



Odisha State Open University



Commonwealth of Learning

INTRODUCTION TO MULTIMEDIA

Art & Science of Multimedia

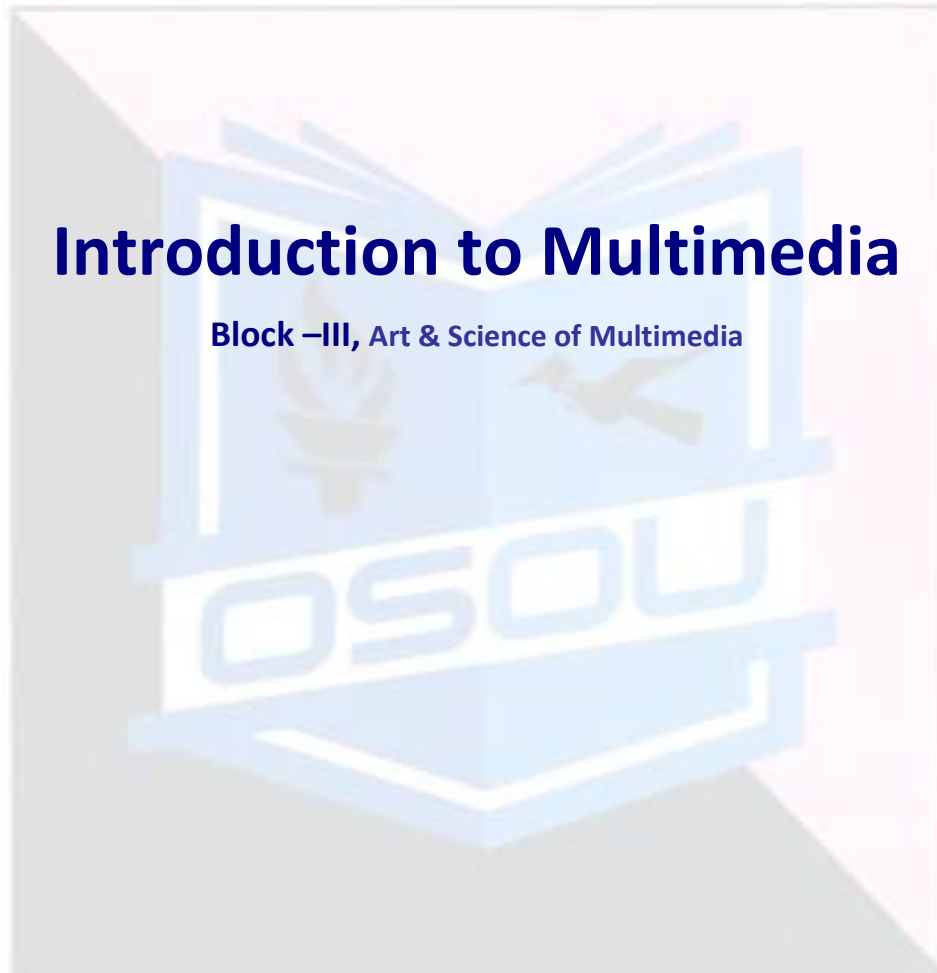


Diploma in
Multimedia and Animation (DMA)

DMA-01
BLOCK-3

Introduction to Multimedia

Block –III, Art & Science of Multimedia



ଓଡ଼ିଶା ରାଜ୍ୟ ମୁକ୍ତ ବିଶ୍ୱବିଦ୍ୟାଳୟ, ସମ୍ବଲପୁର
ODISHA STATE OPEN UNIVERSITY, SAMBALPUR

Introduction to Multimedia

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Course overview

Welcome to Art & Science of Multimedia

In this block, you are going to study about the Art & science of Multimedia. With the expansion of multimedia in all aspects of our life, inclusion of audio in that equation is increasingly important. Audio technology has expanded dramatically over the last few years. In our daily life, we use all components of multimedia presentation i.e. Sound, video, animation, text and images etc.

This block will demonstrate the process of creating images and videos. Also describe the different type resolution and type of formats mostly used in both image & video.

It will elaborate all techniques, camera function/parts, composition rules, lighting and other important aspects of photography which are prerequisite to taking a better photograph.

Printing is a process for reproducing text and images using a master form or template. Sometimes it may not be possible to preserve or circulate the original template among mass.

Audio Fundamentals

This course is intended for people who have flair of knowledge in sound as well as computer. Specifically, sound refers to the range of frequencies detectable by the human ear. *Sound* is any disturbance that travels through an elastic medium such as air and it is heard by the human ear.

Understanding Image & Video

This course is intended for people who want to make a career in Multimedia and Animation industry. This course brings up the process of creating images and video. One has to be



technically very strong combined with creative skills to make a mark in the industry.


Film & Digital Photography

This course is intended for people who want to make their career in the field of Photography. After studying this unit Learner will be able to know all the techniques, camera function/parts, composition rules, lighting and other important aspects of photography which are prerequisite to taking a better photograph.

Introduction to Printing Technology

This course is intended for people who want to make their presence in the Print medium. Printing technology has evolved a lot. Printing is the process for reproducing text and images using a master form.

This video will provide a brief overview of this course.

Topic	YouTube link	QR Code
Video 1 –Digital Media Content Layout	https://youtu.be/wdvoJbujgFo	

Course outcomes

Upon completion of Content Development and Distribution you will be able to:



Outcomes

- *Describe* how sound is produced.
- *Identify* factors influencing quality of sound.
- Create images and videos.
- Utilize the various composition & lighting techniques for better photography.
- Get acquainted to various kinds of printing process and its equipment.

Timeframe



How long?

This course will be completed within “4” classes.

This course is of “1” credits.

4 Hours of study time is required for this unit.

Study skills



This is a totally practical oriented course.

Hence, you should have access to personal computer or personal laptop for better understanding of this unit.

Each and every options are explained step by step in the course material.

Apart from this course material, the learner has to adopt the tendency of learning from multiple sources i.e.,

Internet tutorials

Video tutorials on YouTube

Collaboration with people working in the industry etc.



Only classroom study will not make you a professional. You have to be active to grab the opportunity of learning wherever you get a chance.

Need help?



Help

In case of any help needed you can browse the internet sites like youtube.com for video tutorials about the subject.

Apart from that, you can contact the writer of this course material at rsharma@ignou.ac.in

Assignments



Assignments

There will be some assignments at the end of each unit.

These assignments are mostly practical based and should be submitted in CD or DVD. Theoretical assignments are to be submitted neatly written on A4 size sheet.

All assignments will be submitted to Regional centre of Odisha State Open University or as directed by Co-ordinator.

All assignment should be unit wise on separate CD/DVDs clearly mentioning course title and unit on Top. Theoretical Assignment will be neatly filed or spiral bind with cover clearly mentioning necessary information of course, student detail on top.

Assessments



Assessments

There will be few assessment questions for each unit.

All practical assessment will be submitted to OSOU.

Assessment will take place once at the end of each unit.

Learner will be allowed to complete the assessment within stipulated time frame given by the university.



Video Resources



This study material comes with additional online resources in the form of videos. As videos puts in human element to e-learning at the same time demonstrating the concepts visually also improves the overall learning experience.

















You can download any QR code reader from Google Play to view the videos embedded in the course or type the URL on a web browser.

Getting around this Course material

Margin icons

While working through this Course material you will notice the frequent use of margin icons. These icons serve to “signpost” a particular piece of text, a new task or change in activity; they have been included to help you to find your way around this Course material.

A complete icon set is shown below. We suggest that you familiarize yourself with the icons and their meaning before starting your study.

			
Activity	Assessment	Assignment	Case study
			
Discussion	Group activity	Help	Note it!
			
Outcomes	Reading	Reflection	Study skills
			
Summary	Terminology	Time	Tip



Unit-1

Audio Fundamentals

Introduction

With the expansion of multimedia in all aspects of our life, inclusion of audio in that equation is increasingly important. Audio technology has expanded dramatically over the last few years. In our daily life, we use all components of multimedia presentation i.e. Sound, video, animation, text and images etc. One can easily say that speech is often the most preferred and used tool of interaction. That is why; in multimedia presentation sound is one of the most important elements of communication. A presentation can be based on sound alone or sound may be used in supporting role in the form of music and sound effects. In the form of speech, the sound becomes the main tool of communication but its supporting role is equally important as it influences the emotions of the audience. In order to utilise sound to its maximum potential in our multimedia presentations, it is very important to understand the very nature of the sound itself and the devices used to create, process and record the sound. In this unit, we will explore the basics of audio and sound, as well as some of its fundamental frequency, format, equipments, other tools, etc.

Outcomes

Upon completion of this unit you will be able to:



Outcomes

- *Describe* how sound is produced.
- *Identify* factors influencing quality of sound.
- *Judiciously* use recording devices for quality recording.
- *State* techniques of noise suppression and utilisation.
- *Evaluate* and *select* right kind of microphones.
- *Explain* studio system
- *Differentiate* between mono, stereo and surround sound systems



Terminology



Sound:	Disturbance in the air that can be heard.
Audio:	Generally refers to the sound in electrical form.
Frequency:	Cycles/vibrations per second.
Amplitude:	Height of Sound wave.
Hertz:	Unit of frequency measurement.
Polar:	Related to direction of sound
Reverberation:	Persistence of sound in space.
Equalisation:	Adjusting relative levels of different frequencies.

What is Audio?

Audio means "of sound" or "of the reproduction of sound". Specifically, it refers to the range of frequencies detectable by the human ear — approximately 20Hz to 20 kHz. It's not a bad idea to memorise those numbers — 20Hz is the lowest-pitched (bassist) sound we can hear, 20 kHz is the highest pitch we can hear.

