Preface

Multimedia communication involves software and hardware design for capturing, processing, storing, disseminating, editing, reusing, and managing different types of media sources over a variety of devices and transmission media to satisfy different application requirements. Therefore, there is an inherent need to present frameworks, techniques, standards, and networks that adopt multimedia communication technologies to a range of networking applications. Nowadays, several techniques are available for multimedia transmission over high-speed and IP networks. There are also various media synchronization control techniques such as group synchronization control schemes. To this end, there is a need for new control schemes that will achieve high quality of media synchronization and keep the interactivity high. For another perspective, in smart surveillance systems, automated video analysis is required. One the challenging aspects of automatically understanding a scene is the presence of contextual information. Contextual information is required in order to correctly interpret the actions. The extraction of contextual information must be considered in several aspects such as spatial, motion, depth and co-occurrence, depending on applications.

In another framework, there is a need to propose new advanced techniques for robust video coding and adaptation of compressed streams in multipath communications environments. To this end, we need also multiple description video adaptation schemes to operate at network edges. There is also a need to present new video broadcasting protocols for streaming applications. Besides, novel techniques must be deployed for multimedia transmission in wireless sensor networks (WSNs) as these networks can bring many possibilities for innovative applications that cannot be addressed by conventional wireless network technologies. From another perspective, we need innovative techniques that can be used in conjunction with current multimedia techniques in order to improve the quality of multimedia experience.

BOOK OBJECTIVES AND INTENDED AUDIENCE

This book aims to provide relevant theoretical frameworks and the latest empirical research findings in the area of multimedia communication systems. The main purpose of the book is to promote the discussion of and present advances in multimedia techniques, standards, and networks for a range of networking applications. Actually, the adoption of multimedia communication technologies to current networks and applications can solve a variety of problems apart from the well-researched multimedia sharing related problems such as multimedia transmission over wireless sensor networks. Furthermore, the role and issues arising from the deployment of multimedia communication systems are investigated. Such issues are group synchronization control, video coding, video transmission, video broadcasting, multimedia
Quality of Experience (QoE), QoE estimation methods and techniques, Quality of Service (QoS)/QoE learning algorithms, QoE measurements and analysis for Video over IP (VoIP) services.

The ultimate goal of this publication is to be a scholarly edition suitable for practitioners and researchers in the area of multimedia communication with a focus on video coding, video transmission, video broadcasting, video analysis, and QoE ecosystems.

**ORGANIZATION OF THE BOOK**

After more than a decade of development, substantial advances have been achieved in the diverse areas of multimedia communication, and a number of promising research directions are springing up. Following an open call for chapters and a few rounds of extensive peer-review, 12 chapters of good quality have been finally accepted, ranging from technical review and literature survey on a particular topic and solutions to some technical issues to implementation of a multimedia communication system, as well as perspectives of promising applications. All the contributions have been reviewed, edited, processed, and placed in the appropriate order to maintain consistency with the intention that any reader irrespectively of his/her level of knowledge in multimedia communication systems would get the most out of it.

According to the scope of those chapters, this book is organized into five sections. The organization ensures the smooth flow of material as successive chapters are built on prior ones. In particular, the topics of the book are the following:

- User and network QoS requirements for multimedia communication
- Adaptive media coding and multimedia streaming
- End-system support for multimedia communication
- Multimedia transmission over content delivery networks (CDNs) and IP networks
- Multimedia optimization over heterogeneous wireless and wired networks
- Group synchronization control schemes
- Multiple description video coding
- Advanced video coding
- Data partitioning (a promising video source-coding technique)
- Automated video analysis for surveillance applications
- Video broadcasting protocols
- Video-on-demand
- Video streaming
- Multimedia transmission in Wireless Sensor Networks
- Multimedia Quality of Experience (QoE) ecosystem
- QoE estimation methods and techniques
- Quality of Service (QoS)/QoE learning algorithms
- QoE measurements and analysis for VoIP services
- QoE for Mobile TV
- Networked Music Performance (NMP) systems
- Digital Cinema specification and systems
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Below, we briefly summarize the chapters in each section.

Section 1 (Chapter 1 to Chapter 2) presents fundamental issues on multimedia networking and focuses on issues for achieving multimedia optimization over heterogeneous wireless and wired networks. It also considers group synchronization control schemes.

