions in interdisciplinary research, both from the University of Maryland. Dr. Liu is a Fellow of IEEE. Dr. Liu is the Editor-in-Chief of IEEE Signal Processing Magazine and was the founding Editor-in-Chief of EURASIP Journal on Applied Signal Processing. Dr. Liu is a Board of Governor and has served as Chairman of Multimedia Signal Processing Technical Committee of IEEE Signal Processing Society.

Lecture 3 *Professor Shih-Fu Chang*

Pattern Mining in Large-Scale Image and Video Sources

Detection and recognition of semantic events has been a major research challenge for multimedia indexing. An emerging direction in this field has been *unsupervised discovery (mining) of patterns* in spatial-temporal multimedia data. Patterns are recurrent, predictable occurrences of one or more entities that satisfy statistical, associative, or relational conditions. Patterns at the feature level may signify the occurrence of primitive events (e.g., recurrent passing of pedestrians). At the higher level, patterns may represent cross-event relations; e.g., recurrent news stories across multiple broadcast channels or repetitive play-break alternations in sports. Patterns in an annotated image collection may indicate collocations of related semantic concepts and perceptual clusters.

Mining of patterns of different types at different levels offers rich benefits, including automatic discovery of salient events or topics in a new domain, automatic generation of alerts indicating unusual situations, and summarization of concepts structures in a massive collection of content.

Many challenging issues emerge. What are the adequate representations and statistical models for patterns that may exist at different levels and different time scales? How do we effectively detect and fuse patterns supported by different media modalities, as well as how to handle patterns that may have relatively sparse occurring frequencies? How do we evaluate the quality of mining results given its unsupervised nature?

In this talk, I will present results of our recent efforts in mining patterns in structured video sequences (such as sports and multi-channel broadcast news) and large collection of stock photos. Specifically, we will discuss the potential of statistical models like Hierarchical HMM for temporal structure mining, probabilistic latent semantic analysis for discovering hidden concepts, a hierarchical mixture model for fusing multi-modal patterns, and the combined exploration of electronic knowledge (such as WordNet) and statistical clustering for image knowledge mining.

Evaluations against real-world videos such as broadcast sports, multi-channel news, and stock photos will be presented. Future directions and open issues will be discussed.

Professor Shih-Fu Chang *is a Professor of Electrical Engineering at Columbia University. His research focuses on multimedia signal processing and communication, video indexing, wireless/mobile video, and multimedia authentication watermarking. He is currently leading Columbia's ADVENT*

industrial consortium and the Digital Video/Multimedia Group. He contributes to digital video research in several cross-disciplinary projects at Columbia, including Columbia's Patient Care Digital Library (sponsored by the cross-agency DLI phase 2 program), Multimedia Education Project supported by AT&T foundation, and Columbia's Digital News System Project supported by NSF. Prof. Chang has been awarded a Young Investigator Award from Office of Naval Research in 1998, a Faculty Development Award from IBM in 1995, and a CAREER Award from the National Science Foundation in 1995. He has served as an associated editor for several journals and has been a general co-chair for ACM 8th Multimedia Conference 2000. He and his students have been awarded three best paper awards from IEEE, ACM, and SPIE. He currently serves as a Distinguished Lecturer in the Multimedia Track of IEEE Circuits and Systems Society, and an advisor for several media companies. His group has worked closely with industrial partners for the development of MPEG-7, the emerging multimedia content description standard. In 2003, he was elected an IEEE fellow for his contributions in digital video and multimedia technologies.

Lecture 4 *Professor Steven Blostein*

Directions and New Challenges in Fourth Generation Wireless Communication Systems

Historically, data and voice communication has been concerned with information transmission from one fixed location to another. Over the past decade, this emphasis has shifted to personal wireless communication, i.e., between arbitrarily located people in motion. Future systems will emphasize communication at unprecedented data rates, not only between people, but ubiquitous communications among people as well as a variety of machines, including computers, sophisticated sensors, smart appliances and real-time systems. The talk will first overview major worldwide activities and issues related to the vision of fourth-generation (4G) wireless communication systems aimed to provide these future services. Smart antennas, a critical technology that enables dramatically more efficient use of spectrum, will be introduced. Specific research challenges related to signal processing and coding for smart antennas will then be highlighted, including reliable beam forming, multiple input multiple output (MIMO) transmitter optimization, interference management and multiple access. Results emphasizing more practical signal processing under limited system knowledge and inaccurate assumptions will be presented.

Steven D. Blostein *received his B.S. degree in Electrical Engineering from Cornell University in 1983, and the M.S. and Ph.D. degrees in Electrical and Computer Engineering from the University of Illinois at Urbana-Champaign, in 1985 and 1988, respectively. He has been on the faculty at Queen's University in Kingston, Ontario Canada since 1988 where he currently holds the position of Professor and Head of the Department of Electrical and Computer Engineering. His current interests lie in signal processing for wireless communications as well as detection and estimation theory. He is a Senior Member of IEEE and a registered Professional Engineer in Ontario. From 1998-2003 he has been Leader of the Multirate Wireless Data Access Major Project of the Canadian Institute for Telecommunications Research. Currently he leads a project on Smart Antennas for 4G Wireless Communications Systems co-sponsored by Bell Mobility and Samsung Electronics.*