Audio work involves the production, recording, manipulation and reproduction of sound waves. To understand audio you must have a grasp of two things:

1. **Sound Waves:** What they are, how they are produced and how we hear them.
2. **Sound Equipment:** What the different components are, what they do, how to choose the correct equipment and use it properly.

Fortunately it's not particularly difficult. Audio theory is simpler than video theory and once you understand the basic path from the sound source through the sound equipment to the ear, it all starts to make sense.

Note: In physics, sound is a form of energy known as *acoustical energy*.

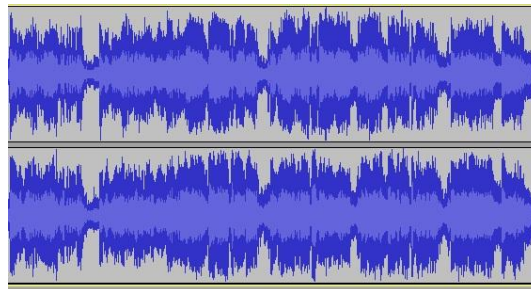


What is Sound?

Sound is any disturbance that travels through an elastic medium such as air and it is heard by the human ear. We are saying that sound is a disturbance not because it is useless, but actually it refers to the mechanism of sound production/generation. Anything that vibrates would disturb the air around it and it is this disturbance which travels in the air and reaches our ears. The disturbance in air produces a sensation of hearing in us by vibrating our ear drum. You may observe the phenomenon of sound generation by placing your fingers on your throat when you are speaking. Same way, when you hit a table or any other solid object, it vibrates and generates the sound.

Nature of sound

A vibrating (oscillating) body causes a periodic (rhythmic) disturbance in the surrounding air and generates sound waves (also called pressure wave) which on reaching us produce a sensation of hearing. In real life, the vibrating objects could be of any shape and sizes vibrating in a very complex manner, therefore the sound generated are very complex. A typical sound wave represented graphically, as shown below.



Title- Fig. 1.1 Graphical Representation of Sound Wave

Attribution- Screenshot

Source-

Link-

This kind of waves you would be able to see while working on audio workstation. For the sake of understanding, the wave is usually shown as simple wave, in the form of sinusoidal wave (sine wave), as depicted below



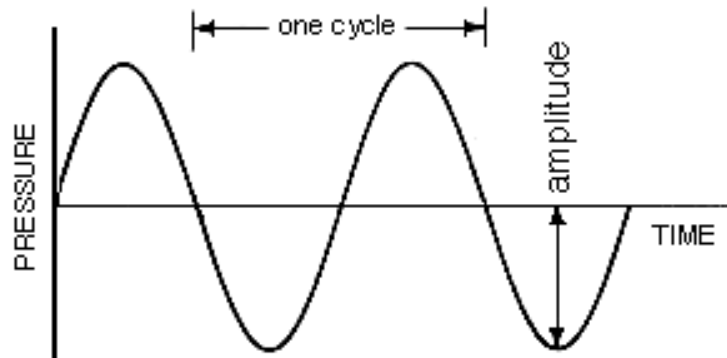
Title- Fig. 1.2 Simple / Sinusoidal Sound Wave

Attribution-

Source-

Link-

Let us understand how a vibration converts into a waveform. In the diagram below, the body is vibrating along the vertical axis. The body starts from its initial position at the centre and goes to one side of the centre (say above) and after reaching an extreme position comes back to the centre. Continuing its journey, it moves to another extreme point on the other side (lower side) and then come back to the centre. This completes one cycle of the vibration. You may see that the wave is simply imitating this movement but expanded along X-axis with time. The image below indicates how a single vibration is translated into waveform.



Title- Fig. 1.3 Diagram showing a vibration converting into a waveform

Attribution-

Source- www.sfu.ca

Link- https://www.sfu.ca/sonic-studio/handbook/Sine_Wave.html

The number of vibrations occurring per a second is the *frequency* of the vibration and therefore of the sound being generated due to this vibration. The frequency is measured in *Hertz*, named after the scientist Heinrich Hertz and is denoted as Hz. The human ear can listen to the sounds only in the frequency range from 20Hz to 20 kilo hertz (KHz.). All the sounds of frequency below 20Hz are called *subsonic* and the sounds above 20 KHz. are called *ultrasonic*.



The word “Sonic” refers to sounds within the audible range. The frequency range from 20 Hz. to 20 kHz is called the *audible range*.

The graph is merely a representation of the sound wave and it helps us in understanding the quality of sound being generated, processed and recorded by various audio devices. In the image above, the amplitude of the wave represents the strength of the wave which in the case of sound represents the power/, intensity of that sound wave. More is the sound amplitude (level), louder is the sound.

The terms “sound” and “audio” may be used interchangeably but the convention is to use word “sound” in the physical space while “audio” is more often used to represent sound travelling through the devices in the form of electric current. How sound is converted into electrical current we shall understand later in this unit.

The intensity/level of the sound is measured in “decibels” denoted as “db”.



Title-Fig. 1.4 A VU Metre

Attribution- [lainf](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:VU_Meter.jpg

The audio level in audio devices is usually measured by a metering device known as VU metre, as shown above.

Perceiving Sound & Listening

Our brain separates the desired sounds from the unwanted sounds through a very complex psycho acoustical process. When we are listening to a conversation or a piece of music, our ears keep adjusting to small changes in the sound levels.

The quality of sound that our ear will accept and prefer shall depend on what we are used to listening in our daily life. If we



listen to good quality sounds in routine e.g. sounds of good quality TV and music systems, then we are not satisfied with an inferior quality sound as we are able to differentiate between good quality sound and the bad one. At the same time, any person deprived of good quality sound may remain happy with an inferior quality. It means quality of sound may become a subjective issue. Different quality may be acceptable to the same person listening to different types of programmes e.g. telephonic sound is much inferior to the sound in a cinema hall. Another thing to keep in mind is that our ear sensitivity is highest at 1 KHz. and the loudness of sound is a subjective quality.

The Audio Quality

As you know the basic taste of food depends upon factors like its saltiness, sweetness, sourness or the bitterness. The additional parameters which are colour flavour, hardness, temperature and its crispness (sound in food!!!) also influence the taste. Therefore an expert in food tasting would consider all above parameters while evaluating food. Similarly, the major factors which need utmost attention to decide the quality of the sound are:

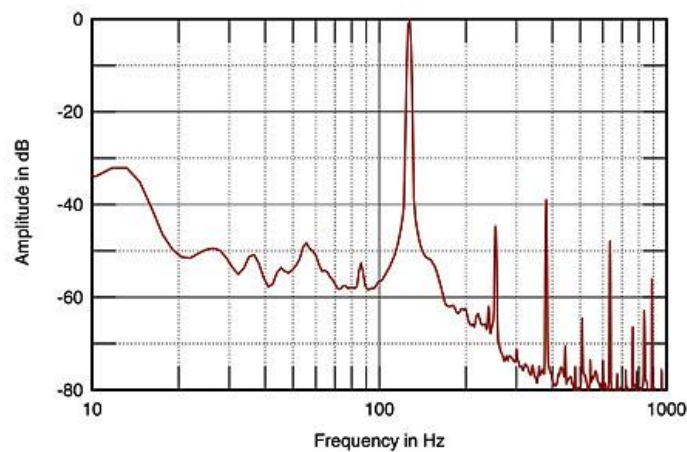
1. Frequency response
2. Distortion
3. Noise
4. Reverberation

These four factors influence the quality of the sound to a great extent therefore we need to understand them in detail as discussed below.

Frequency response

You know that human ear can listen to sounds ranging from 20Hz. to 20 kHz but all the sources of sound do not produce or receive the sound in full audio range.

The *frequencyrange* a device is capable to generate, process, record or playback is known as frequency range of that device. A device having a 'flat' frequency response would mean it will not change the weighting i.e., intensity of the audio signal across the specified frequency range while processing. A typical frequency response is shown graphically in the diagram below.



Title-Fig. 1.5 A typical frequency response shown graphically

Attribution- John Atkinson

Source- stereophile.com

Link- <https://www.stereophile.com/content/audioengine-2-powered-loudspeaker-measurements>

You may observe that in graph the signal from 20 Hz to 20 KHz is at the same level of about 0 db. If the gain (Level control) of the system is turned down, the graph would also come to a lower level but maintaining the horizontal line across the frequency range.

Any sound in nature is usually not generated as a single frequency. The lowest frequency in a sound is called *fundamental frequency*. Along with fundamental frequency some high frequencies are also produced called *overtones*. These overtones add special character and richness to the sound. The low frequency sounds are called “*Bass*” and they attribute heaviness and richness to the sound e.g. Sound of a drum has a heavy bass. On the other side, the high frequencies give brilliance to the sound and are generally known as “*treble*”. The chirping sound of the birds belongs to high frequency.

In music, the range of frequencies generated by a musical instrument is known as the range of that musical instrument. The range may be understood as the distance between the lowest pitch (frequency) and the highest pitch produced by the instrument.

A single frequency sound, in the music reference, is known as “*note*”. For example, Sa, Re, Ga, Ma, Pa, Dha, Ni sounds are called notes where Sa is the lowest frequency and Ni is the highest



frequency (double of Sa) in an octave. The octave is the range of sounds in which frequency doubles i.e. the frequency of the last note is two times of the frequency of starting note. Range from “Sa” to “Ni” is one octave.

A musical composition comprises of combinations of these notes at different intervals and intensities. Therefore to preserve the originality of the music any sound recording device should neither alter the frequency of the notes and their relative intensities. If the device is unable to record different frequencies at their relative levels then such deviation would mean that the device has a poor frequency response (non-flat or limited frequency response). The concept of frequency response can be understood by listening to a piece of music on a portable device e.g. mobile phone through its speaker and then listening to the same piece of music on a home theatre system or a cinema hall. You will notice that the music on two situations gives you different experience. It sounds quite differently in cinema hall as compared to mobile phone. It is so because of difference in frequency response of the sound systems in mobile phone and cinema hall.