- In Chapter 1 titled “Next steps in Multimedia Networking”, the author presents fundamental issues on multimedia networking such as multimedia applications and services, network and user QoS requirements, bandwidth on demand, multicasting, media synchronization, adaptive media coding, multimedia streaming, and end-system support for multimedia communication. He deals with content delivery networks (CDNs) and concentrates on issues for achieving multimedia optimization over heterogeneous wireless and wired networks. The author also presents the main approaches for QoS guarantees over the Internet. He includes the important aspects that have significantly impacted the enhancements to the basic Internet architecture and its associated protocols. In addition, he discusses briefly future Internet architectures and future research directions in multimedia networking.

- In Chapter 2 titled “Media Synchronization Control in Multimedia Communication”, the authors explain media synchronization control. They survey media synchronization control techniques and classify them. Furthermore, they compare group synchronization control schemes and propose a new control scheme called the dynamic local lag control in joint musical performance. The proposed scheme has severe requirements on high quality of media synchronization and high interactivity. In the performance, multiple users play their respective same or different types of musical instruments together. However, the media synchronization quality and interactivity may seriously be deteriorated owing to the network delay. By Quality of Experience (QoE) assessment, they demonstrate that the new control can achieve high quality of media synchronization and keep the interactivity high. Finally, they discuss future research directions on media synchronization control.

Section 2 (Chapter 3 to Chapter 5) addresses video coding and automated video analysis techniques.

- In Chapter 3 “Multiple Description Coding for Multipath Video Streaming”, the authors consider robust video coding and adaptation of compressed streams in multipath communications environments, using Multiple Description Coding (MDC). They present a review of Multiple Description (MD) video coding by covering different video coding approaches. They describe different path diversity topologies and MDC networking applications including MD video adaptation schemes to operate at network edges, for robust video streaming. In addition, they describe a multi-loop architecture for Advanced Video Coding (AVC) to prevent drift distortion accumulation. Finally, they present a simulation study of MDC for AVC to evaluate the coding efficiency, the effects of distortion propagation and streaming performance in lossy networks.

- Chapter 4 titled “Data partitioning: A video source-coding technique for layered video and error resilience over multimedia networks” presents Data Partitioning - a source-coding technique that has existed in the standardized hybrid video codecs up to recent times. In essence, it is a method of prioritizing coding data, resulting in video layers that can be separately communicated across an error-prone network. As the authors discuss, it differs from scalable video because the output from conventional, single-layer encoders can be converted to multi-layer form, rather than
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requiring specialist codec extensions. The authors show that the methods of forming the partitions are so far employed: dividing transformed, residual coefficients into two or more layers; and dividing coded data by function into headers, intra-, and inter-coded residuals to form three or more layers. It is shown how layering naturally combines with protection by channel coding. Used as an error resilience tool, data partitioning presents a low overhead method, suitable for benign as well as bad channels. And in the three-layer variety, error concealment at the decoder can significantly aid the reconstruction of damaged video frames. This Chapter will be of particular interest to developers charged with making a mobile, low-latency, or interactive video streaming application robust, as they can select from the data partitioning methods and apply them to open source code of the recent High Efficiency Video Coding (HEVC) codec standard.

- Chapter 5 titled “Adding context information to video analysis for surveillance applications” addresses smart surveillance systems that detect and track moving objects, classify these objects and detect their activities. Obviously, automatic object detection is currently being embedded in smart surveillance systems. To achieve a higher level of semantic scene understanding, the objects and their actions have to be interpreted in the given context. One of the challenging aspects of automatically understanding a scene is the presence of contextual information. Contextual information is required in order to correctly interpret the actions. The authors explore the extraction of contextual information in several aspects such as spatial, motion, depth and co-occurrence, depending on applications. They show that using contextual information enables the automated analysis of complicated scenarios that was previously not possible using conventional object classification techniques.

Section 3 (Chapter 6 to Chapter 7) focuses on video broadcasting, and multimedia transmission in wireless sensor networks (WSNs)

- In Chapter 6 titled “Video Broadcasting Protocol for Streaming Applications with Cooperative Clients”, the authors propose a new transmission protocol denoted as Harmonic-Based Peer-to-Peer Broadcasting (HPB) to release the burden of Harmonic Broadcast (HB) by dispersing a large portion of workload over a number of clients denoted peer servers. As the bandwidth requirement of each segment in HB is different, the authors first develop a segment placement algorithm to balance the workload among peer servers. Then, they study the dynamic nature of peer-to-peer (P2P) paradigm on the design of the system. An analytical model is developed to determine the optimal number of peer servers required for the system under certain level of availability such that the workload of the central server can reach a target level. Their results show that the workload of central server can be significantly reduced.

