CHAPTER 11

ELEMENTS OF MULTIMEDIA

CONTENTS

11.0 OBJECTIVES:

After reading this chapter you will be able to:

- Understand different color models
- Identify different type of images
- Discuss the basics of sounds
- Identify different type of texts
- Learn about different video file formats
- Learn about animations

11.1 INTRODUCTION:

In this chapter we shall discuss different building blocks of multimedia. Multimedia is mainly composed of images, animations, texts, graphics, audios and videos. How the colors are generated, how the animation is done, how audio and video are stored in computers, these are the important parts of multimedia. These along with several other elements of multimedia will be discussed in this chapter.

11.2 COLORS:

Color is probably the most vital component of multimedia. The readers should know the technicalities of colors i.e., what is color, how we see the colors, how colorsare generated in computer etc. This section deals with that.

11.2.1 COLOR BASICS:

This universe is full of amazing things. One of theme is electromagnetic waves. Its different frequency bands give us different things. At low frequency end it gives radio waves then microwaves, infrared, then visible color then ultraviolet and x-rays. Following is the chart for frequency and the corresponding waves.

10^6Hz	→	AM Radio
10^8Hz	→	FM Radio
10^{10}Hz	→	Microwaves
10^{13}Hz	→	Infrared
10^{14}Hz	→	Visible Colors
10^{16}Hz	→	Ultraviolet
10^{19}Hz	→	X-rays

Actually $4.3x10^{14}$Hz – $7.5x10^{14}$Hz is the range of visible colours. In this, $7.5x10^{14}$Hz gives us violet color and $4.3x10^{14}$Hz gives us red color. In between we have another five fundamental colors. They are indigo, blue, green, yellow and orange. If all of these seven colors come at a time we see white light. Sunlight is an example of white light. When a white light is incident upon an object, some colours are absorbed and some colors are reflected. The combination of reflected colours gives us the color of the object.

There are other properties of color also. One of these is brightness which is the intensity of the light and another is purity or saturation. How pure the color of the light appears. The term chromaticity means collectively purity and frequency. We shall now discuss different color models that are used in computer systems.

11.2.2 RGB COLOR MODEL:

In RGB (Red-Green-Blue) color model, the primary colors are red, green and blue. These are the basic three colors of the model. Other colors are the combination of these three colours. This model is called additive model because the intensity of primary colors are added to produce other colors. For example if we add green and red it will produce yellow. So, with the three colors we can produce 8 different colors including black and white. By setting the intensity of primary colors ranging from 0 to 255 we can produce 255 different shades for red,

255 shades for green and 255 shades for blue. So the total colors will be 255x255x255 i.e. near about 17 millions of color. To store 0 to 255 different color shades, we need 8 bit. i.e. for three primary colors we need 24 bit to store the information. That is why this is also called 24-bit true color system.

11.2.3 CMY COLOR MODEL:

The color produced by hard copy is different from the color produced by the monitor. In hard copy, we use the property of light absorption of the object. CMY is a combination of cyan, magenta and yellow. We know that cyan can be formed by adding green and blue. Therefore when white light is reflected from the cyan colored ink, the reflected color must not have red color because that will be absorbed by the ink. We can say that red color will be subtracted by the ink. That is why cyan, magenta and yellow are called subtractive primary colors. In this color model cyan and yellow will form the green color. The following table illustrates the color produced by the combination of CMY colors.

Cyan	Magenta	Yellow	Output Color
Yes	No	No	Cyan
No	Yes	No	Magenta
No	No	Yes	Yellow
Yes	Yes	No	Blue
Yes	No	Yes	Green
No	Yes	Yes	Red
No	No	No	White
Yes	Yes	Yes	Black/Gray

In general printing devices often uses four colors, cyan, magenta, yellow and black because combination of cyan, magenta and yellow produces dark gray that is why one black ink is used.

11.2.4 HSB MODEL:

In this model the description of the color is used. In this case the user selects a spectral color and the amount of black and white that are to be added for

different shades. The parameters in this model are Hue(H), Saturation(S) and Brightness(B). In this model color or hue is specified as an angel ranging from 0^0 to 360^0 on a color wheel and saturation and brightness as percentage. Brightness is the percentage of white or black that is to be added. 100% brightness means white and 0% brightness means black. Saturation is the intensity of color. At 100% saturation, the color is pure and at 0% saturation, the color is white or black.

