

Introduction

Multimedia is probably one of the most overused terms of the 90s (for example, see [Sch97]). The field is at the crossroads of several major industries: computing, telecommunications, publishing, consumer audio-video electronics, and television/movie/broadcasting. Multimedia not only brings new industrial players to the game, but adds a new dimension to the potential market. For example, while computer networking was essentially targeting a professional market, multimedia embraces both the commercial and the consumer segments. Thus, the telecommunications market involved is not only that of professional or industrial networks—such as medium- or high-speed leased circuits or corporate data networks—but also includes standard telephony or low-speed ISDN and DSL. Similarly, not only the segment of professional audio-video is concerned, but also the consumer audio-video market, and the associated TV, movie, and broadcasting sectors.

As a result, it is no surprise when discussing and establishing multimedia as a discipline to find difficulties in avoiding fuzziness in scope, multiplicity of definitions, and non-stabilized terminology. When most people refer to multimedia, they generally mean the combination of two or more continuous media, that is, media that have to be played during some well-defined time interval, usually with some user interaction. In practice, the two media are normally audio and video, that is, sound plus moving pictures.

One of the first and best known institutes that has studied multimedia is the Massachusetts Institute of Technology (MIT) Media Lab in Boston, Massachusetts. They have been conducting research work in a wide variety of innovative applications, including personalized newspapers, life-sized holograms, or telephones that chat with

callers [Bra87]. Today, many universities, large-scale research institutes, and industrial organizations work on multimedia projects.

From the user's perspective, "multimedia" means that information can be represented in the form of audio signals or moving pictures. For example, movement sequences in sports events [Per97] or an ornithological lexicon can be illustrated much better with multimedia compared to text and still images only, because it can represent the topics in a more natural way.

Integrating all of these media in a computer allows the use of existing computing power to represent information interactively. Then this data can be transmitted over computer networks. The results have implications in the areas of information distribution and cooperative work. Multimedia enables a wide range of new applications, many of which are still in the experimental phase. Please remember that the World Wide Web (WWW) took its current form only at the beginning of the 90s. On the other hand, social implications inherent in global communication should not be overlooked. When analyzing such a broad field as multimedia from a scientific angle, it is difficult to avoid reflections on the effects of these new technologies on society as a whole. However, the sociological implications of multimedia are not the subject of this book. We are essentially interested in the technical aspects of multimedia.

1.1 Interdisciplinary Aspects of Multimedia

If we look at applications and technologies, there is a strong interest in existing multimedia systems and their constant enhancement. The process of change that takes place in the background in various industrial sectors should not be underestimated:

- The telecommunications industry used to be interested primarily in telephony. Today, telephone networks evolve increasingly into digital networks that are very similar to computer networks. Switching systems used to be made up of mechanical rotary switches. Today, they are computers. Conventional telephones have been evolving into computers, or they even exist as pure software in the form of "IP telephony."
- The consumer electronics industry—with its "brown ware"—contributed considerably to bringing down the price of video technology that is used in computers. Optical storage technology, for example, emerged from the success of CD players. Today, many manufacturers produce CD drives for computers and hi-fi equipment or television sets and computer screens.
- The TV and radio broadcasting sector has been a pioneer in professional audio-video technology. Professional systems for digital cutting of TV movies are commercially available today. Some of these systems are simple standard computers equipped with special add-on boards. Broadcasters now transmit their

information over cables so it is only natural that they will continue to become information vendors over computer networks in the future.

- Most publishing companies offer publications in electronic form. In addition, many are closely related to movie companies. These two industries have become increasingly active as vendors of multimedia information.

This short list shows that various industries merge to form interdisciplinary vendors of multimedia information.

Many hardware and software components in computers have to be properly modified, expanded, or replaced to support multimedia applications. Considering that the performance of processors increases constantly, storage media have sufficient capacities, and communication systems offer increasingly better quality, the overall functionality shifts more and more from hardware to software. From a technical viewpoint, the time restrictions in data processing imposed on all components represent one of the most important challenges. Real-time systems are expected to work within well-defined time limits to form fault-tolerant systems, while conventional data processing attempts to do its job as fast as possible.