In the same way, the deficiency in the frequency response of a device would also affect the speech quality. Therefore you may conclude that good frequency response is one the essential features of good quality audio device. Closer is the frequency response to 20-20KHz., better is the device.

In a marriage or other party, you might have observed that parties having, each speaker box/enclosure of the music system comprises of two or more speakers. It is because; no single speaker can reproduce full audio range from 20 Hz. to 20 KHz. The largest speaker, known as *woofer*, handles low frequency spectrum whereas the smallest speaker, known as *Tweeter*, playback all the middle and high frequencies. In superior speaker systems a third speaker is also added, known as *Mid-Range/Squawker*, which exclusively handles the mid-range of the audio spectrum.

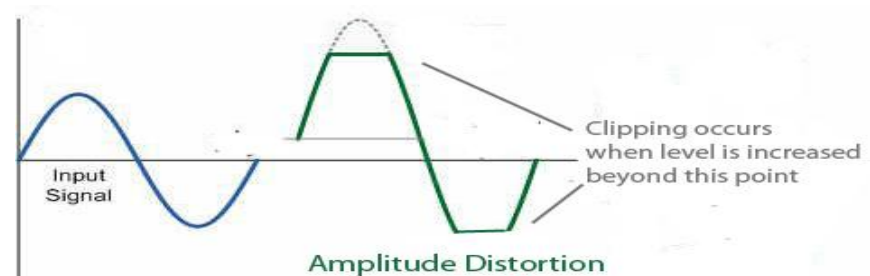
Distortion

The distortion in simple understanding is the deformity in the shape or character of an object. Usually a distortion occurs

because of overloading of a system. For example, a sheet metal table capable of taking a 50 kg is loaded with more than 50 kg then it would bend under the excess weight. The table's shape would distort, which is a deviation from the original shape. Similarly, the electronic devices such as microphones, recorders, amplifier etc, can handle audio signal up to certain level (threshold) but if the signal level exceeds this limit then the audio signal being recorded/playback would get deformed i.e. distorted.

The “VU metre” as discussed before, is used to control the audio level to avoid any distortion in the sound being recorded. If, the pointer (needle) moves into the red zone i.e. beyond 0 dB level, then signal would start distorting. Therefore, VU metre is a very useful device to control the quality of an audio recording. At the time of recording one needs to adjust the recording level so that the pointer only occasionally enters into the red zone. The two kinds of distortions are introduced by the audio devices known as “*amplitude distortion*” and “*frequency distortion*”.

The **amplitude distortion** occurs due to overloading of the electronics because of high level of input signal as described above.



Title-Fig. 1.6 Tkop;phe Amplitude Distortion

Attribution-

Source-

Link- <http://www.qooljaq.com/AmplifierDistortion.htm>

A typical amplitude distortion can be seen as a clipping (cutting/chopping) of the peaks of the sound waves as depicted above. Beyond a certain threshold level, the audio device is unable to handle (amplify) the input signal and therefore distorts its shape.

The **frequency distortion** happens due to imperfect/limited frequency response of the audio device. Different frequencies in



an audio signal are amplified unequally thus leading to change in the tonal quality of the sound (also known as colouring of sound).

In professional quality audio recordings, the distortion level is maintained below 1%. Though quite often subtle distortions may not be easily comprehensible to general listener but high level distortions may make communication unclear and unpleasant. Therefore, to have an effective communication through multimedia content, the distortion in audio must be kept to the minimum possible.

Noise

Any unwanted sound may be categorised as *noise*. It means, irrespective of the quality of the sound, the question is whether a sound is desired or not. For example, if two persons are in conversation and some other sounds are also present in area disturbing their conversation, then these disturbing sounds may be referred to as noise. One would like to keep the noise at minimum by adopting different mechanisms to do so. For example, one may simply move away from the source of noise.

In another case, if a presenter standing in the market is describing a story related to the market then the noise around him in the market is desired to have a feeling of the location being shown. In this case, this noise in the market becomes a desired one and this sound effect is known as *ambience*. However you need to avoid too much of ambient sound that may disturb the main voice making it difficult to comprehend.

The electronic devices used for recording and playback of the sound exhibit an inherent electronic noise are known as “*mush*”. This noise is usually represented as “*noise figure*” or “*signal to noise ratio*” (S/N). The unit of noise measurement is *decibel* (db.). Higher the signal to noise ratio better is the equipment.

Similarly, the magnetic tape/cassette recording systems generate a noise known as “*hiss*”. This noise originates from the tape material. With the introduction of the digital recording systems, this kind of noise from recording media (tape, CD etc.) has been nearly eliminated.



At the time of recording, the noise is kept to minimum by keeping the recording level around 0 decibels. If the recording level is quite low then the noise of the system would become audible and interfere with the communication capability of the recorded sound. Best noise rejection should be achieved at the time of recording else it would be very difficult to deal with during post-production.

The louder sound tends to suppress weaker sound and this phenomenon is called *masking*. The masking technique is often used during post-production to suppress the noise. For example, if there is some noise in the recording then, as a rescue measure, it may be masked by mixing background music at a level higher than noise.

Reverberation

The *reverberation*, also called "*reverb*" in short, is the quality of the space in which a sound is being produced, captured or playback. It is basically the persistence of sound after the sound source has ceased to generate. Reverberation occurs due to multiple reflections of sound in a closed space (e.g. room, hall). To understand it better let us take an example of clapping in a large size hall. If you clap once and listen to the sound of the clap, you will notice that the sound does not vanish (fade away) immediately. It is because the sound keeps reflecting from the hard surfaces of the walls and it takes some definite time to completely fade away.

The time period that sound takes to completely fade out is known as *reverberation time (RT)*. The **reverberation time** is defined as the *length of time* required for sound to decay 60 decibels from its initial level. Larger the room size higher is the reverberation time. You might have noticed that it is difficult to hold a conversation in a big empty hall. The large reverberation time of hall makes the speech difficult to understand. It implies that a short reverberation time is desired for the speech and generally a RT of around 0.4 seconds is preferred.

Another phenomenon we observe in our daily life is our tendency to sing in a bathroom. Even though the size of the bathroom is



quite small but because of the hard tiles (highly reflective surface) on the walls of the bathroom, the sound keep reflecting without getting absorbed by the walls. Longer reflection sustenance results in longer reservation time which is most desired for singing and music. Quite often, reverberation times of longer than 0.5 seconds are preferred for song and music recording.

Therefore it may be concluded that to have clear verbal communication a short reverberation time is preferred while a longer reverberation is more suitable for song and music recording. The reverberation quality of a space can be controlled to certain extent by introducing soft materials in the recording space for higher absorption of sound. For example, the curtains, carpets, sofas, furniture and the humans help in reducing the reverberation time by way of more sound absorption. The sound studios are generally designed keeping in mind the intended purpose of the studio i.e. whether studio would be used more often for the speech recording or the music recording

In case of reverberation the reflected waves reach our ears so quickly that we are mostly not able to hear it as a separate sound from the direct sound. The reflected sound mixes well with the original (direct) sound. But, if the sound takes very long time to reflect due to large distance it has to travel e.g. sound in a valley of hills, then the reflected sound can be heard as a separate sound. If you shout hello then valley would reflect the same hello after some time. This effect of space on sound is called “echo”.

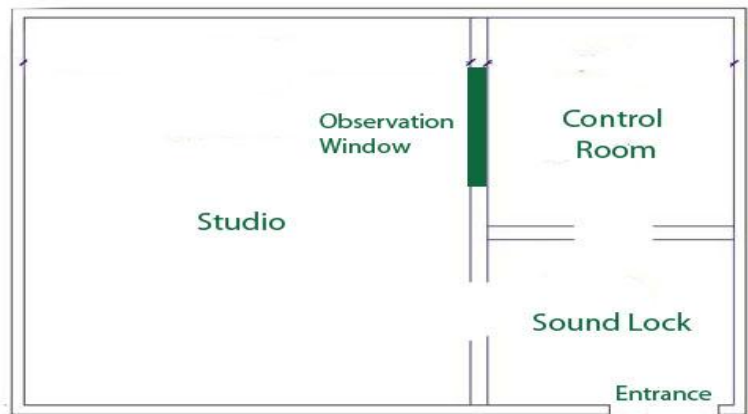
Note: During post production/editing the reverberation time can be increased or echo can be added electronically.

The Audio Studio

Audio studio not only offers a space suitable for the performers but it is also equipped with lot of audio equipment used for sound capturing, processing, monitoring and recording. A typical sound studio would comprise of at least two major areas where one area called “*studio*” is an acoustically treated area created for the artists to perform and the other area, adjacent to the studio, is known as the “*control room*”. Both areas are generally acoustically treated for controlling the reverberation time. The common brick



wall between the two rooms usually has an observation window from where the audio professionals and the performers can see and signal each other. The diagram below shows a simple audio Studio setup.



Title-Fig. 1.7 A Typical Sound Studio Layout Diagram

Attribution- Drawn by Author

Source-

Link-

The Audio Equipment

The studio area is well isolated from the outside world and the control room through sound proof doors and observation window to keep it noise free. The control room is installed with a range of audio equipment as listed below. Generally Control room is the place where most of the equipment along with the technical and production professionals is accommodated

1. Microphones
2. Audio mixer
3. Audio processors
4. Audio recorders and Audio workstations

These are the basic building units of an audio studio. The list is not exhaustive and varies from studio to studio. In order to make use of the equipment to our advantage an understanding of them would help us in making their optimum use. Let us understand them one by one.

