

4 Multimedia System

Chapter Objectives

The objective of this chapter is to understand the multimedia system, which occupies the most important position in the current computer system. Likewise, the basic technology that implements the multimedia system will be studied.

- ① Understand the meaning of multimedia and the multimedia service outline.
- ② Understand the technology that supports the multimedia system, in particular audio and image related technologies.
- ③ Consider future multimedia-related application systems.

Introduction

The computer, which was created as a calculating machine, has seen its application range extended without limits, and audio and image processing, which formerly were considered as its weak points, have been made possible.

In this way, the system in which simultaneous processing of almost all human information transmission means is possible, is generically known as the multimedia system.

Here, a brief description of the technology supporting the multimedia service and multimedia processing, which have been attracting attention recently, is made.

4.1 What is multimedia?

Use of the word "multimedia" began in 1993 as a result of the announcement of the "Information superhighway plan" by the U.S. government. This plan aimed at covering the entire U.S. territory with optical fiber networks in order to implement a bi-directional and high-level communication infrastructure to enable mutual understanding.

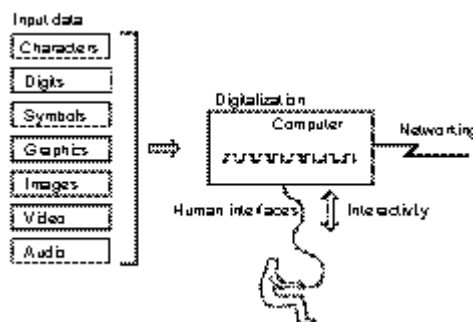
Multimedia is a medium, a method which has the following four factors:

- Digitalization
Through the digitalization of audio, images and other information besides characters and numeric values, high-quality and easy-to-process information can be integrated and used.
- Networking
Through the interconnection of computers using communication lines such as optical fiber, large amounts of information can be exchanged accurately at high speed.
- Interactivity
As with the telephone, bi-directional interactive processing with a high response level can be performed.
- Inclusion of human interfaces
Diverse types of information can be naturally and easily handled.

Overall, the multimedia system is a processing system that is based on multimedia technology, performs the digitalization of characters, digits, symbols, graphics, images, video and audio, exchanges information in real time using communication lines, etc. and can be easily operated by anybody (Figure 4-1-1).

Figure 4-1-1

Multimedia system outline



4.1.1 Multimedia service

The service provided to the users, based on the multimedia system, whose use in diverse fields is expanding along with the progress of computer and network technology, is generically called multimedia service. Here, application examples of multimedia service in the most representative fields, which are listed below, will be explained.

- Business field
- Medical care field
- Publication field
- Education field
- Game field

(1) Business field

Today, since PDAs (Personal Digital Assistants) and notebook personal computers are equipped with communication functions, mobile computing, which enables information exchange with the computer network of one's company or with the Internet through public telephones or cellular telephones, has become popular.

Systems that handle characters and digits are simply information processing systems, but, in multimedia systems, conferences can be performed while watching the face of the person(s) one is speaking to, and animated images and other information can be handled.

(2) Medical care field

Medical systems in which diagnoses are efficiently made through collective management of patients' personal information and medical records, radiographs, etc. as well as in-home medical systems in which patients for whom it is difficult to go to the hospital or patients who live in remote places can be diagnosed while watching the computer display screen, have been put to practical use.

In the system that offers support for remote medical diagnosis, general hospitals of large scale and clinics which do not have the necessary medical facilities are connected through communication lines, enabling patients of small scale clinics located in remote places to receive medical treatment of the same level as that at general hospitals.

(3) Publication field

Nowadays, large amounts of information contained in dictionaries, encyclopedias, illustrated reference books, etc., have been recorded on commercialized CD-ROM. Conventional encyclopedias and illustrated reference books contained only information based on printed characters and pictures. However, in encyclopedias and illustrated reference books for multimedia use, besides the conventional character-based information, images of flower petals unfolding can be displayed and the calling of birds can be heard over the speakers.

(4) Education field

In the education field, multimedia has begun to be used to present research results, exchange opinions, etc., providing image information on display devices as well as audio information conveyed through microphones and speakers. Through this trial, mutual understanding between students of schools located in depopulated areas and students of inner city schools can be promoted without regard to distance.