For multimedia applications, fault tolerance and speed are the most critical aspects because they use both conventional media and audio-video media. The conventional data (e.g., control information, metadata) must be delivered in a reliable fashion in order to assist audio-video data. The data of both media classes needs to get from the source to the destination as fast as possible, i.e., within a well-defined time limit. However, in contrast to real-time systems and conventional data processing, the elements of a multimedia application are not independent from one another. In other words, they must be integrated and synchronized. This means that in addition to being an integrated system, composed of various components from both data types, there has to be some form of synchronization between these media.

Our goal is to present the multimedia application and systems from an integrated and global perspective. However, as outlined above, multimedia applications and systems include many areas, hence we have decided to split the content about multimedia system fundamentals into three books. The first book deals with media coding and content processing (*Ralf Steinmetz, Klara Nahrstedt, "Media Coding and Content Processing", Prentice Hall 2002*). The second book describes media processing and communication (*Ralf Steinmetz, Klara Nahrstedt, "Multimedia Systems", Springer Verlag 2004*). The third book presents topics such as multimedia documents, security, and various applications (*Ralf Steinmetz, Klara Nahrstedt, "Multimedia Applications and Security", Springer Verlag 2004*).

1.2 Contents of This Book

This book is on *Multimedia Applications*, presenting fundamental information and properties of multimedia document handling, multimedia security, and various aspects of multimedia applications. The primary objective is to provide a comprehensive panorama of multimedia technologies, and their integration. Understanding of the close relationship among the wide range of disciplines and components that make up a multimedia system is a prerequisite for the successful building of multimedia systems and their applications.

The book is structured as a *reference book*, so that it allows fast familiarization with all issues concerned. However, it can be also used in educational process as an introductory book for a multimedia systems class in computer science and related disciplines. Solid introductory background on concepts in media coding as well as basic system and service issues would be very helpful.

1.3 Organization of This Book

As mentioned above, this book as an integral part of a comprehensive overview and practical view on multimedia technologies. Figure 1-1 shows the global view of the most important multimedia fields spanning across the three volumes. The overall organization attempts to explain the largest dependencies between the components involved in terms of space and time. We distinguish between:

- *Basics*: One of the most important aspects is a media-specific consideration, in addition to the computer architecture for multimedia systems.
- *Systems*: This group of multimedia fields relates system areas such as processing, storage, and communication, and their relevant interfaces.
- *Services*: The multimedia fields such as content analysis, document handling, security and others represent important multimedia functions that rely and are implemented on the basis of system components.
- *Applications*: The group of multimedia fields such as design, learning and user interfaces studies the type and design of applications and the interface between users and multimedia applications and systems.

In this book, we emphasize the field of multimedia applications, and some service and system aspects (see Figure 1-1). Thus, the book first covers generic multimedia database management systems, programming issues, security aspects, and document handling. The book then deals with more dedicated, application-related issues: media design, general user-interface topics, and multimedia learning. Finally, we discuss various possible applications and present a case study.