Microphone



In the simplest form, the *microphone* is a device that converts the sound into electrical signal known as *audiosignal*. Even though some of you may not have visited an audio studio or a video studio but still you might have used the microphone fitted into your mobile phone. Whatever you speak into the mobile is converted into electrical signals by the microphone and after required processing it is sent to the receiving phone of the distant person where the audio signal is converted back into the sound through a speaker or an earphone. Similarly, in the sound studio, an artist/performer speaks in front of a microphone and his voice is converted into audio signal and recorded.

All microphones are not the same. They come in different shapes and sizes for different kind of applications. They can be classified into different categories as below

1. The technology used i.e. their electrical characteristics,
2. The way they pick sound around them i.e. Polar characteristics and
3. According to their application i.e. the way they are used.

The same microphone may get different names in different situations and applications.

Microphones - Electrical Characteristics

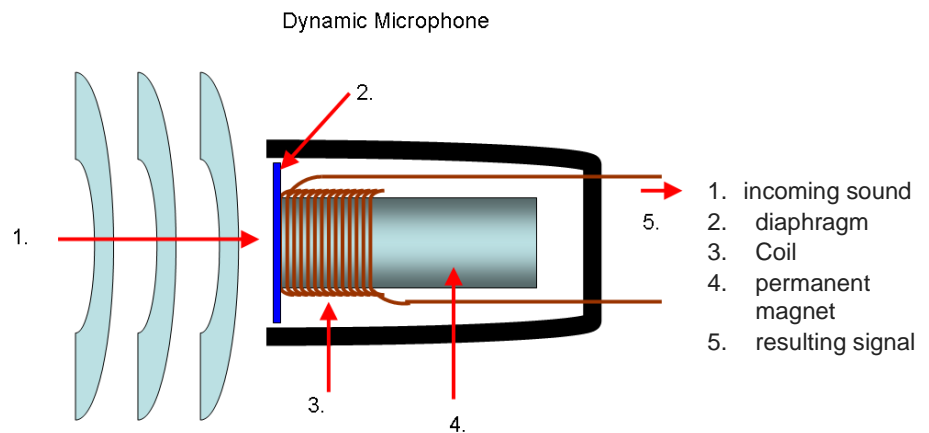
There are many microphone design technologies but for professional applications primarily two types of microphones would find use in our multimedia productions. These microphones are – the *Dynamicmicrophone* and the *Condensermicrophone*.

Dynamic Microphone

Any microphone would have a diaphragm which vibrates when sound waves fall on it. Microphones differ from each other in the way the movement of the diaphragm is converted into electrical signal. Dynamic microphone uses the same dynamic principle as in a loudspeaker, only reversed. A small movable coil made of thin conducting wire positioned in the magnetic field of a permanent



magnet, is attached to the diaphragm. When sound enters the microphone, the sound waves move/vibrate the diaphragm.



Title-Fig. 1.8 A Dynamic Microphone

Attribution- [Banco~commonswiki](#)

Source- [wikimedia.org](#)

Link- <https://commons.wikimedia.org/wiki/File:Mic-dynamic.PNG>

When the diaphragm vibrates, the coil moves in the magnetic field, producing a varying current in the coil through electromagnetic induction.

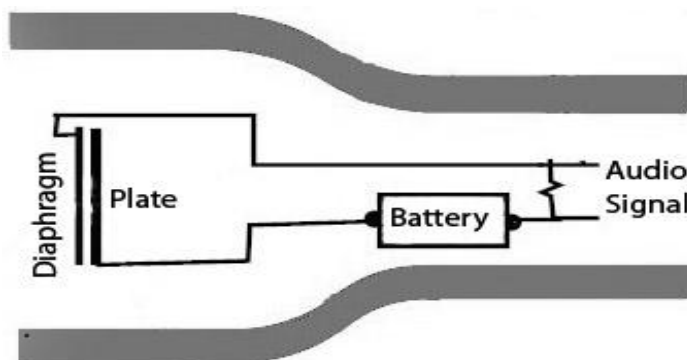
The current generated varies in strength in accordance to the wave shape of the sound falling on the microphone diaphragm. You might have noticed that this kind of microphone generates audio signal without requiring any power supply or the batteries. The dynamic microphone has the following primary features:

- It is quite robust in operation.
- Does not require any power supply to operate
- Low sensitivity – captures loud sounds without distortion.
- The output level ranges from - 60 dB to -70 dB.

Condenser Microphone

While the dynamic microphone is preferred for the stage performances due to its ruggedness, the condenser microphone is preferred in the studio due to higher sensitivity and audio quality. The condenser microphone is also called a *capacitormicrophone* or the *electrostaticmicrophone*. The name condenser or capacitor comes from a component called condenser/capacitor which comprises of two parallel metallic plates separated by a medium

e.g. air to store electric charge. The capacitance of these plates is inversely proportional to the distance between them.



Title- Fig. 1.9 A Condenser Microphone

Attribution- [Harumphy](#)

Source- [Harumphy](#) at [en.wikipedia](#)

Link- https://commons.wikimedia.org/wiki/File:AKG_C451B.jpg

In case of condenser microphone, when sound waves strike the diaphragm they change the distance between the diaphragm and the plate causing a current to flow through a battery powered circuit in proportion to the sound signal. The current variations become an audio signal. Some of the primary features of a condenser microphone are:

1. Superior audio quality
2. Higher sensitivity
3. Low noise
4. Must be handled carefully
5. Need power supply to operate

As you know the condenser microphone needs a power supply for it to function, there are two possibilities of powering it. A good number of condenser microphones have a provision for installing small battery in the microphone body itself. The battery is usually an AA size cell also known as *pencilcell*. This kind of internal battery is quite useful when the microphone has to be used in external environment directly connecting to the camera or recorder. There is a possibility for connecting an external power source to the microphone. Such a power supply is known as "*Phantom power*". In the case of studio recording, the microphone is usually connected to an audio mixer which may have a provision for powering the microphone. Audio mixers with provision for



phantom power obviate the need for battery replacement of the condenser microphone. The phantom power supply is usually of +48 volts.

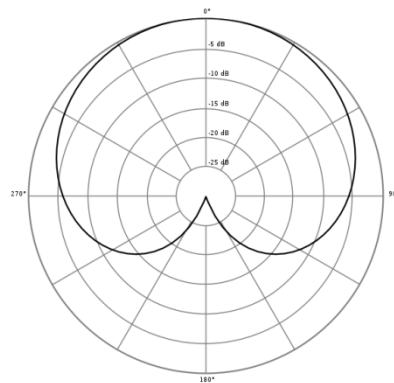
In addition to the dynamic and the condenser microphones described above there are number of other kind of microphones using different technologies in their design. Since these microphones may not be often used for our purpose, we only list them here for reference.

- **Ribbon Microphone** – It usually has a corrugated metal ribbon suspended in a magnetic field. Ribbon microphone doesn't require power supply but is quite fragile.
- **Carbon Microphone**- It uses a capsule or button containing carbon granules pressed between two metal plates. Have extremely low-quality sound reproduction and a very limited frequency response range but is very robust.
- **Piezoelectric Microphone** - Uses the phenomenon of Piezoelectricity, which is the ability of some materials. This Microphone utilises the sound pressure waves to produce an audio signal.
- **Fibre optic Microphone** - A Fibre optic microphone converts acoustic waves into electrical signals by sensing changes in light intensity. Fibre optic microphones are robust, resistant to environmental changes in heat and moisture,
- **MEMS** – Micro Electrical-Mechanical System (MEMS) microphone is also called a microphone chip or silicon microphone. Most MEMS microphones are variants of the condenser microphone design.
- **Loud Speaker as a microphone** - Since a conventional loud speaker is constructed much like a dynamic microphone (with a diaphragm, coil and a magnet), the speaker can actually be used as microphone if instead of sending current to it, it picks sound and current is taken from it. Speakers are sometimes used as microphones in applications where high quality and sensitivity are not needed such as stage shows in villages.

Microphones - Polar Characteristics



So far we have studied that microphones are classified on the basis of technology employed in their design. The technology greatly influences the quality of the microphone but the design also takes care of the way a microphone would capture the sound from its surrounding. A microphone may be able to pick up sounds only from a particular direction and reject other sounds coming from other directions. The microphone directionality helps in achieving a good quality sound recording by rejecting the undesired sound coming from other directions. It helps in controlling the ambient noise and at the same time the revelation that adds to the voice.



Title- Fig. 1.10 A Cardioid Microphone

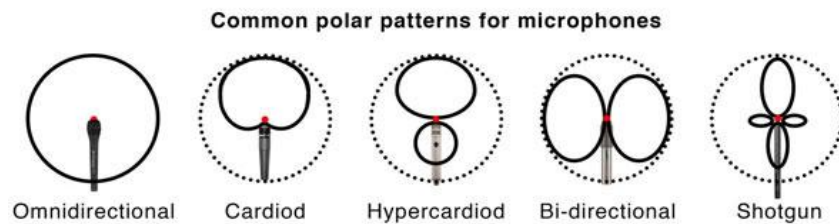
Attribution- [Nicoquaro](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Polar_pattern_cardioid.svg

The microphone directionality is also known as its *polar pattern*. The polar pattern of a microphone shows the sensitivity of the microphone relative to the direction or angle from which the sound arrives.

The most common types of directionality are omni directional, bidirectional and Unidirectional. The diagram below illustrates a number of polar patterns. The microphone faces upwards in each diagram.



Title- Fig. 1.11 Microphone Polar Patterns

Attribution- jay goodman

Source- adorama.com

Link- <https://www.adorama.com/alc/8502/article/recording-interview-audio-all-budgets>

Omni Directional Microphone

An *omnidirectional* (or non-directional) microphone's response is generally considered to be a perfect sphere in three dimensions as shown. But in the real world, this is not the case as the body of microphone obstructs sound from rear side from reaching its diaphragm.