Education using computers in this way is generically known as CAI (Computer Aided Instruction).

(5) Game field

In the game field, virtual reality is widely used. Virtual reality is a world that imitates the real world on the computer display, created through the comprehensive use of three-dimensional graphics and three-dimensional sounds.

Virtual reality is not limited to the game field; it is also used in flight simulators at airline companies, etc., for pilot training.

(6) Interface technology

GUI (Graphical User Interface) is used as a multimedia system interface. In GUI, the use of graphics called icons, which can be understood at first sight, is basic.

Figure 4-1-2

Icon example



(7) Software production technology

The application software (application programs) that handles multimedia is called a multimedia title. Here, besides character and numeral text data, multiple audiovisual data with different properties such as still images, animated images, audio, etc. is handled. In order to create multimedia titles, tools that enable easy manipulation of multimedia data become necessary. The tools (software) are called an authoring tool. Nowadays, authoring tools are widely used for the production of multimedia titles.

4.1.2 Platforms that implement the multimedia system

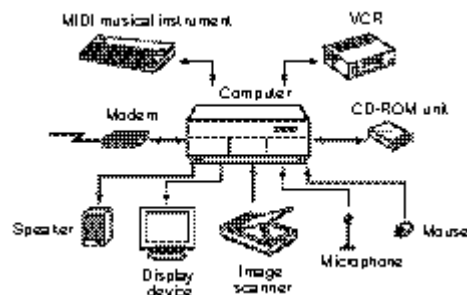
In many cases, we use the word "platform" to refer to the platforms of the stations. However, in information technology, it is used to refer to "the environment for the implementation of a given processing function." Here, the hardware configuration and software used as platforms for the implementation of multimedia systems will be explained.

(1) Hardware needed in multimedia systems

The hardware configuration required in order to implement a multimedia system in a personal computer is shown in Figure 4-1-3.

Figure 4-1-3

Example of a multimedia system hardware configuration



① Display device

Unlike conventional information processing systems that only handled characters and digits, in order to represent faithfully and beautifully multimedia data, which is complex and handles large amounts of information, high resolution displays are necessary. In order to support images of high picture quality, a resolution of $1,280 \times 1,024$ dots is required.

② Image scanner

Handy scanners and high-resolution image scanners are used. These devices input color pictures and other still images and process them as multimedia data.

③ Video equipment

Video cameras and VCRs are used. This viewdata can be recorded and played using QuickTime and other software.

④ Audio equipment

In video conferences, etc., that require interactive conversation, microphones and speakers are indispensable.

⑤ Digital sound equipment

In order to edit, create and play music using the computer, synthesizers and other MIDI musical instruments are necessary to input data.

⑥ Pointing device

As an input device, besides the keyboard, the mouse is widely used as a pointing device. The mouse is an indispensable input device in GUI environments.

⑦ Storage medium

In order to store enormous amounts of data, a storage medium of large capacity is necessary. Mainly hard disks, CD-ROMs, magneto-optical disks, etc., are used.

Currently, the mainstream is to use CD-ROMs as the medium to supply multimedia software. CD-ROMs have a large storage capacity (640 MB), are low-priced and convenient to carry about.

⑧ Modem

The modem is a device that connects telephone lines, dedicated lines and other analog lines with the computer in multimedia processing systems of communications network systems. It modulates digital computer signals into analog signals and performs the reverse, i.e., demodulation too. In order to connect a digital line, a DSU (Digital Service Unit) is necessary.

(2) Operating systems of multimedia systems

Among the operating systems of multimedia systems, the following can be mentioned:

- Apple's Macintosh OS + QuickTime
- Microsoft's Windows 95 as well as Windows 98 and Windows 2000
- Microsoft's Windows NT as well as UNIX

These operating systems are generically known as multimedia operating systems.

The following characteristics can be mentioned for Windows 95:

- GUI adoption
- Multi-task implementation
- Provision of network functions
- Provision of multimedia functions

① GUI adoption

In former operating systems, in order to operate the computer, commands were input through the keyboard. In GUI, the screen is composed of windows and icons, and operations are instructed to the computer through the manipulation of a pointing device such as a mouse (Figure 4-1-4).

