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Tim Morris

Multimedia Systems

**Delivering, Generating and Interacting
with Multimedia**

Springer

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Preface

What are Multimedia Systems?

This book is intended to expose you to multimedia in its widest sense. The popular understanding of this subject is that it is the integration and delivery of text, images and sound, usually on a desktop PC. We are all familiar with examples from the extensive range of multimedia titles available on CD-ROM. These give us a rich set of sensory experiences, and, perhaps more important, we are free to navigate our way through the information as we choose. However, this is only half of the story since these titles can only *deliver* information.

A recent IEEE publication (Chen, 1997) suggested that multimedia should include all systems that integrate diverse media, in standalone or networked applications, either for presentation or communication. Diverse media implies visual and aural information (text, static and moving pictures and sound). Networking could be realised using intranet or telephone links. Presentation systems would imply the multimedia delivery systems with which we are all familiar. Communication implies a two-way interaction with the computer. So as well as transmitting information, multimedia systems should also be able to understand and react to information presented to them using the same set of diverse media (such as typed text, pictures and sound).

The aims of this book are therefore twofold:

1. to introduce the methods of generating, manipulating and delivering multimedia data;
2. to give an overview of current research that will illustrate what tasks multimedia systems will soon be achieving in the realm of human and computer interaction.

Multimedia Delivery Systems

A multimedia delivery system can be any computer system capable of presenting multimedia information. This implies that the computer system has a graphics subsystem that is able to display high resolution images and also has a throughput rate sufficiently high to present moving images on screen. The computer system will also have a sound subsystem whose throughput requirements are less demanding but must nevertheless deliver realistic sound data. At one time this would have meant a computer system with significant hardware additions, at present, an entry-level computer is likely to have these capabilities.

The delivery system must also have some means of receiving input from the operator. Typically this will be via a keyboard or mouse, but voice input is becoming more common.

The delivery system will be of limited use without data to deliver and the software to drive it. The archetype example is the CD-ROM. A CD may contain a game, an encyclopaedia, a travel guide or any other data, plus the software to browse that data. More esoteric examples can be found. A national chain of supermarkets has a computer system with which customers are able to browse a small database of recipes and vouchers. A local transport authority has a publicly accessible information booth that provides data regarding bus routes and timetables. Systems such as these two have very different hardware requirements to a computer system that is to sit on a desk in the home, classroom or office. But these systems also have the same delivery characteristics as a desktop system: the user has some control over what data he is presented and how he is able to navigate through the available information.

Multimedia Interactivity

All multimedia systems are interactive to a certain, limited, degree. If this were not so then we would be unable to navigate a path through the data. However, the currently available multimedia systems have extremely limited channels of interactivity. Typically, we may use the mouse, keyboard or perhaps voice input to control the system. The systems themselves are also limited, the majority being desktop PCs, with some exceptions. A major strand in this book will be to examine novel multimedia interactions. The single outstanding characteristic of these systems is that they allow communication from the computer user to the computer to be via any more natural channel than the mouse or keyboard. This could be using voice control, using gestures, by the computer “reading” sign language or lips. Example systems are being developed by most major hardware and software manufacturing corporations, whether this is to control domestic appliances, to simplify office work patterns or to deliver information on the shop floor.

The look and feel of the computer is also changing. If the aim of developing multimedia interactivity is to facilitate human/computer interaction, then the computer can be removed from the desktop and there may be no need for a mouse or keyboard, or perhaps even the screen. Ultimately, using the multimedia computer will seem as natural as talking to a friend.

Course Background

This book was developed for a single semester course of the same name given to advanced undergraduate and postgraduate students in the Department of Computation at UMIST. None of the students who attend the course has had any previous exposure to courses dealing with multimedia systems. Although some students have attended modules dealing with computer vision, computer graphics or speech understanding, these are not prerequisites for the course which is entirely self contained.

The course has been delivered using a mixture of formal lectures, tutorials and assessed exercises over a period of 12 weeks. Some of the students attending the course have a stronger background in mathematics than others. Rather than exclude any because of their prior knowledge, the specialist topics required by the course are presented in appendices.

The Book's Organisation

My intention in this book is to do more than equip students to design multimedia delivery systems. I also intend to outline what multimedia computers could be doing five years from now. Therefore the book is divided into two parts. Part I (Chapters 2 to 4) will discuss how multimedia delivery systems are designed and constructed. The description is necessarily brief and the interested reader is referred to more specialist books on each topic. Part II (Chapters 5 to 11) will discuss methods of realising true multimedia computing; hence the book's subtitle: generating and interacting with multimedia.

Part I starts with an examination of human perception and data coding (see Chapter 1). The rationale for this is that if we are to present information in a pleasing and realistic fashion, then we ought to be able to specify what pleasing and realistic actually mean. In perceptual terms, this implies that we must examine the typical human's ability to see images and video and to hear sound to find what is the resolution of our visual and aural systems. This then dictates the resolution we must have for the images, videos and sounds that our multimedia systems must deliver if they are to look realistic. Methods of storing these objects are also examined.

The next chapter presents an examination of the methods with which multimedia delivery systems are assembled. How is the raw data organised and how is the reader's path through the data facilitated? The first half of the book concludes with an examination of the hardware used in multimedia systems, what are the requirements of a multimedia computer and what peripheral devices are required to capture, manipulate and present multimedia data. The typical multimedia computer is presented, along with alternatives and their areas of application.

The second half of the book examines a number of topics, most of which are still based in the laboratory, some of which are beginning to appear as commercial products. These are perceptual interfaces. They include systems able to understand human speech, systems able to synthesise speech, systems able to observe the user's eyes and interpret direction of gaze as a command to move the cursor, systems able to recognise and interpret gestures made by the user and systems able to respond to completely unconstrained input. In short, the input to these systems is via any channel other than the keyboard or mouse. A chapter is devoted to each topic. The penultimate chapter is concerned with the generation of visual feedback. In the same way as speech synthesis was examined as a method of providing aural feedback, visual feedback is necessary in particular systems.

The book has several appendices that contain information that is useful but not directly relevant to the course. An overview of HTML (hypertext mark-up language) is presented. This is useful as it is a vehicle for presenting multimedia systems and has been used by students following the course in designing websites as an assessed exercise. The overview is necessarily brief and the reader must be referred to other texts for a more complete description. All of the specialist mathematical techniques are described in a second appendix. Finally, a discussion of some publicly available software is given, this is restricted to relevant software that will manipulate images, sounds and video sequences.

Supplementary Materials

The text is supplemented by information available on an associated website: www.co.umist.ac.uk/~dtm/software.html. This material includes transparencies and source material used in assessments.

Bibliography

Tsuan Chen (1997) The past, present and future of multimedia signal processing. IEEE Signal Processing 14.

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