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Editorial

Next Generation Mobile Video Networking

▶ Guest Editors

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Dr. HWANG received the 1995 IEEE Signal Processing Society's Best Journal Paper Award. He is a founding member of the Multimedia Signal Processing Technical Committee of IEEE Signal Processing Society and was the Society's representative to IEEE Neural Network Council from 1996 to 2000. He is currently a member of Multimedia Technical Committee (MMTC) of IEEE Communication Society and also a member of Multimedia Signal Processing Technical Committee (MMSP TC) of IEEE Signal Processing Society. He served as associate editors for *IEEE T-SP*, *T-NN* and *T-CSVT*, *T-IP* and *Signal Processing Magazine (SPM)*. He is currently on the editorial board of *ZTE Communications*, *ETRI*, *IJDMB* and *JSPS* journals. He served as the Program Co-Chair of IEEE ICME 2016 and was the Program Co-Chairs of ICASSP 1998 and ISCAS 2009. Dr. HWANG has been named a fellow of IEEE since 2001.

WEN Yonggang received the Ph.D. degree in electrical engineering and computer science (minor in western literature) from the Massachusetts Institute of Technology, USA, in 2008. He is currently an Associate Professor with the School of Computer Science and Engineering, Nanyang Technological University, Singapore. Previously, he worked at Cisco Systems, Inc., San Jose, CA, USA, to lead product development in content delivery network. He has authored or co-authored more than 140 papers in top journals and prestigious conferences. His work in Multi-screen Cloud Social TV has been featured by global media (more than 1600 news articles from over 29 countries). His research interests include cloud computing, green data center, big data analytics, multimedia network, and mobile computing.

Prof. WEN serves on the Editorial Board of *IEEE Transactions on Circuits and Systems for Video Technology*, *IEEE Wireless Communication Magazine*, *IEEE Communications Survey & Tutorials*, *IEEE Transactions on Multimedia*, *IEEE Transactions on Signal and Information Processing over Networks*, *IEEE Access Journal*, and *Elsevier Ad Hoc Networks*. From 2014 to 2016, he was elected as the Chair for IEEE ComSoc Multimedia Communication Technical Committee. He was the recipient of the ASEAN ICT Award 2013 (Gold Medal). His work on Cloud3DView, as the only academia entry, was the recipient of the Data Centre Dynamics Awards 2015 DCD APAC. He was the recipient of the 2015 IEEE Multimedia Best Paper Award, and the Best Paper Awards at EAI/ICST Chinacom 2015, IEEE WCSP 2014, IEEE Globecom 2013, and IEEE EUC 2012.

The most recent Cisco Visual Networking Index (VNI) forecasts that more than three-fourths of the world's mobile data traffic, which is expected to be 49 exabytes per month by 2021, will be video, i.e., a 9-fold increase between 2016 and 2021. The exponential growth in bandwidth demand of the mobile Internet is fueled by the transfer of high definition (HD)/ultra HD (UHD) video consumption to online dissemination, as well as by matured deployments of IPTV and video on demand (VOD) streaming services. It is also expected that virtual reality (VR)/augmented reality (AR) and 3D point cloud traffic will increase significantly in the near future. In the meanwhile, there are huge amount of user generated videos being uploaded to cloud servers, ranging from live streamed social media videos from smartphones, mobile surveillance videos from home/vehicles/drones, environmental monitoring videos from various Internet of Things (IoT) based cameras, etc.

To cope with this growth of video driven mobile Internet, there is an urgent need of advanced video source/channel coding techniques, effective next generation mobile networking architectures and cloud services, to disseminate and/or collect these big visual data, so as to provide best streaming services at the client side and/or perform intelligent data analytics at the cloud server side. Currently the coding technologies, such as advanced video coding (AVC, H.264) and high efficiency video coding (HEVC, H.265), mainly focus on two-dimensional video compression. A new video coding standards working group, called Future Video Coding (FVC), has also been established to fully consider the unique attributes of immersive media, such as the 360-degree panoramic VR/AR videos.