11.2.5 OTHER COLOR MODELS:

Other color models include CIE, YIQ, YUV etc. But these are less used in multimedia application.

CIE describes the color value in terms of frequency, saturation and luminance where as YIQ and YUV describes the color value in terms of luminance, chrominance and the phase of the wave. These are other color models also but this study material is not a suitable place to discuss them.

11.3 IMAGES:

Images are very important in multimedia. Image means still image. Their manipulation is one of the fundamental components of multimedia. In this section we shall discuss some fundamentals about images.

An image may be a small or large, it may be colored or black and white, and it may be a very simple or a very complex image. Whatever are they, in computer, still images can be generated in two ways. One is bit map and the other is vector drawn.

11.3.1 BITMAP IMAGES:

A bitmap is a simple information matrix describing the individual dots or the pixels. A bitmap image is a photo realistic image. For black and white, a simple matrix, whose each cell can store one bit, i.e., a two dimensional array is sufficient. These types of black-white images are called monochrome images. Higher dimensional matrix can describe a color images. 4bit per cell of a matrix can describe 16 colors where as 24 bit per pixel can describe 14 millions of colors or 24 bit true color. There are several different file formats of bit map images.

Some are uncompressed like .BMP files and some are compressed like .GIF and .JPEG files.

11.3.2 VECTOR DRAWING:

When we need to draw the shapes like lines, boxes, circles, ellipses and other graphic shapes that can be mathematically defined, we use vector drawing. This needs the knowledge of computer graphics. That is the algorithms for drawing curves, lines, circle etc. vector drawing requires less memory space to store the definition of the image. For example, if we want to draw a straight line, we need to store the two end points of the line segment only. The actual line will be generated from these two end points by applying algorithms.

Most multimedia software provides tools for vector drawing. Using those tools, we can draw lines, circles and other simple geometric shapes and texts also. There are certain advantages of vector drawn images over the bitmap images. One is if takes very less memory to describe the image. The second one is the manipulation of images is very easy and cost effective. If we want to enlarge an image or want to rotate and image, in vector drawing, it is relatively more efficient. In bitmap images, these operations are very complicated. But there are certain disadvantages of vector drawing also. If an image contains large number of such vector-drawing-shapes then the processing time may be large which is not there in bitmap image. In case of the bitmap image, the processing time is independent of the complexity of the image.

11.3.3 IMAGE FILE FORMATS:

There are several file formats for images. Windows uses device independent bitmaps as its image file format. This file format is known as .BMP file format. JPEG and GIF are mainly used in web development. GIF images are limited to 8 bit color depth. So they can generate only 256 colors. Because of this property it can compress an image file but that compression will be a lossy compression. .JPEG scheme can give better compression but it is very slow. It takes considerable amount of time to compress a large size image file.

11.4 SOUNDS:

Sound is a very important element of multimedia. The sound can be anything ranging from whisper or speech to music or sound generated by a turbo engine. The sound of music can elevate the listener near to the heaven. A good instrumental sound can make the whole thing of a multimedia project very charming and attractive. So, how one is using sound in his multimedia is very important. The sound can make an ordinary multimedia project an excellent one.

11.4.1 BASICS OF SOUND:

When something vibrates in the air by an oscillatory motion, it creates waves. These waves spread like ripples from the source of the vibration to outword direction. When they reach to our ear, our ear catches the vibration in the form of sound. In air the sound wave propagates at about 750 miles/hours. Sound wave needs a medium to propagate. In earth, air is that medium. So, without air, sound would not be there in the earth.

The loudness of the sound is measured by decibels (dB). The grater the dB the greater the loudness of the sound and the loudness may be so high that it may be irritating. For example, a generator that produces sound at 42dB faces no reaction from the neighbors. But if it generates sound at 55-60 dB, a lot of complaints may come. A good multimedia designer always takes care of that. Though the multimedia designer need not know the science of sound, it is better to have a little bit of idea of that. Mainly they should know how to create sound, how to record and edit sounds and how to incorporate sounds in the multimedia project.

11.4.2 DIGITAL AUDIO:

Digital audio is the technology in which sound signals are represented as a series of binary digits. We can digitize sound from a microphone, tape recorder, radio, TV and from any source. Digitized sound is sampled sound. Every k^{th} fraction of a second, a sample sound is taken and stored as s string of bits. How

often the sample is taken is the sampling rate. The amount of information stored for each sample is sample size. The more often the sample is taken, the finer the resolution and quality of the sound when it is played back.