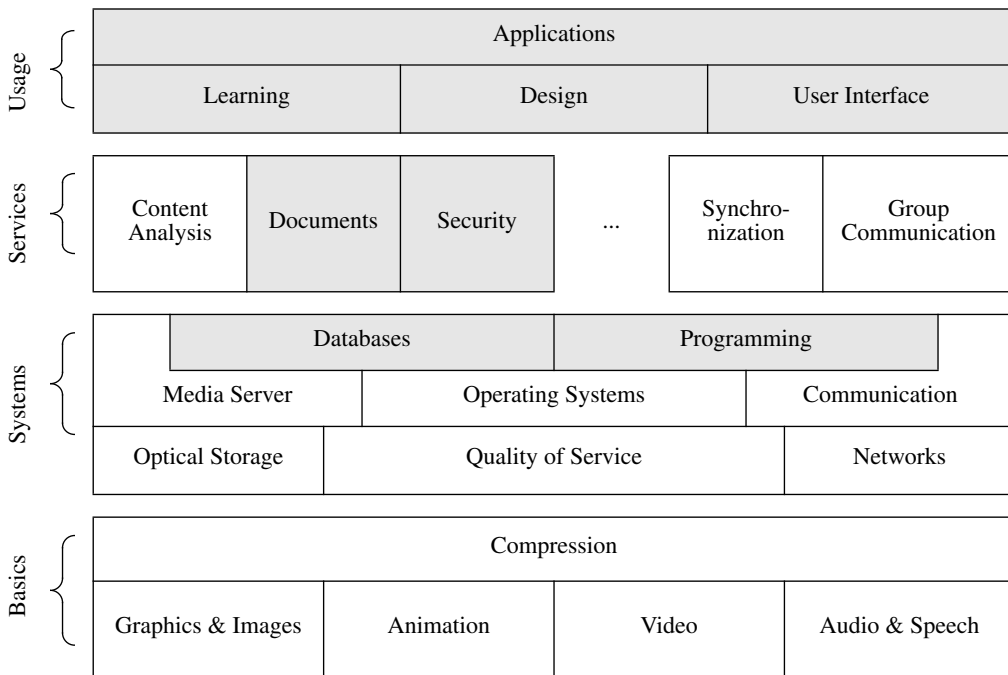


Figure 1-1 Global presentation of most important fields, as discussed in this book.

1.3.1 Systems and Services for Multimedia Applications

The first topic of this book are multimedia database management systems (MMDBMS), which are very important for the efficient handling of multimedia data and are intended to appropriately support multimedia applications.

While MMDBMSs allow for the management of a large amount of multimedia data, there are several possibilities how the data can be represented and accessed by the developers of multimedia applications. Therefore, we address programming issues at different levels of abstraction, covering some object-based and object-oriented approaches.

More and more current multimedia applications are executed on several computers within cooperative tasks in networked environments. The trend towards networking, particularly for communication over public networks, increases the risk of damage caused by intruders or malicious users. The acceptance of new information technology systems depends largely on the security offered by the distributed application. Consequently, the book covers topics related to technical data protection and data security, which are becoming increasingly important. Thereby, the focus is on digital watermarking of different media types.

The subsequent chapter is dedicated to the handling of multimedia documents, which are usually composed of a set of various media types. These documents can be generated dynamically at presentation time, and are presented by a multimedia user interface.

1.3.2 Multimedia Applications

The design of commercially successful multimedia applications, which use the possibilities offered by new media, involves new requirements to graphics design. Thus, one chapter of the book deals with issues regarding the design goals to be achieved by each medium, and the available design tools. In particular, we concentrate on typography and layout issues, and the production of images.

Subsequently, the book introduces a series of general aspects for the design of multimedia interfaces in general, and graphical user interfaces (GUIs) in particular. An important property of such an interface is the use of graphical or typographic means to present data and operations, since visualization and graphical interaction form the two sides of a GUI. Based on an example, conflicts in the design of user-friendly user interfaces are explained, whereby various principles and their benefits and drawbacks will be described.

The introduced design and user interface principles are supposed to help in the development of more appealing and user-friendly applications, such as for the purpose of multimedia learning. The latter application area has gained increasing interest by schools and companies recognizing the potential pedagogic and didactic benefit of multimedia learning environments, which allow for a wide spectrum of representation forms. Hence, the book covers learning theories, learning systems, and eLearning standards.

Applications are of central significance for users of multimedia systems wanting to interact with multimedia data. In the case of multimedia learning, e.g., the user might be a teacher who wants to create a presentation combining audio, video, and animation. There is a large number of existing applications for creating, modifying, viewing, and interacting with multimedia data. This book introduces a representative set of this wealth and variety of multimedia applications, and presents a case study.

1.4 Further Reading About Multimedia

There is an extensive literature on all aspects of multimedia systems. Some journals frequently publish multimedia systems and networking research results such as *IEEE Multimedia*, *IEEE Transactions on Multimedia*, *ACM/Springer Multimedia Systems Journal*, and *Kluwer Multimedia Tools and Applications Journal*. Many other journals have special issues on this subject such as the *IEEE Journal on Selected Areas on Communication*, *Elsevier Computer Communication Journal*, and others.

In addition to a large number of system and networking national and international conferences and workshops, that have special tracks or sessions on multimedia system research, there are several international conference focussed on multimedia systems only, in particular: *ACM Multimedia Conference* (the first conference took place in Anaheim, California, August 1993), *IEEE International Conference on Multimedia and Expo* (the first conference was held in May 1994), *SPIE Multimedia Computing and Networking* (MMCN), *ACM Network and Operating System Support for Digital Audio and Video* (NOSSDAV), and *International Workshop on Multimedia Interactive Protocols and Systems* (MIPS, former IDMS).