Bi-directional Microphone

"Figure of 8 (eight)" or *bi-directional* microphone receives sound equally from both the front and back of the element. Most ribbon microphones are of this pattern.

Unidirectional microphone

Unidirectional microphones can further be subdivided into

- Cardioid microphone.
- Hyper cardioid microphone.
- Super cardioid microphone.

All these microphones have highly directional characteristics with a difference in their area of coverage in a particular direction. The Super cardioid microphones, also called *gunmicrophones*, are mainly used for picking up the sound from the distance. Such microphones find good application in television program production where the microphone is used with a boom rod and kept out of the camera frame.

Microphones - as per application



Irrespective of the technology used in the making of microphone and its directional pattern, the microphones are also named according to their use. The microphone held by hand is known as *handheld microphone* and the same microphone can be fitted on a stand, through a microphone adaptor, to make it a stand mike. Same microphone when attached to a boom rod is called a *boom mike*.

There are some small microphones which can be clipped on to the clothing near the neck for good pickup of sound and even giving the freedom of face movement. Such microphone is called *livelier microphone* or *lapel microphone*.



Title-Fig. 1.12 A Livelier / Lapel Microphone

Attribution- jay goodman

Source- adorama.com

Link- <https://www.adorama.com/alc/8502/article/recording-interview-audio-all-budgets>

Any microphone which has the capability to connect through a radio frequency link instead of a cable/wire is known as *wireless* or *RF* microphone. Such microphones usually have a small transmitter attached to the microphone. In some cases the transmitter is built in the body of the microphone. A distant receiver receives the radio signal that carries sound and after separating audio from radio signal, sends audio signal to the recorder. These microphones are very suitable in the situations where cable is either to be avoided or cannot be laid. RF microphones provide complete mobility to the person carrying it and particularly the lapel microphones are easy to hide.

How to use microphone?



In our discussion, it is apparent that condenser microphones are highly sensitive and superior in quality of sound as compared to dynamic microphone. That is why condenser microphones are expensive and mostly used in the studios. You may be tempted to use condenser mike for good quality sound but actually the choice of the microphone is dictated by the situation in which a recording is to be performed.

Due to their robustness and relatively low sensitivity, the dynamic microphones are preferred in the situations where harsh environmental conditions exist. These microphones can be easily placed close to the sound sources without the fear of overloading or failure.

Dynamic microphones are good at feedback rejection in the public address applications. The feedback usually occurs when sound from nearby loudspeakers reach back to the microphone and generate a whistling sound. The feedback can be eliminated either by turning down the volume control or by increasing the distance between loudspeakers and the microphone. Another technique to keep the feedback low is by holding microphone too close to the lips so that volume control need not be turned up too much.

You might have witnessed singing competition TV shows having large studio audience and the judges using public address system for monitoring. The singers keeping the microphone too close to their lips to avoid feedback but this is possible only if the microphone has a low sensitivity. In such a situation, the dynamic microphone becomes the first choice. If condenser mike is to be used then enough damping (cutting sound level) needs to be added. Dynamic microphones are more frequently used for audio only programs where there is no need to hide the microphone and it can be used conveniently in close proximities.

Generally, dynamic microphone will not be the right choice if it cannot be placed within 12 inches from the sound source. Then condenser microphone becomes the choice as it is capable of picking up sounds from a distance due to its high sensitivity. The shotgun microphone, because of their narrow pickup pattern (high directivity), is a good choice for noise rejection. Condenser



microphone (Shotgun) quite frequently finds application as a boom microphone.

In outdoor recording, the wind noise becomes an issue in sound recording. When the blowing wind strikes the diaphragm of the microphone, it creates a low frequency noise. In such situations the windscreen, a piece of moulded foam, is placed on the microphone.



Title-Fig. 1.13 A Windshield Microphone

Attribution- jay goodman

Source- adorama.com

Link- <https://www.adorama.com/alc/8502/article/recording-interview-audio-all-budgets>

The windshield breaks the speed of the air reaching the diaphragm but at the same time, due to its perforations, it permits the sound to reach the diaphragm without much resistance.

If you don't find a windshield available at the location then you may wrap a handkerchief over the microphone for similar effect.

The wind noise can also be minimised by changing the microphone direction to avoid facing the direct air.

The wind screen also helps in reducing the “pop sound” generating due to the air gushing out of the mouth of the presenter when a microphone is placed too close to the lips.

Multi microphone recording

When many people are to be recorded together, in some situations, an omni directional microphone may become the choice as it receives sounds from all the directions. Inside a studio the persons can be placed around and near to the Omni microphone and a reasonably good audio can be recorded. If the



Omni microphone have to be placed at a large distance from the persons it may start sounding hollow, The hollowness is the degradation in the sound quality due to excessive reverberation (high reflected sound) reaching the microphone in comparison to the direct sound from the source. The richness in the audio is lost due to hollowness and it sounds to be coming from a distance.

A bi-directional microphone would allow dividing all the persons into two groups on both sides of the microphone. The dead sides of the microphone would not pick up any reflected sound thus reducing the hollowness.

An alternative choice would be to use many unidirectional microphones and provide separate microphone for each individual. The situation would allow each microphone to be placed near to the resource person avoiding the hollowness in sound. However, it is not as simple as it appears to be. For example, if all the persons are on one side of the table and sitting close to each other. Then each microphone would also receive the sound from the adjacent resource persons. This delayed sound coming from a distant person would again introduce hollowness. The best technique would be to arrange the seating arrangement so that each microphone would receive only the sound from its main source and all other persons are either away from it or they are on the dead side (behind the mike) of the microphone. Use of shotgun mike is another possibility.

Audio mixer

The simplest kind of audio recording system would consist of a microphone connected directly to a recorder. This kind of system works best for simple outdoor recordings when either single presenter is speaking or two persons are in conversation. In the studio, usually the system is so arrange that several persons can participate together in a performance. You need to have several microphones for different persons and instruments. Also you may like to take some piece of music or speech from previously recorded source. An audio device known as *audiomixer* accepts inputs from all the microphones and audio devices and mixes them down for feeding to a recorder. The mixer has several controls on its surface as shown in the image.



Title- Fig. 1.14 An Audio Mixer

Attribution- [Biggerbyfar-commonswiki](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Audio_mixer_faders.jpg

The audio mixers are capable of receiving mainly three types of input signals namely Line, Mic (Microphone) and Aux (Auxiliary). The input signal handling capacity of a typical mixer may be as:

Mic	:	-40 db. to -70 db.
Line	:	0 db. And +4 db.
Aux	:	-10 db. to -30 db.

The professional audio devices provide line output signal and consumer grade audio devices more often are able to offer an Aux audio output. The microphones are connected to the mixer through the XLR connectors marked as mic inputs. The number of inputs an audio mixer can handle will depend upon the number of channels available on the mixer. Each channel consists of at least one input connector, gain control and the channel fader for controlling the audio level of that channel. In the image you can see there are 8 white faders which mean it is an 8 channel audio mixer. The output of all the channels goes to the master faders who control the final mixed audio level of the program and this mixed output of the mixer is connected to a recorder through the XLR or RCA output connectors.

Generally, the mixers are also equipped with equalizers for changing the frequency response of the mixer for that particular channel and hence the tonal quality of the sound being mixed.



Generally three controls termed as “Bass”, “Mid” and “Treble” allow cutting down or boosting the related frequencies by about 10db to 15 db.

Some mixers may also have a Phantom power supply provisions at the inputs for powering the condenser microphones. The supply is marked as +48V and is often associated with a corresponding on/off switch.

Audio processors

Audio signal processing or *audio processing* is the intentional alteration of audio signals often through an audio effect unit. The processors are used to introduce echo in recording. Echo is used to simulate the effect of reverberation in a large hall. In this process, one or several delayed signals are added to the original signal. To be perceived as echo, the delay has to be of the order of 35 milliseconds or above.

In equalisers, different frequency bands are attenuated or boosted to produce desired frequency response. Moderate use of equalization (often abbreviated as "EQ") can be used to fine-tune the tone quality of a recording; extreme use of equalization, such as heavily cutting certain frequency can create more unusual effects.

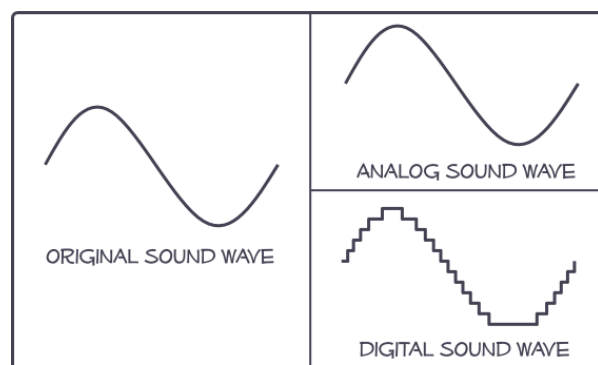
Some of other roles performed by the processes are chorus, phaser, flanger, compressors, filtering, overdrive, robotic voice, pitch shift, time stretching and modulation etc.

Audio Recording Device

Audio recording Technology has evolved greatly. It has made a transition from earlier magnetic tape/cassette recorders to today's Flash Memory based portable recorders. For more Complex audio works the computer based audio workstations are being used. Even today's smart phones have the capability to make a quality audio recording if attached to a good quality external microphone. The modern devices are based on digital technology and the earlier recorders used to be of analogue technology. In the case of analogue technology, the quality of the sound heavily depends upon the medium of recording e.g. Magnetic tape.