There are few frequencies that are frequently used in multimedia. These are 44.1 KHz, 22.05 KHz and 11.025 KHz. Sample sizes are either 8bits or 16bits. Preparation of digital audio is very simple. The first step is to digitize the analog signal. This means playing the analog signal directly into the computer using audio digitizing software. Then we have to do two things (i) balance the sound quality with the RAM size (ii) set the proper recording levels to get the good and clan sound.

The resolution of audio is the accuracy with which a sound can be digitized. The more the resolution, the better the quality of the sound. In higher resolution, the digitized sound yields the sound almost equal to the original one. If we record a sound with stereo facility it will be better than its mono counter part but it will take more space to store the sound file. Following is some commonly used resolution and their corresponding file sizes.

Sampling rate	**Resolutions**	**Mono/Stereo**	**Bits Needed for 1 Minute**
44.1KHz	16 bit	Stereo	10.5 MB
44.1KHz	16 bit	Mono	5.25 MB
44.1KHz	8 bit	Stereo	5.25 MB
44.1KHz	8 bit	Mono	2.6 MB
22.05KHz	16 bit	Stereo	5.25 MB
22.05KHz	8 bit	Mono	1.3 MB
11.025 KHz	8 bit	Stereo	1.3 MB
11.025 KHz	8 bit	Mono	650 KB

Source: Multimedia Making it work (4th Ed) by Tay Vaughan, page-252

There are certain problems with digital sounds or digital recording process. These are –

(i) Quantization: The value of each sound sample during analog to digital conversion process is rounded off to the nearest integer value and this is called quantization. Quantization produces an unwanted background noise.

(ii) Clipping: During analog to digital conversion, if the amplitude of the sample is greater than the interval available, the wave is clipped in top and bottom. This results in a distortion of the original sound.

11.4.3 MIDI FUNDAMENTALS:

Though digital audio are used extensively in multimedia, they have a major disadvantage. This disadvantage is its file size. As we have seen in the above table, a one minute good quality sound file may take 10 MB of disk space. When there will be multimedia application with say 30 minutes of background music, then the sound file itself may be the only problem. For this problem, the researchers around the world tried to find out a new technology where the file size will be less still the quality of the sound will be good. They ultimately came up with MIDI.

Musical Instrument Digital Interface, in popularly known as MIDI, is a technology which is gaining popularity day by day. It is not only because of its ability to produce fine and noise less sound but also because of take less, very less space for storing the files.

The concept of MIDI is not difficult to understand. Instead of storing the actual sounds, the MIDI stores the description of the music. i.e., it stores the notes, their time durations and the instrument that is playing the music in the form of binary digits. MIDI can identify several different notes from various instruments. They are stored in binary form instead of the actual sound. This recorded information is then sent to MIDI compatible hardware such as sound card. The sound card then converts the MIDI file back to the sound form and plays it via sound box.

The file size of MIDI format files is very small with respect to digital audio files. The ratio for file size can reach up to 1:1000 even. A digital sound file of 200 KB can store only a few seconds of sound but 200KB of MIDI file can generate music of 15 to 20 minutes. This is the most important advantage of MIDI files. There are other advantages also. They are discussed below

As MIDI files are small in size, the MIDI files attached with a web page plays more quickly than its counterpart. If the source and the hardware are of high quality, the MIDI sounds better than digital sounds. MIDI sounds are completely editable i.e., if somebody wants, he can change the duration of the music without degrading the audio quality.

Through the MIDI format sound have several advantages, it has some disadvantages also. One problem is that the play back will be different in different system and it will not be equal to the original one. Another disadvantage is, MIDI cannot be used to play back spoken dialog. Though some research is going on in this area but they are very expensive and the result is not also very satisfactory.

11.4.4 FUNDAMENTALS OF SOUND CARDS:

Sound cards are the most essential hardware for every multimedia system. MIDI sounds are dependent on sound card for the recording, amplification and play back of the sound. The process by which a sound card creates music is called sound synthesis. There are two types of sound systems technologies. One is FM systems and the other is Wavetable systems.

FM synthesis is an old technology. In this technology the synthesis is done by blending a range of frequency modulation. In this case, the output was much like electronically generated sound and not like the original sound. Yet these cards were very popular because of their low cost. It is then replaced by wavetable synthesis cards later on.