- Chapter 7 titled “Multimedia Transmission in Wireless Sensor Networks” presents the state of the art of multimedia transmission in wireless sensor networks, covering topics such as routing, error control, congestion avoidance, real-time delivery, compression and QoS, potentially supporting in the development of wireless multimedia sensor networks. It is noteworthy that wireless sensor networks bring many possibilities for innovative applications that cannot be addressed by conventional wireless network technologies.

Section 4 (Chapter 8 to Chapter 10) focuses on Quality of Experience and Quality of Service.
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- In Chapter 8 titled “Multimedia Quality of Experience”, the authors introduce the overall concept of Multimedia quality of experience (QoE) over the Internet. They present all the elements of multimedia QoE ecosystem and emphasize their roles in determining the user satisfaction. They also present different multimedia transmission components and how these components contribute in successful transmission of the media content. In addition, they present some key performance indicators relevant to the multimedia QoE with more emphasis on network and application level indicators. Furthermore, they present different QoE estimation methods and techniques along with QoS/QoE learning algorithms.

- Chapter 9 titled “QoE measurements and analysis for VoIP services” presents a detailed description about the process to perform comparative quality evaluations of multimedia services from both QoS and QoE perspectives. In particular, the authors present a comparative study of two voice codecs employed by two well-known VoIP applications, namely Skype and Jitsi, analyzing the provided quality from two perspectives: objective and subjective evaluations. To this end, several network metrics have been taken into account. In addition, the participants in this study completed different quality surveys in order to obtain their opinion about the evaluated services. Concretely, 60 quality tests with 60 subjects have been performed in a controlled wired scenario. The obtained results suggest a clear relationship between QoS and QoE.

- Chapter 10 titled “Quality of Experience factors for Mobile TV users” helps the professionals involved in the Mobile TV industry to methodically engineer the Quality of Experience (QoE) of mobile TV users. It investigates the factors that influence the QoE of mobile TV users. Such factors are involved in the design of customer experience improvement programmes of mobile TV industry. The author describes the ways in which customers-users can be directly engaged in the design and improvement process. He also proposes a comprehensive road-map for improving the QoE of mobile TV users. The proposed research-based road-map can be used by professionals (e.g., content providers, advertisers) of the mobile TV industry for improving their customer experiences. The road-map can help to bridge gaps between other studies that have either focused on QoE for mobile TV or have addressed frameworks for mobile TV.

Section 5 (Chapter 12 to Chapter 11) presents a new platform for networked music performance and explains the Digital Cinema chain from production to distribution.

- Chapter 11 titled “Facilitating open standards and open source software to assembly a platform for Networked Music Performance”, presents a Networked Music Performance (NMP) system by tailoring and re-using open source software components. Initially, the authors provide an overview of NMP research, and delineate the design criteria of NMP system development. Following, they describe the network protocols involved in videoconferencing. Then, they present a number of relevant open source software initiatives for implementing these protocols. These initiatives are also compared for their suitability for NMP system development. Finally, the authors describe a baseline NMP platform that can serve as a test-bed for further research on distributed ensemble performance and remote musical interactions.

- Chapter 12 titled “A review of the digital cinema chain – from production to distribution” provides a brief overview of the Digital Cinema (DC) specification and discusses how JPEG 2000 was utilized within this specification. The current status of digital cinema was surveyed with a focus on the compression part of the DC system. To make the system practical and economic,
various coding techniques have been applied to compress DC data for archive and distribution purposes. This chapter considers standardization process for archival applications and presents features used for shot cut detection that are robust against the artifacts in film material.

This book impacts the field of multimedia communication technologies by presenting a new synchronization control scheme. It also addresses state-of-the art video coding and video analysis techniques. In addition, it proposes a new transmission protocol denoted as Harmonic-Based Peer-to-Peer Broadcasting (HPB) to release the burden of Harmonic Broadcast (HB) by dispersing a large portion of workload over a number of clients denoted peer servers. The book presents the state of the art of multimedia transmission in wireless sensor networks, covering topics such as routing, error control, congestion avoidance, real-time delivery, compression and QoS, potentially supporting in the development of wireless multimedia sensor networks. It also presents different QoE estimation methods and techniques along with QoS/QoE learning algorithms. Moreover, it presents a comparative study of two voice codecs employed by two well-known VoIP applications, namely Skype and Jitsi, analyzing the provided quality from two perspectives: objective and subjective evaluations. Finally, the book presents a number of relevant open source software initiatives for implementing protocols involved in videoconferencing. It also describes a baseline Networked Music Performance (NMP) system/platform that can serve as a test-bed for further research on distributed ensemble performance and remote musical interactions.

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