Even though 4G+/5G mobile architectures have also involved some of mobile video networking requirements, but most of them are under the framework of network slicing for diversified service, as facilitated by the incorporation of software defined networking (SDN)/network function virtualization (NFV). It is well known that wireless channel conditions vary frequently with channel environments and user behaviors. MPEG's Dynamic Adaptive Streaming over HTTP (MPEG-DASH) is thus incorporated as an effective video streaming platform, which enables the adaptive rate selection based on the channel conditions. DASH can provide superior video experience by giving clients a chance to receive the video quality based on their channel condition and buffer status, resulting in better quality of experience (QoE). To achieve greater spectral efficiency, the use of multiple radio access technologies (Multi-RAT) or LTE-WiFi aggregation (LWA) resource allocation for video delivery is also being promoted. Moreover, most of the metrics used to measure the quality of mobile video networking are based on quality of service (QoS)/QoE, which are targeting on the human perception on streamed/distributed videos, while there are more and more uploaded videos are to be analyzed by machines without human viewing. Therefore, a new type of video quality assessment scheme which measures the quality of contents (QoC) for video

analytics needs to be adopted. In this special issue, we have collected papers which address all aspects of mobile video networking mechanisms, from application, transport, network and MAC/PHY layers of future mobile networks.

More specifically, emerging immersive media services, such as 360 VR/AR videos and 3D point cloud, enable customers to feel being personally at the scene with personalized viewing perspective and enjoy real-time full interaction. A 3D point cloud video transmission demands a huge amount of data bandwidth, and causes high complexity in the scattered random distribution of the spatial distribution, which brings great challenge to the storage and transmission system. These data cannot be directly encoded with the existing H.264/H.265 and/or VR/AR compression schemes. Hence, more advanced compression coding techniques are needed to significantly reduce the amount of data, combining with the unique consumption characteristics of immersive media. The paper entitled "Introduction to Point Cloud Compression" presents a wonderful review of static and dynamic point cloud compression techniques to overcome the challenges of high bandwidth demands and dynamic users' viewing perspectives.

The paper entitled "Adaptive Mobile Video Delivery Based on Fountain Codes and DASH: A Survey" first provides a thorough overview of several typical forward error correction (FEC) codes which can be used for combating the noisy wireless channels. A novel delay-aware fountain (DAF) coding technique is then proposed to maximize the code word length under the constraint of a given delay. Two extensions of DAF are also proposed; one is the unequal error protection DAF (UEP-DAF) for improving the video PSNR and the other is the model predictive control DAF (MPC-DAF) for reducing the computational complexity. This paper also provides an excellent review of video streaming technologies, including the dynamic adaptive streaming over HTTP (DASH) and DASH over multiple content distribution servers (MCDS-DASH) in detail. Finally, based on MCDS-DASH that adapts video bitrate at the block level to alleviate video fluctuation, a novel approach to integrating fountain codes with MCDS-DASH is proposed to achieve unprecedented high throughput.

On-demand video streaming is already the major video content platform and private broadcast is also getting more popular. In addition to fast growing of streaming videos, there are also growing demands of VR and AR data traffic, which calls huge amount of wireless resource to satisfy users' QoE. Therefore, it is necessary to apply the wireless transmission scheme that has better spectral efficiency and the video rate adaptation to provide the best quality to the users. The paper entitled "DASH/DASH-VR Video Multicast Systems" investigates the state-of-the-art VR video multicast along with adaptive video quality control over LTE mobile systems. The QoE enhanced algorithm has the procedures of deciding the video rates, resource allocations, and user groupings.

The Internet of Things (IoT) based video networking applications, such as environmental monitoring, healthcare, surveillance, event recognition and traffic control, are amongst the most commonly deployed applications over the Internet. Since the delivery of video can be destined to a machine or human, it is important to distinguish video quality between the two, i.e., QoE for video services involves human visual system. However, what will involve a machine or process? To distinguish between the two, the paper "How to Manage Multimedia Traffic: Based on QoE or QoT?" defines a new concept of acceptable quality of things (AQoT) which involves IoT devices and their applications. The proposed AQoT metric aims at minimizing bandwidth without compromising quality in IoT devices.

Network service operators are expected to deliver significantly more network traffic with the growing video services. Media cloud inheriting the advances from cloud computing, has emerged as a promising computing paradigm to provide novel multimedia services with satisfied QoS and reduced cost. Machine learning, which has been intensively applied in various multimedia applications, can provide a natural solution to address several challenges in media cloud. In particular, machine learning represents the set of algorithms that can progressively improve the performance on a specific task without being explicitly programmed. The article entitled "When Machine Learning Meets Media Cloud: Architecture, Application and Outlook" presents a wonderful survey of how machine learning addresses the challenges in media cloud, from the infrastructure and platform perspectives.

As we conclude the introduction to this special issue and the contents of six papers, we would like to thank all authors for their valuable contributions. We also express our deep gratitude to all the reviewers for their timely and insightful comments on all submitted papers. It is our sincere expectation that the contents in this special issue are informative and useful from various aspects related to next generation mobile video networking.