Wavetable synthesis technique is far improved than FM synthesis. In Wavetable synthesis, the sounds are almost like original sound. These works as follows,

The Wavetable synthesis technology is collection of wide variety of bit in sound samples of various instruments. When a not from a particular instrument is played the card actually looks up its table for an equivalent sample sound. It then records the sample sound identification number to the MIDI file. When the sound is played back, the sound card again searches the table for the sound according to the sequence of sound identification number written in the MIDI file and produces the sequence of sounds. The user doesn't understand the fact that they re listening different sound clips rather than a continuous one. As wave table synthesis process generates the actual recording (in small sample size and in discrete form) the sound quality is far better than FM synthesis technology.

11. 5 TEXT:

Texts play an important role in multimedia. They narrate the purpose of some element or describes about things. There are several areas where text can be used in a multimedia project. These are –

- Titles of the multimedia project,
- Text in buttons to indicate the action
- In menu
- Headings of the particular page
- Definition and description of things
- Scientific formula

There are several fonts and faces of text. In the following section we shall discuss them.

11.5.1 FONTS AND FACES:

A type face is a collection of characters type sizes and styles. A font is character set of single size, style and belongs to single type face. The example of a

typical style is bold face. A type size is usually expressed in ponts. A point is 1/72 inch. And font size is measured from top of the capital betters to the bottom of the letters like g or y or p etc.

Principally these are two types of fonts they are serif and sans serif. Serif fonts are said to guide the reader when they read a large word. So for printed text, the serif fonts are used. Sans serif fonts, on the other hand are used for bold statements and headlines. Times, Bookman, Palatino are the examples of serif fonts and Helvetica, MS Sans Serif, Arial are the example of Sans Serif fonts. Following are some of the fonts that are commonly used in windows platform.

- Arial
- Bookman old style
- Century Gothic
- Courier new
- MS Sans Serif
- Times New Roman
- Lucida Sans.

11.5.2 SYMBOLS:

Not only English characters, the text can be any other language characters or it can be symbols also. Symbols are mainly used in writing mathematical formula. For this, the symbol set is defined. Almost in every word processing or multimedia software, the user will get a handful of symbols that are sufficient for almost every mathematical expression. There are other symbols also which are necessary for other fields like the symbols of playing cards, the symbol of bullets etc.

A little bit of care should be taken when you are assigning the fonts. The font in which you are preparing your multimedia project that font should also be present where your project will run. Otherwise the font will be replaced by the default font. So, it is better to use the fonts that are universally available on all machines. The same thing is true for symbols also.

11.5.3 HYPER TEXT:

When there is a large number of information in a multimedia project, they cannot fit in a single page. So, some indexing method is needed so that we can retrieve the relevant information quickly. When words are indexed to other words or other set of information, we say the former ward as a hypertext system. Hyper text is the most important part of World Wide Web. Using hyper text system, one can search through all the text of a dictionary software, locate the reference to a certain word and then can go back to the page where the word was found. This is done by a technology called hyperlink. The word which carries a hyperlink is called a "Hot Word". Hypertext is one of the important components of multimedia.

11. 6 VIDEO:

Video is the ultimate media of a multimedia project. Without video there is probably no multimedia project. Suppose an edutainment multimedia project is there which teaches the alphabet to the children. It is clear that this project cannot be done without video. There are other categories of projects also where video is an important part or the most essential part.

11.6.1 WORKING PRINCIPLE OF VIDEO CAMERA:

When light reflects from the object, the light passes through the video camera. In video camera, that light is converted into an electronic signal by a sensor called CCD (Charged Coupled Device). A top quality camera may have more than one CDD sensors. The signal contains three color information Red, Green and Blue plus one synchronization pulse. The signals are sent separately. This method produces high quality video. Not only that, if this technique is used then color correction will be very effective. Some armature level video cameras mixes up all the RGB colors and send them via a single channel, but the color definition in that camera is less-precise.

11.6.2 VIDEO STANDARDS:

There are three video standards that are very popular in the world. These are NTSC, PAL and SECAM. There is another standard which is called HDTV (High Definition Television). These standards are not easily interchangeable. So the multimedia designer has to think, where the project will run and they have to choose the standard accordingly. We shall now discuss the first three popular standards.