② Multi-task implementation

In multimedia operating systems, multiple application programs can be switched in short intervals to simultaneously perform multiple processing. Switching of application programs is compulsorily performed by the operating system. This operation is called preemptive multi-tasking.

Figure 4-1-4
Example of GUI
(Window screen)



③ Provision of network functions

The rules for communication or data exchange between computers are called protocols. Through the use of communications software, multimedia operating systems are enabled to connect to networks supporting protocols, mentioned below:

- TCP/IP (Internet support)
- IPX/SPX (NetWare support)
- NetBEUI (Windows network support)

④ Provision of multimedia functions

The following multimedia playback software is equipped as standards in multimedia operating systems:

- Video for Windows (animated images playback)
- CD player (music data playback)
- Media player (Diverse media playback)

(3) Creation of multimedia titles

The application software for multimedia systems is called a multimedia title. In order to create multimedia titles, the following are necessary:

- Editing software
- Authoring tools

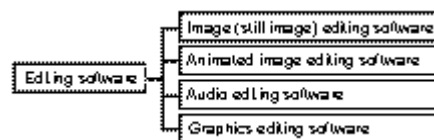
① Editing software

Editing software is software that creates still images, animated images, music and other media (material). Figure 4-1-5 shows the classification of this software.

a. Image (still images) editing software

Image (still images) editing software creates still image data, as well as edit and process data captured using a scanner. A large number of software packages handle this data as bitmap files, which are composed of sets of dots, and files in JPEG format.

Figure 4-1-5
Types of editing
software



b. Animated image editing software

Animated image editing software creates and edits videos, animated images, etc. Besides multimedia titles, there is a large number of software packages that enable the creation of videos, animated images, etc.

c. Audio editing software

Audio editing software is software that manages and controls sequencers, which automatically play synthesizers and other MIDI musical instruments, as well as create, edit and play MIDI data.

d. Graphics editing software

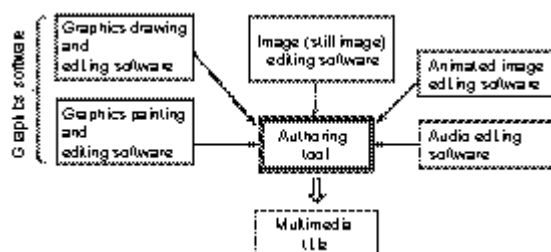
Graphics editing software is software that creates and edits graphical designs and illustrations. There is painting software that creates images using bitmaps, and drawing software that creates images through the combination of straight and curved lines. Furthermore, there is three-dimensional software that adds depth to input or created two-dimensional still images.

② Authoring tools

Authoring tools are software packages used to compile the media that compose multimedia titles. Music, still images, animated images, etc., which are the fundamentals of multimedia titles are all created by the respective editing software.

In order to create multimedia titles using authoring tools, all one needs to do is to look at the screen, think about the design and story and paste the respective multimedia items. For example, animated images are created by combining multiple still images, specifying the movements, and adding audio.

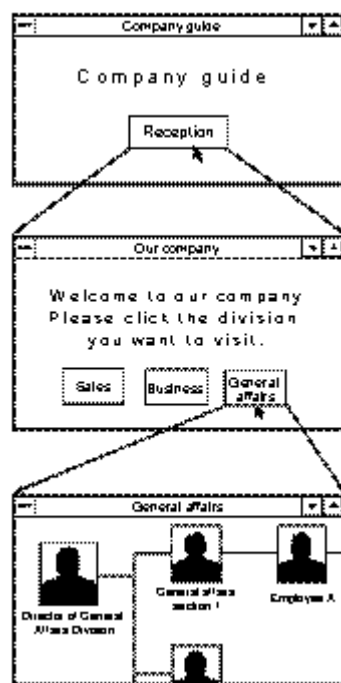
Figure 4-1-6
Role of the authoring tools



③ HyperText

CAI software and application software for presentations created with authoring tools have a structure that enables access to other specified information by clicking the image on the screen with the mouse. The function (concept) that enables free access to information by designating, one after another, the words, signs, images, etc. on the screen is called HyperText (Figure 4-1-7).