Digital Audio

Analogue (Analog) sound is the sound we hear and these sound waves are continuous in time and are analogous to another time varying signal. The digital signals are abruptly/sharply changing signals. In the case of digital technology, an analogue signal is taken as input and is converted into digital through a process of sampling and quantization. The digital signal is basically a kind of mathematical number which any computer can understand where the numbers are made up of only 0 and 1 digits. These mathematical numbers are unaffected by the medium of recording and can be easily manipulated using the computers which are good at processing the digital signals.



Title- Fig. 1.15 Analog Sound Wave

Attribution-

Source-

Link- <http://www.centerpointaudio.com/Analog-VS-Digital.aspx>

We are accustomed to do mathematics using “decimal number system” comprising of 10 digits from 0 to 9. The prefix “deci” comes from the Latin *decimus*, meaning “tenth”. With these 10 digits we are able to count any number and also do all sorts of mathematical computations. Similarly the digital electronics uses “Binary number system” consisting of only two digits i.e. 0 and 1. As we do with decimal system, the mathematical calculations can be done using only 0 and 1 using Boolean (scientist’s name) algebra.

Most digital recorders accept analog audio signal and do the conversion to digital internally before recording in digital audio file format. The analogue to digital conversion (A/D conversion) is done through a process of “sampling” and “quantization”. Instead of taking the whole waveform a number of samples are taken



from the audio wave and at the time of playback these samples; (through approximation) form the basis for recreating the audio signal back to analogue signal.

The number of samples obtained per second is known as *sampling frequency*. Higher the frequency better would be the signal quality. These samples are then converted into binary numbers (Quantisation) using a set of binary digits/numbers. The set of digits could be 8 bit or more. Higher the bit size better is the quality of audio. However, recording higher quality audio either by raising the sampling frequency or by using more bits, results in larger file size requiring more storage space to record.

Digital Audio File Formats

The digital audio is stored in various file formats which includes WAV and MP3 file formats.

Wav File Format

This format was developed to reduce the file sizes by compromising quality but in an efficient manner. *Wav* is the extension used for files containing digitized sound recorded in a professional sound recording system. Wav files are normally large in size depending on length, whether it's recorded in stereo or mono and the sampling rate used. Most of good quality recordings are done at sampling rate of 44.1 kHz or 48 KHz. using 16 bit or higher. Wave file name has a three digit extension represented as .wav.

MP3 file format

It is an open compression standard, designed for storing digital sound's suitable for the Internet. The *MP3* compression algorithm (formulas) analyses the digital file to eliminate sounds inaudible to the human ear. This reduces the file size by up to 90%. The filters can be adjusted to increase the compression with a decrease in both file size and quality. A good quality MP3 should be recorded at a bit rate of 192 Kbits/second or more. Most internet compatible audio content in mp3 format is available at 128 Kbps or less and is not really suitable for good quality music jobs. MP3 file name carries a three digit extension represented as .mp3.

Mono, Stereo and Surround Sound



Monaural or *monophonic* sound reproduction also called *monosound* is intended to be heard as if it were a single channel of sound coming from one direction. Any music system with single speaker may be termed as mono sound system. In the case of Mono sound, the sound reaches listener from a single direction.

In real life, we find sounds coming from all different directions, and to achieve that effect stereo system was developed. The stereo system comprises of two speakers as left and right source of sound. Stereo uses two channels to convey the impression of sound coming from different places i.e. from left, middle, and right.

The stereo system was unable to offer sounds coming from all directions i.e. from the front as well as the rear. To achieve more realism, the surround sound system was developed.

The *Surround System* comprises of minimum 4 sound sources (speakers), out of which 2 are placed in front and two at the rear position in comparison to the sitting position of the listener. Since two front speakers placed at two corners of the room leave a sound gap in the middle, a speaker was added in the centre making a total speakers count of 5. Because the channel speakers are of small to medium dimensions and are not able to handle very low frequency sounds in the range of 20 to 100 Hertz, a special speaker known as *subwoofer* was added to the system.

The sub-woofer does not carry any individual channel information but is used to provide the very low frequency content of all channels combined. The Sub-woofer is termed as 0.1 of the system thus upgrading a 5 channel surround to 5.1 surround sound system. Further development in the technologies introduced more channel surround systems to bring higher level of realism in the sound reproduction. Various technologies like "*Dolby*" were developed to record multi-channel surround sounds on audio recorders capable of recording only two channels/tracks.

The recording techniques of stereo and surround sound are quite complex. In today's film industry, the sound recording technique has evolved to the level of sound designing where the films are made keeping in mind the special theatres (e.g. Dolby/DTS audio based theatres) capable of reproducing surround sound.



Unit summary



Summary

In this unit you learn about the basic nature of sound in terms of frequency and amplitude. The audio ingredients like frequency response, distortion, noise and reverberation primarily influence the quality of sound. Moreover the quality becomes a subjective matter because it depends on the quality of sound that a person is accustomed to hear in his routine life. Different methods of attaining the good audio quality recording are discussed. Understanding the technologies behind the microphone design helps in making a right selection of microphone in different recording situations. Various microphone placement techniques are also learnt. An overview of audio mixer and studio is also discussed. A basic knowledge about mono, stereo and surround system is obtained for generating interest in further learning.

Assignment



Assignment

1. Can you use a sound recorded over a telephone call for your multimedia content? Find out the issues involved and methods to tackle them.
2. The audio can be recorded using the microphone mounted on a video camera but is that recorded sound suitable for professional works like your multimedia presentation? Find the reasons for the quality issues and how to overcome them?
3. Make a recording using sound coming from a loud speaker. What are the quality concerns?

Assessment



Assessment

1. What is Audio?
2. What is Sound?
3. What is the importance of audio / sound quality in a



multimedia work?

4. Explain the various types of microphones.
5. What is noise & distortion?
6. When and how you can use the “Proximity Effect” to your advantage?
7. You are recording in a big empty hall. Describe the expected problems and write how you will overcome these problems?

References and Further Readings

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Unit 2

Understanding Image & Video

Introduction

This unit will expand the knowledge about image and video. It will demonstrate the process of creating images and videos. Also describe the different type resolution and type of formats mostly used in both image & video. This knowledge is necessary for both photographer and videographer.

Outcomes



Outcomes

Upon completion of this unit you will be able to:

- Demonstrate the knowledge of image and video.
- Differentiate the various kinds of image and video on the basis of their resolution and formats.
- Create images and videos.

Terminology



Terminology

Image:

An image is a picture that has been created or copied and stored in electronic form. An image can be described in terms of vector graphics or raster graphics.

Video:

Visual multimedia source that combines a sequence of images to form a moving picture.

Resolution:

A measure of the sharpness of an image or of the fineness with which a device (such as a video display, printer, or scanner) can produce or record such an image usually expressed as the total number or density of pixels in the image.



What is an Image?

The term image means physical resemblance or representation of a person, animal, or thing that is photographed, painted, sculptured or made otherwise made visible.

In other words it can be referred as an optical counterpart or appearance of an object as is produced by reflection from a mirror or refraction by a lens on a surface.

Overview of Image

As discussed above an image is the representation of someone or something. We need to capture a person or animal or a particular moment then we record it as a painting or photograph.

Images may be two-dimensional, such as a photograph or screen display, or three-dimensional, such as a statue or hologram. They may be captured by optical devices such as cameras, mirrors, lenses, telescopes, microscopes, etc. or through natural phenomena, such as the human eye or water.

The word 'image' is also used in the broader sense for two-dimensional figures such as a map, a graph, a pie chart, or a painting. In wider sense, images can also be rendered manually, such as by drawing, the art of painting, carving, rendered automatically by printing or computer graphics technology.

A volatile image is one that exists only for a short period of time. This may be a reflection of an object by a mirror, a projection of a camera obscura, or a scene displayed on a cathode ray tube. A fixed image, also called a hard copy, is one that has been recorded on a material object, such as paper or textile by photography or any other digital process.

Another type of image is graphical image which are generated by computer softwares.



A still image is a single static image. This phrase is used in photography, visual media and the computer industry to emphasize that one is not talking about movies, or in very precise or pedantic technical writing such as a standard.

A *film still* is a photograph taken on the set of a movie or television program during production, used for promotional purposes.

Types of images

The images can be categorized as *analogue* and *digital* depending upon the equipment used to create them.

Mostly the images created on films or canvas are called as analogue images. The images those which are generated through computer or digital modes are called digital images.

Considering images as photographs, the camera which used films or celluloid created analogue images. These type of images are much fine in quality than digital images as it allows the magnification of the images to any level without much distortion. Mostly light sensitive films and papers are used to capture and reproduce analogue images, whereas digital images are made up of pixels which depend on the sensor of the recording or filming device. These images can be magnified or edited to a certain extent as they tend to distort.

The digital images are further divided into two types called raster and vector.

Raster Images:

Raster (or bitmap) images are generally what you think about when thinking of images. These are the types of images that are produced by scanning or photographing an object. Raster images are compiled using pixels, or tiny dots containing unique colour and tonal information that come together to create the image.

Since raster images are pixel based, they are resolution dependent. The numbers of pixels that make up an image as well as how many of those pixels are displayed per inch, both

determine the quality of an image. The more pixels in the image and the higher the resolution is, and the higher quality the image, the larger will be the file size.

For example, if we scale a raster image to enlarge it, without changing resolution, it will lose quality and look blurred or pixelated. This is because we are stretching the pixels over a larger area, thus making them look less sharp. This is a common problem, but can be remedied by using raster image editing programs such as Adobe Photoshop to change resolution and properly scale images.



Title- Fig 2.1 Pixilated raster image

Attribution-

Source- iimagedesign.com

Link- <https://iimagedesign.com/vector-vs-raster-for-logo-design/>

Vector Images:

Instead of trying to keep track of the millions of tiny pixels in a raster image, *vector images*, or *lineart*, keep track of points and the equations for the lines that connect them. Generally speaking, vector images are made up of paths or line art that can infinitely scalable because they work based on algorithms rather than pixels.