NTSC:

United States and many other countries use this standard. This standard was specified by NTSC committee. In this standard, a single frame of video is made up of 525 horizontal scan lines drawn onto the inside face of a phosphor-coated picture tube in every $1/30^{th}$ of a second. This is done by a first moving electron beam. The scanning of lines is done in interlaced form, i.e., first the odd lines are drawn then the even lines. So each phase is done in $1/60^{th}$ of a second.

PAL:

The PAL system is mainly used in United Kingdom and in Australia. Its full form is Phase Alternate Line. In this standard, per video frames, there are 625 liens and the frame rate per second is 25. This standard also adopted the interlacing. This interlacing is also two pass interlacing so each pass in the standard takes $1/50^{th}$ of a second.

SECAM:

Some countries like France, Russia uses a different standard called SECAM. Its full form is SEquential Color And Memory. It also uses 625 lines for one video frame and its frame rate is also 25 per second. But it uses different technology for its broadcast system. The television sets sold in Europe often supports both PAL and SECAM standards.

11.6.3 VIDEO COMPRESSION:

Video need a huge amount of disk space. Just one frame of digital video at 24-bit requires about 1MB of computer space. 30 seconds of video requires about 1GB of disk space. A full size, full motion video requires about 30 MB of data transfer per second which is huge. This bottleneck has been overcome by video compression technology. The video compression algorithm is called codec (Coder/Decoder) technology. The video compression algorithm is called codec (Coders/decoders). The codec algorithm compresses the video and decodes it at real time for fast playback. Some real-time compression algorithms that are very popular are MPEG, DVI, ClearVideo, RealVideo etc. there compression ratio ranges from 5:1 to 200:1. In addition to compressing video data, streaming technology is also introduced. Streaming technology provides low band width videos of reasonable quality. We shall now discuss two of the compression technologies.

MPEG:

MPEG was developed by Moving Pictures Expert Group. This group was formed by ISO and IEC (International Electrotechnical Commission). Their main objective was to prepare a standard for moving pictures and associated audio. They came up with MPEG-1 and MPEG-2. using MPEG-1 one can deliver 1.2 MbPs of video and 250 Kbps of two channel audio using CD-ROM. MPEG-2 is a different technology. It requires higher data rate but is provides better video.

DVI:

DVI is a programmable compression decompression technology based on Intel-i750 chip set. It is also known as Indeo. It is a hardware chip and it has two VLSI chips. One is for image processing and the other is for display. DVI provides two levels of compression and decompression. Production Level Video (PLV) and Real Time Video (RTV). The algorithms used in DVI can compress video images at a ratio between 80:1 and 160:1.

11.7 ANIMATION:

Animation is one of the interesting parts of multimedia. Animation means motion of objects. But it is not video. Animation means moving the object artificially. Animation adds a visual impact to the multimedia project.

11.7.1 Principles of Animation:

Let us now see how animation is possible. It is possible because of a biological fact called persistence of vision. An object seen by the human eye remains mapped on the eyes retina for a small amount of time after viewing. For this property, if a series of images, that are changed slightly and moves very rapidly (At les 24 images per second) one after another, our eye cannot differentiate them rather we see a moving picture.

11.7.2 ANIMATION TECHNIQUES:

There are two types of animations. One is cell animation and the other is object animation.

Cell Animation: In this technique, the entire sequence is split up into a series of frames or into a series of still images. When the images are displayed in sequence at high speed (24-30 images per second), they seem to move. This technique is very old and it was there even before the computers also. Walt Disney used this technique to prepare his world famous cartoons.

Object Animation: In object animation, there are two things. One is backdrop and the other is moving object. A picture which does not change with the change of time is called backdrop and that is set as background. The object moves over this background. In this type of animation, motion sequence of object calculated and generated. That is why this type of animation is called object animation.

11.7.1 ANIMATION FILE TYPES:

Some file formats are designed specially to contain animations. These are Director (.DIR), AnimatorPro(.FLE), 3D Studio Max(.MAX), Windows Audio-Video Interleaved format(.AVI) and CompuServe(GIF). There are other file types also, but these are the most popular.

11.8 KEY WORDS:

- Cell Animation
- CMY Color
- JPEG
- MPEG
- RGB Color
- Sans Serif
- Serif

11.9 SAMPLE QUESTIONS:

11.9.1 Discuss the different color models used in computer system.

11.9.2 Discuss about fonts, faces and symbols.

11.9.3 Write down the working principle of a video camera.

11.9.4 Discuss different video standards and different video compressions.

11.9.5 Write down the principles and techniques of animations.