Figure 4-1-7
HyperText functions



4.1.3 Multimedia technology

The current expansion of the multimedia system is based on the diversity of technologies accumulated up to now. The technologies that result, indispensable for the implementation of the multimedia system, will be summarized here.

(1) AI

AI (Artificial Intelligence) is the research aimed at giving to computers functions found in humans, such as recognition, judgment, reasoning, problem solving and learning. AI is one of the technologies needed to implement the pattern recognition, etc., used in input operations of the multimedia system.

(2) Pattern recognition

In information processing, pattern recognition is the recognition of characters, images, audio, etc., using the computer. Pattern recognition is performed by extracting special characteristics of the input information (image, etc.) and comparing these special characteristics with a matching pattern. OCRs are an example of input devices that perform character pattern recognition. Pattern recognition will be explained in detail in the following section.

(3) AR/VR/CG

AR is an acronym for Artificial Reality and VR is an acronym for Virtual Reality. While AR creates an "artificial reality," VR creates a "virtual world." They tend to be deemed to have the same meaning, but in the U.S. they are clearly distinguished. Likewise, the technology needed to implement them is CG (Computer Graphics) technology.

(4) Agent

In information processing, the agent is the software that operates inside the computer on behalf of the user. The agent is software that supports user activities, and is capable of judging by itself when executing schedule management, seat reservations, etc. In order to play these roles, in addition to data and the procedures to process data, the agent is composed of a knowledge base to judge the situations.

4.2 Multimedia applications

Following the description of the multimedia system outline of Section 4.1, the multimedia actual implementation will be explained here.

4.2.1 Voice and image pattern recognition

In multimedia systems, besides characters, voice and images are also handled as digital data. The technology used to search for this voice and image data in an existing matching pattern is called pattern recognition. Here, pattern recognition methods for voice and image will be explained.

(1) Voice pattern recognition

The research and development of voice pattern recognition had gone forward before the word "multimedia" was born.

In the current voice recognition system, audio recognition is performed as follows:

1. Phoneme recognition processing
Special characteristics of the voice input are detected and matched with a phoneme model and the phoneme candidates are obtained from those that match the best.
2. Word recognition processing
Word candidates are obtained by combining the recognized phonemes and checking, in the dictionary, whether or not they have a meaning as a word.
3. Language processing
The word candidates are subject to syntactic analysis and semantic analysis and the input voice is settled as data having a meaning.

When these processes are performed, dog words (er-r-r-, uh-uh, huh, er-hum-er-), etc., are excluded and conjecture of the next word based on the context is performed, in order to avoid misconceptions, using AI technology.

(2) Image pattern recognition

In a broad sense, OCRs, etc., that read handwriting are also included in image pattern recognition. The image pattern recognition is performed according to the following procedures:

1. Image input processing
The image is scanned and entered as data.
2. Image recognition preparation processing
Elimination of noise, highlighting the part to be recognized, color adjustment, etc., is performed on the input image.
3. Characteristic s extraction processing
The characteristics of the image that is subject to recognition are extracted.
4. Partial recognition processing
Based on the characteristics extracted from each partial component of the image, the image patterns that match the existing patterns are obtained as candidates.
5. Total recognition processing
The image patterns obtained in the partial recognition are combined and, in order to decide the image (meaning) they have as a whole, matching with existing models is performed.

4.2.2 Synthesis of voice and image

In the multimedia system, besides the technology performing pattern recognition of the input voices and images, technology to create (synthesize) voices and images is also necessary. Here, the synthesis techniques of voices and images will be explained.

(1) Voice synthesis technology

Voice synthesis technology research has also been in place for a long time. Today, composite tones can be heard in train guidance information and household electric appliances. The following are the three main audio synthesis technologies.

① Editing method

The editing method is the method that edits recorded voices and creates specified documents (conversations). The implementation of this method is easy and is widely used, but a sense of disharmony in the edited (connected) parts can be felt and there are times when the intonation becomes strange. However, today, research aiming at the elimination of this lack of naturalness has progressed, and it is possible to synthesize audio that sounds as real as conversations of human beings.

② Analysis method

The analysis method is the method that analyzes and encodes voices, and after storing them as information, synthesizes them while adjusting them to the specified documents (conversations). By encoding the voices in advance, it is possible to synthesize only the required voices necessary at the time.