One of the greatest things about vector images is that you can re-size them infinitely larger or smaller, and they will still print out just as clearly, with no increase (or decrease) in file size, instead of having to keep track of tons of pixels, the computer just has to keep track of a different number. That takes almost no file space at all.



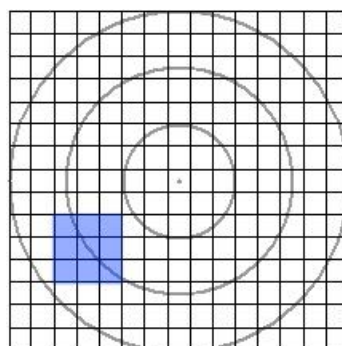
So, what types of graphics would typically be vector? Well, almost all computer font files are based on vector images of the letters - that's why it's possible to scale them WAY up or WAY down and still have the letters be clear.

Resolution of Images

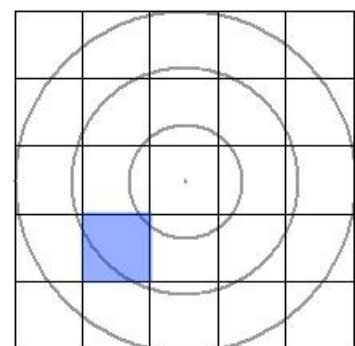
Resolution refers to the quality of image, more technically the amount of pixels the image holds decide its resolution. Resolution is basically referred for digital images.

Before knowing about resolution lets understand the concept of pixels first.

If we take a digital image and look it into it very closely then we can find that there are many small dots. These small dots can be called as pixels. In other words the information about light and colour is recorded as pixel. As in case of film image, the part which is exposed by light creates the image the pixel in digital imagery performs the same role. The amount of pixels decides the resolution or quality of images. The more or less density of pixels results into low or high resolution picture. Resolution can also be related to the clarity of the image. The more amount of pixel in a frame could capture more detail about the subject.



High Resolution



Low Resolution

Title- Fig 2.3 Quality of image / Resolution

Attribution-

Source-

Link-

(Picture source: google.com)



In an image the pixels are arranged in horizontal and vertical pattern. So the resolution can be calculated as the total pixels in one horizontal line x total pixels in one vertical line. So if it is written as 640 x 480, it can be considered as the file size of the image. Similarly other file size is 1028 x 720.

Formats of image

Image file formats are standardized means of organizing and storing digital images. Image files are composed of digital data in one of these formats that can be rasterized for use on a computer display or printer. An image file format may store data in uncompressed, compressed, or vector formats. Once rasterized, an image becomes a grid of pixels, each of which has a number of bits to designate its colour equal to the colour depth of the device displaying it. Formats are necessary for working upon in different timelines and also for storage.

Some of the most commonly used image formats are jpeg, bmp, tiff, png, gif, exif, etc.

JPEG

JPEG (Joint Photographic Experts Group) is a loss compression method; JPEG-compressed images are usually stored in the **JFIF** (JPEG File Interchange Format) file format. The JPEG/JFIF filename extension is **JPG** or **JPEG**. Nearly every digital camera can save images in the JPEG/JFIF format, which supports eight-bit greyscale images and 24-bit colour images (eight bits each for red, green, and blue).

JPEG applies *lossy compression* to images, which can result in a significant reduction of the file size. Applications can determine the degree of compression to apply, and the amount of compression affects the visual quality of the result. When not too great, the compression does not noticeably affect or detract from the image's quality, but JPEG files suffer generational degradation when repeatedly edited and saved. (JPEG also provides lossless image storage, but the lossless version is not widely supported.)



EXIF

The *EXIF* (Exchangeable image file format) format is a file standard similar to the JFIF format with TIFF extensions; it is incorporated in the JPEG-writing software used in most cameras. Its purpose is to record and to standardize the exchange of images with image metadata between digital cameras and editing and viewing software. The metadata are recorded for individual images and include such things as camera settings, time and date, shutter speed, exposure, image size, compression, name of camera, colour information. When images are viewed or edited by image editing software, all of this image information can be displayed.

TIFF

The *TIFF* (Tagged Image File Format) format is a flexible format that normally saves eight bits or sixteen bits per colour (red, green, blue) for 24-bit and 48-bit totals, respectively, usually using either the **TIFF** or **TIF** filename extension. The tagged structure was designed to be easily extendible, and many vendors have introduced proprietary special-purpose tags. TIFFs can be lossy or lossless, depending on the technique chosen for storing the pixel data. Some offer relatively good lossless compression for bi-level (black & white) images. Some digital cameras can save images in TIFF format, using the *LZW* compression algorithm for lossless storage. TIFF image format is not widely supported by web browsers. TIFF remains widely accepted as a photograph file standard in the printing business. TIFF can handle device-specific colour spaces, such as the *CMYK* defined by a particular set of printing press inks. *OCR* (Optical Character Recognition) software packages commonly generate some form of TIFF image (often monochromatic) for scanned text pages.

GIF

GIF (Graphics Interchange Format) is in normal use limited to an 8-bit palette, or 256 colours (while 24-bit colour depth is technically possible). GIF is most suitable for storing graphics with few colours, such as simple diagrams, shapes, logos, and cartoon style



images, as it uses LZW lossless compression, which is more effective when large areas have a single colour, and less effective for photographic or dithered images. Due to GIF's simplicity and age, it has achieved almost universal software support. Due to its animation capabilities, it is still widely used to provide image animation effects, despite its low compression ratio compared to modern video formats.

BMP

The *BMP* file format (Windows bitmap) handles graphic files within the Microsoft Windows OS. Typically, BMP files are uncompressed, and therefore large and lossless; their advantage is their simple structure and wide acceptance in Windows programs.

PNG

The *PNG* (Portable Network Graphics) file format was created as a free, open-source alternative to GIF. The PNG file format supports eight-bit palette images (with optional transparency for all palette colours) and 24-bit true colour (16 million colours) or 48-bit true colour with and without alpha channel - while GIF supports only 256 colours and a single transparent colour.

Compared to JPEG, PNG excels when the image has large, uniformly coloured areas. Even for photographs – where JPEG is often the choice for final distribution since its compression technique typically yields smaller file sizes – PNG is still well-suited to storing images during the editing process because of its lossless compression.

PNG provides a patent-free replacement for GIF (though GIF is itself now patent-free), and can also replace many common uses of TIFF. Indexed-colour, greyscale, and true colour images are supported, plus an optional alpha channel. PNG can store gamma and chromaticity data for improved colour matching on heterogeneous platforms.

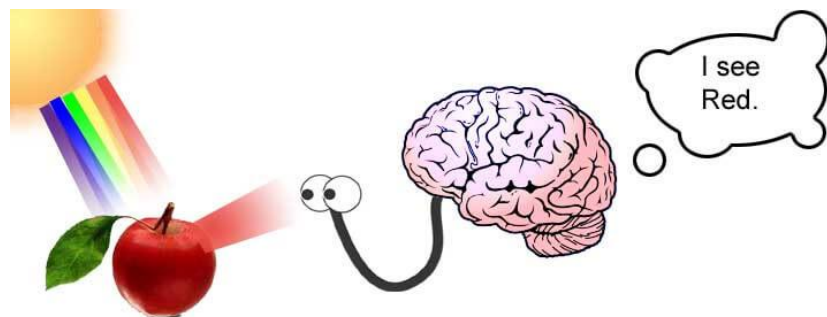
PNG is designed to work well in online viewing applications like web browsers and can be fully streamed with a progressive display option. PNG is robust, providing both full file integrity checking and simple detection of common transmission errors.

What is “colour”?

Colour is the aspect of things that is caused by differing qualities of light being reflected or emitted by them.

To see colour, you have to have light. When light shines on an object some colours bounce off the object and others are absorbed by it. Our eyes only see the colours that are bounced off or reflected.

The sun’s rays contain all the colours of the rainbow mixed together. This mixture is known as *white light*. When white light strikes a white crayon or marker barrel, it appears white to us because it absorbs no colour and reflects all colours equally. A black crayon or marker cap absorbs all colours equally and reflects none, so it looks black to us. While artists consider black a colour, scientists do not because black is the absence of all colour.



Title- Fig 2.4 How do we see colour?

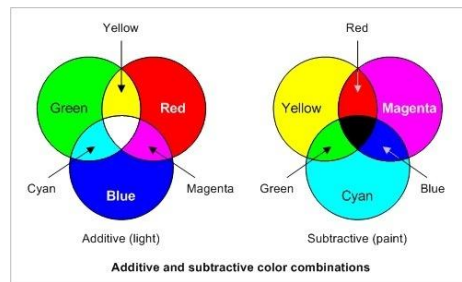
Attribution- Ranjan Gupta & Rahul jindal

Source- pixabay.com

Link-

<http://www.funscience.in/studyzone/Physics/OpticalInstruments/HowDoWeSeeColours.php>

Briefly knowing about photography or image formation one should have a clear idea about colours. Whenever an image is captured, the light falling on the subject reflects onto the image field carrying the information about light and colour. For example if a person is wearing red shirt then only the red colour will be reflected back and other spectrum of light will be absorbed by the shirt.



Title- Fig 2.5 RGB & CMYK color

Attribution- [Bara Darya](#)

Source- quora.com

Link- <https://www.quora.com/Can-you-combine-two-other-colors-to-make-red-If-so-what-two-colors-do-you-use>

An image can be categorized as *colour* image or *black & white* or *monochrome* image. The colour image can further be divided into *RGB* and *CMYK*. The RGB represents **Red**, **Green**, and **Blue** spectrum of light which also called as *primarycolour*. The CMYK represents **Cyan**, **Magenta**, **Yellow**, and **Black** spectrum of light which are known as *secondarycolours*.

