Guest Editorial

Special Issue: Multimedia over Mobile IP

By Chang Wen Chen and Jiebo Luo, Guest Editors

The rapid advance in wireless communication and Internet has ushered in a new era of mobile/wireless multimedia applications and services. Tremendous growth opportunities lie ahead of us as academia, industry and government agencies make giant strides in the development of Multimedia Over Mobile IP. Apart from the marketing and economic impacts, the convergence of wireless communication, Internet, and multimedia is creating a new paradigm of research and development in order to deliver multimedia content over Internet and mobile wireless networks. With the benefit of increased bandwidth in such networks, newer and more powerful mobile devices, and continued effort towards standardization, wireless communication is quickly moving beyond voice and text-based emails into the reality of multimedia content delivery and access at anytime and from anywhere.

In this Special Issue, we are extremely pleased to bring together a team of the leading experts from academia, industry and government agencies to provide an in-depth, comprehensive overview of the rapidly evolving field of Multimedia Over Mobile IP.

Mobile person to person speech communication has turned out to be extremely popular with more than one billion users at present. Today, mobile networks are evolving quickly to support multimedia communications. This Special Issue opens with a paper on the latest products and services for carrying Multimedia Over Mobile IP. The paper ‘Wireless meets multimedia’ by Jukka Yrjänäinen and Yrjö Neuvo provides an excellent overview of the wireless multimedia products and services in coming years. The access to various sources of multimedia will further enrich mobile communication; new mobile phones with graphical color displays and integrated cameras will provide a natural platform for large sets of multimedia applications; and open software architectures in these terminals are giving new possibilities to the developer community. Clearly, evolution of the mobile multimedia will create new challenges and exciting opportunities for related research and development activities.

3G has been a buzzword in the past couple of years. With the development of the 3G network infrastructure, emerging wireless communication standards and products, wireless multimedia applications and services are imminent and are poised to significantly change the way people live around the world. In their paper ‘3G wireless multimedia: technologies and practical issues’, Wenjun Zeng and Jiangtao Wen present an overview of the emerging wireless communication standards, end-to-end wireless streaming systems, and relevant wireless multimedia technologies. The paper highlights some of the challenges in the deployment of 3G wireless multimedia services, using an commercially available solution as an example.

Video streaming is a highly demanding multimedia application for wireless channels. Bernd Girod, Mark Kalman, Yi Liang and Rui Zhang review recent advances in channel-adaptive video streaming in their paper ‘Advances in channel-adaptive video streaming’. Adaptive media playout at the client can be used to reduce receiver buffering and therefore average latency, and provide limited rate scalability. Rate-distortion optimized packet scheduling determines the best packet to send given the distortion reduction associated with sending that packet, interpacket dependencies, and the success of past transmissions. Channel-adaptive packet dependency control can greatly improve the error-robustness of streaming video and reduce or eliminate the need for packet retransmissions. Three architectures are considered for wireless video streaming, along with...
discussions on the utility of the related techniques for each architecture.

A very important aspect of multimedia experience is perception and interaction. Interaction is desired for playing games on wireless devices. At present, most multimedia experience is delivered and enjoyed in a passive mode. Between audio and video, we argue that the more important perception is visual perception. As consumers move beyond the initial “wow” stage, the quality of the multimedia experience becomes increasingly important. This often over-looked aspect is addressed by a unique paper in this Special Issue on ‘Displaying images on mobile devices: capabilities, issues, and solutions’ by Jiebo Luo, Amit Singhal, Gustav Braun, Robert Gray, Nicolas Touchard and Olivier Seignol. Indeed, wireless imaging is enabling visual communication at any time and from anywhere to become a reality. However, a key technical challenge is how to achieve best-perceived image quality given the limited screen size and display bit depth of the mobile devices. In this paper, the authors present an overview of the current capabilities of various mobile devices, highlight some of the technical issues, and present potential solutions. In addition, to help sort through the myriad of commercial solutions and anticipate what is to come, a review of some of the major software products on the market and an outlook of the trend towards more capable devices are provided.

In many applications such as construction, manufacturing, ground robotic vehicles, and rescue operations, there are many issues that necessitate the capability of transmitting digital video and that such transmissions should be performed wirelessly and in an ad-hoc manner. In ‘IEEE 802.11 FHSS receiver design for cluster-based multihop video communications’, Koichiro Ban and Hamid Gharavi proposed an ad-hoc, cluster-based, multi-hop network architecture for video communications. For implementation, the IEEE 802.11 FHSS wireless LAN system using 2GFSK modulation has been deployed. To help analyze ways to enhance the overall throughput rate for higher quality video communications, a performance evaluation of the IEEE 802.11 FHSS was conducted when 4GFSK modulation option is selected. It was found that the 2Mb/s system utilizing 4GFSK modulation is not very efficient in terms of RF range. Therefore, to improve its performance for multihop applications, a combination of diversity and non-coherent Viterbi based receiver is considered. For the video transmission part, the team has considered a bitstream splitting technique together with a packet-based error protection strategy to combat packet drops under multipath fading conditions. Finally, the paper presents the simulation results, including the effects of the receiver design and diversity on the quality of the received video signals.