For that reason, since it can be implemented with small capacity storage devices, this method is frequently used in household electric appliances, etc.

③ Rule-based method

The rule-based method is the method that analyzes human voices and establish rules and in order to generate voices. That is, based on the characteristics of the analyzed voices, voices are generated by changing the base tones. However, in practice, there are many parts that sound unnatural, and therefore it is a method requiring further improvement.

(2) Image synthesis method

Image synthesis is a technology included in CG in the broad sense. It can be performed using existing image patterns or by creating new images. In particular, since the method that creates new images enables the creation of a diversity of things without having to stick to reality, this method is used as VR technology. Generally, image synthesis is performed following the three stages mentioned below:

① Creation of the original picture

There are various methods to create an original picture, such as the preparation of existing image patterns, the creation of new images, etc. As the methods of geometric representation to create new images, the wire frame model, surface model, etc., are typical.

② Shape change

Shape change is to change the original picture to synthesize a new image. At this stage, in order to avoid any disharmony in the image, correction is performed from a three-dimensional viewpoint.

③ Image display

At the image display, which is the last stage, the display processing of the synthesized image is performed. In order to display the synthesized image in three dimensions, the position of the light source, etc. should be considered, and shading, filtering and other adjustments have to be performed.

4.3 Multimedia application system

The multimedia system has permeated diverse fields of the real world. Among recent multimedia application systems, the following can be mentioned:

(1) Internet broadcasting

Among broadcasting that have the Internet as medium, there are large-scale broadcasting provided by television stations, as well as small-scale broadcasting at a personal level, and, as a result, a great variety of programs are presented. Regarding the using modes, there are programs that can be enjoyed for free, while there are others for which the user has to sign an agreement with the broadcasting station of his choice and pay for the service.

(2) Nonlinear image edit system

Previous image editing was linear editing, which was performed based on video tapes. In this method, since the tape was used sequentially, in order to edit a one-hour tape, one hour was needed. Conversely, nonlinear editing is a method in which images are edited as digital data on the computer. Since, in this system, the position to be edited can be accessed directly, editing time can be shortened. Likewise, through the digitalization of video data, there is the advantage that video data can be easily processed. However, attention should be paid, since, as a result of repeated data compression, image quality might deteriorate.

(3) Video-on-demand

Video-on-demand is a service consisting of the distribution of video images at the user's request. In this method, since service is provided to single users, the load of communications lines becomes too high. For that reason, there is a pseudo video-on-demand system, in which the program is distributed multiple times at specific intervals. In this case, the user is unable to see the video at the time he requested it, but since he only has to wait a specific period of time, it makes little difference. Currently, the system used in CATV, etc., is the latter.

Likewise, since the word "on-demand" means the provision of a service immediately after its request, besides videos, other on-demand services (such as "karaoke-on-demand," etc.) are expected to be available in the future.

(4) Other application systems

Multimedia application systems have spread from disaster monitoring systems, road traffic control systems, and other social systems to TV games, video shopping and other daily life uses. It is probable that in the near future, a use method with results unimaginable today will be born as a result of new technology.

Exercises

Q1 Which of the following is a correct description of the concept of multimedia?

- A. It is the conversion of analog data into digital data
- B. It is the use of the Internet to exchange electronic mails.
- C. It is handling diverse data such as audio, animated images, etc., in a unified way.
- D. It is watching television programs using personal computers.

Q2 What is the name of the environment required to actually use multimedia software?

- A. Application
- B. Agent
- C. Authoring
- D. Platform

Q3 Which of the following corresponds to the computer interface technology that uses icons, etc.?

- A. CAI
- B. CUI
- C. GDI
- D. GUI

Q4 Which of the following is a correct description of a HyperText?

- A. By designating words and symbols displayed on the screen, information can be accessed one after another.
- B. Detailed animated images can be displayed using high definition displays.
- C. Not only texts, but also music, videos and all types of information can be represented.
- D. A text created with word processing software can be directly converted into an HTML document.

Q5 Which of the following is the general term for the technology capable of creating a virtual world with intense reality using the computer?

- A. AR
- B. IR
- C. OR
- D. VR