Transport of multimedia content over mobile networks is challenged by the error-prone nature of wireless channels. This may result in loss or erroneous decoding of the video. In their paper, ‘Second-generation error concealment for video transport over error-prone channels’, Trista Pei-chun Chen and Tsuhan Chen review different error concealment methods and introduce a new framework, which can be considered as second-generation error concealment. All the error concealment methods reconstruct the lost video content by making use of some a priori knowledge about the video content. First-generation error concealment builds such a priori in a heuristic manner. The proposed second-generation error concealment builds the a priori by modeling the statistics of the video content. Context-based models are trained with the correctly decoded video content, and then used to replenish the lost video content. Trained models capture the statistics of the video content and thus reconstruct the lost video content better than reconstruction by heuristics.

Bandwidth and the diversity in bandwidth have been major limiting factors for transmitting multimedia content across mobile wireless networks. Transcoding becomes a necessity in order to deal with channels with different bandwidth capabilities. Two types of techniques suitable for rate reduction transcoding for wireless video streaming applications are presented by Anthony Vetro, Jianfei Cai and Chang Wen Chen in ‘Rate-reduction transcoding design for wireless video streaming’. They begin by reviewing existing approaches and addressing several issues related to transcoding. Next, they describe the first type of transcoding based on intra refresh architecture for spatial resolution reduction and the second type of transcoding scheme based on rate-distortion (R-D) characteristics of the pre-encoded video. This R-D based approach can be applied to architecture simplification, rate control, frame dropping control, and channel adaptive transcoding. This paper concludes by pointing out that transcoding is an integral part of wireless video streaming because it provides a flexible interface between the wired network and the wireless network.
Joint source-channel coding schemes have been proven to be very effective for reliable multimedia communications. Numerous joint source-channel coding approaches have been proposed to address the important issue on how to allocate limited bit budget between source and channel coding. In their paper entitled “Combined hidden Markov source estimation and low-density parity-check coding: a novel joint source–channel coding scheme for multimedia communications,” Liuguo Yin, Jianhua Lu, and Youshou Wu describe a novel joint source-channel coding scheme for multimedia communications. This approach combines the hidden Markov source estimation and the low-density parity-check (LDPC) codes with an iterative estimation/decoding scheme. With this innovative combination, multimedia source redundancy could be accurately extracted by the hidden Markov estimation without a priori information about the source. Moreover, the interleaver that is usually used to separate the source coding and channel coding can be avoided by exploiting the randomizing property of the LDPC codes. Furthermore, the channel decoding procedure may be implemented in parallel, resulting in good performance with a fairly low decoding complexity and delay. Simulation results have shown that the proposed scheme can achieve much better performance than that of the standard coding scheme over the binary input additive white Gaussian noise channels.

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Guest Editors’ Biographies

Chang Wen Chen is currently the Head of Interactive Media Group at Sarnoff Corporation in Princeton, NJ. He received the B.S. degree from University of Science and Technology of China in 1983, M.S.E.E. degree from University of Southern California, Los Angeles in 1986, and Ph.D. degree from University of Illinois at Urbana-Champaign in 1992.

From August 1992 to September 1996, he was on the faculty of the Department of Electrical Engineering, University of Rochester. He joined the Department of Electrical and Computer Engineering at the University of Missouri-Columbia in September 1996 and is now an Associate Professor. He has consulted with Kodak, NASA Goddard Space Flight Center, and Microsoft Research.

He has received research awards from NSF, NASA, Whitaker Foundation, DARPA, and several major corporations. His Ph.D. students, Jiebo Luo and Li Fan, received the 1994 SPIE Best Student Paper Award for Visual Communication and Image Processing, and the 1999 SPIE Michael B. Merickel Best Student Paper Award Runner-up, respectively.

He is currently serving as an Associate Editor for IEEE Trans on Circuits and Systems for Video Technology and IEEE Trans on Multimedia. He is also on the Editorial Board of the Journal of Visual Communication and Image Representation. He has been a Guest Editor for IEEE Journal of Selected Areas in Communications special issue on Error-Resilient Image and Video Transmission and a Guest Editor for IEEE Trans Circuits and Systems for Video Technology special issue on Wireless Video. Currently, he is serving as a Guest Editor for Wireless Communication and Mobile Computing special issue on Multimedia over Mobile IP. He is a Senior Member of IEEE.

His current research interests include multimedia processing and compression, mobile wireless multimedia communication, image and video coding, MPEG-4, MPEG-7, Internet multimedia streaming, telemedicine, biomedical image processing, and visualization.

Jiebo Luo received the B.S. and M.S. degrees in electrical engineering from the University of Science and Technology of China, Hefei, China, in 1989 and 1992, respectively. In 1995, he received a Ph.D. degree in electrical engineering from the University of Rochester, Rochester, NY.

In the summer of 1995, he was employed at the Joseph C. Wilson Center for Technology of Xerox Corporation, Webster, NY. In 1995, he became a Senior Research Scientist and is currently a Senior Principal Research Scientist in the Imaging Science Technology Laboratory, Imaging Research and Advanced Development, Eastman Kodak Company,
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Dr. Luo was the recipient of the Best Student Paper Award for Visual Communication and Image Processing from SPIE in 1994, and a Certificate of Merit for Scientific Exhibit from RSNA in 1998. He was the Chair of the Rochester Section of the IEEE Signal Processing Society in 2001, and the General Co-Chair of the IEEE Western New York Workshop on Image Processing in 2000 and 2001. He is also a member of the Organizing Committee of the 2002 IEEE International Conference on Image Processing, a Guest Editor for Wireless Communications and Mobile Computing Special Issue on Multimedia Over Mobile IP, and an At-Large Member of the Kodak Research Scientific Council. Dr. Luo is a Senior Member of the IEEE and a member of SPIE.