What is a “video”?

Video is a **Visual multimedia source** that combines a sequence of images to form a moving picture. The video transmits a signal to a screen and processes the order in which the screen captures should be shown. Videos usually have audio components that correspond with the pictures being shown.

History of video

Video technology was first developed for mechanical television systems, which were quickly replaced by *cathode ray tube* (CRT) television systems, but several new technologies for video display devices have since been invented. Video was originally exclusively a live technology.

Charles Ginsburg led an Apex research team developing one of the first practical *video tape recorders* (VTR). In **1951** the first video tape recorder captured live images from television



cameras by converting the camera's electrical impulses and saving the information onto magnetic video tape.

Video recorders were sold for \$50,000 in 1956, and videotapes cost \$300 per one-hour reel. However, prices gradually dropped over the years; in 1971, Sony began selling videocassette recorder (VCR) decks and tapes into the consumer market.

The use of digital techniques in video created *digitalvideo*, which allowed higher quality and, eventually, much lower cost than earlier analog technology. After the invention of the *DVD* in **1997** and *Blu-ray Disc* in **2006**, sales of videotape and recording equipment plummeted. Advances in computer technology allowed even inexpensive personal computers to capture, store, edit and transmit digital video, further reducing the cost of video production, allowing program-makers and broadcasters to move to tapeless production.

As of **2015**, with the increasing use of high-resolution video cameras with improved dynamic range and colour sensors, and high-dynamic-range digital intermediate data formats with improved colour depth, modern digital video technology is slowly converging with digital film technology.

Characteristic of video

Every video signal is a collection of number of still frames with movement. What is frame? A *frame* is the amount of space covered by a lens. If we cut a rectangular piece of paper and try to look through it then we can make out the difference between the amount of area which we can see through bare eyes and the area seen through the piece of paper. This rectangular piece of paper can be related to a frame of a camera. So a video signal is created when a fixed amount of frames captured during a second. The video signals are electricity dependant hence all over the world the video signals are categorized as same.

The three commonly used video signals are **PAL**, **NTSC** and **SECAM**. These are known as standard definition videos.



PAL (Phase Alternating Lines), is a colour encoding system for analogue television used in broadcast television systems in most countries broadcasting at 625-line / 50 fields (25 frames) per second.

NTSC, named after the **National Television System Committee**, the analog television system used in Philippines, and until digital conversion it was used in most of the Americas, Burma, South Korea, Taiwan, Japan, and some Pacific island nations and territories.

NTSC colour encoding uses approximately 29.97 interlaced frames of video per second. Each frame is composed of two fields, each consisting of 262.5 scan lines, for a total of 525 scan lines. 483 scan lines make up the visible raster. The remaining (the vertical blanking interval) allow for vertical synchronization and retrace. This blanking interval was originally designed to simply blank the receiver's CRT to allow for the simple analog circuits and slow vertical retrace of early TV receivers. However, some of these lines may now contain other data such as closed *captioning* and *vertical interval time code* (VITC). In the complete raster (disregarding half lines due to interlacing) the even-numbered scan lines (every other line that would be even if counted in the video signal, e.g. {2, 4, 6, ..., 524}) are drawn in the first field, and the odd-numbered (every other line that would be odd if counted in the video signal, e.g. {1, 3, 5, ..., 525}) are drawn in the second field, to yield a flicker-free image at the field refresh frequency of $60/1.001$ Hz (approximately 59.94 Hz). For comparison, 576i systems such as PAL-B/G and SECAM use 625 lines (576 visible), and so have a higher vertical resolution, but a lower temporal resolution of 25 frames or 50 fields per second.

SECAM(Sequential colour with memory), is an analogue colour television system first used in France. It was one of three major colour television standards.

Just as with the other colour standards adopted for broadcast usage over the world, SECAM is a standard which permits existing monochrome television receivers predating its introduction to



continue to be operated as monochrome televisions. Because of this compatibility requirement, colour standards added a second signal to the basic monochrome signal, which carries the colour information. The colour information is called *chrominance* or *C* for short, while the black-and-white information is called the *luminance* or *Y* for short. Monochrome television receivers only display the luminance, while colour receivers process both signals.

Video can be *interlaced* or *progressive*. Interlacing was invented as a way to reduce flicker in early mechanical and CRT video displays without increasing the number of complete frames per second, which would have sacrificed image detail to remain within the limitations of a narrow bandwidth. The horizontal scan lines of each complete frame are treated as if numbered consecutively, and captured as two *fields*: an *odd field* (upper field) consisting of the odd-numbered lines and an *even field* (lower field) consisting of the even-numbered lines.

Analog display devices reproduce each frame in the same way, effectively doubling the frame rate as far as perceptible overall flicker is concerned. When the image capture device acquires the fields one at a time, rather than dividing up a complete frame after it is captured, the frame rate for motion is effectively doubled as well, resulting in smoother, more lifelike reproduction (although with halved detail) of rapidly moving parts of the image when viewed on an interlaced CRT display, but the display of such a signal on a progressive scan device is problematic.

NTSC, PAL and SECAM are interlaced formats. Abbreviated video resolution specifications often include an “i” to indicate interlacing. For example, PAL video format is often specified as *576i50*, where 576 indicates the total number of horizontal scan lines, *i* indicate interlacing, and 50 indicate 50 fields (half-frames) per second.

In *progressive scan* systems, each refresh period updates all scan lines in each frame in sequence. When displaying a natively progressive broadcast or recorded signal, the result is optimum spatial resolution of both the stationary and moving parts of the image. When displaying a natively interlaced signal, however,



overall spatial resolution is degraded by simple line doubling— artefacts such as flickering or "comb" effects in moving parts of the image appear unless special signal processing eliminates them. A procedure known as *de-interlacing* can optimize the display of an interlaced video signal from an analog, DVD or satellite source on a progressive scan device such as an LCD Television, digital video projector or plasma panel. De-interlacing cannot, however, produce video quality that is equivalent to true progressive scan source material.

Aspect ratio

Aspectratio describes the dimensions of video screens and video picture elements. All popular video formats are rectilinear, and so can be described by a ratio between width and height. The screen aspect ratio of a traditional television screen is 4:3, or about 1.33:1. High definition televisions use an aspect ratio of 16:9, or about 1.78:1.

Pixels on computer monitors are usually square, but pixels used in digital video often have non-square aspect ratios, such as those used in the PAL and NTSC variants of the CCIR 601 digital video standard, and the corresponding anamorphic widescreen formats. Therefore, a 720 by 480 pixel NTSC DV image displays with the 4:3 aspect ratio (the traditional television standard) if the pixels are thin, and displays at the 16:9 aspect ratio (the anamorphic widescreen format) if the pixels are fat.

Formats of Video

Like still images, video is also divided as *analogue* and *digital*.

Analog video is a video signal transferred by an analog signal. An analog colour video signal contains *luminance*, *brightness* (Y) and *chrominance* (C) of an analog television image. When combined into one channel, it is called *compositevideo* as is the case, among others with NTSC, PAL and SECAM.

Analog video may be carried in separate channels, as in two channel *S-Video* (YC) and multi-channel *componentvideo* formats.



Analog video is used in both consumer and professional television production applications.

Analog video are divided into sub categories depending on the transmission of signal such as component, composite, s-video.

Component Video (one channel) is an analog video transmission (without audio) that carries standard definition video typically at 480i or 576i resolution. Video information is encoded on one channel, unlike the higher-quality S-video (two channels) and the even higher-quality component video (three or more channels).

Composite video is usually in standard formats such as NTSC, PAL, and SECAM and is often designated by the **CVBS** initialise, for colour, video, blanking and sync, or simply as **video**. Mostly composite video signals are carried through by RCA cables.

S-Video (also known as **separate video** and **Y/C**) is a signalling standard for standard definition video, typically 480i or 576i. By separating the black-and-white and colouring signals, it achieves better image quality than composite video, but has lower colour resolution than component video. The S-video cable carries video using two synchronized signal and ground pairs, termed **Y** and **C**.

Y is the *luma* signal, which carries the *luminance* – or black-and-white – of the picture, including synchronization pulses.

C is the *chroma* signal, which carries the *chrominance* – or colouring-in – of the picture. This signal contains both the saturation and the hue of the video.

The luminance signal carries horizontal and vertical sync pulses in the same way as a composite video signal. Luma is a signal carrying luminance after gamma correction, and is therefore termed "Y".

In composite video, the signals co-exist on different frequencies. To achieve this, the luminance signal must be low-pass filtered, dulling the image. As S-Video maintains the two as separate signals, such detrimental low-pass filtering for luminance is



unnecessary, although the chrominance signal still has limited bandwidth relative to component video.

Component video is a video signal that has been split into two or more component channels. In popular use, it refers to a type of component analog video (CAV) information that is transmitted or stored as three separate signals. Component video can be contrasted with *composite video* (NTSC, PAL or SECAM) in which all the video information is combined into a single line level signal that is used in analog television. Like composite, component-video cables do not carry audio and are often paired with audio cables.

When used without any other qualifications the term *component video* usually refers to analog YP_BP_R component video with sync on luma.

Digital video is a representation of moving visual images in the form of encoded digital data. Digital video comprises a series digital images displayed in rapid succession.

Digital video was first introduced commercially in **1986** with the **Sony D1 format**, which recorded an uncompressed standard definition component video signal in digital form instead of the high-band analog forms that had been commonplace until then.

Digital video can be copied with no degradation in quality. In contrast, when analog sources are copied, they experience generation loss. Digital video can also be stored on hard disks or streamed over the Internet to end users who watch content on a desktop computer screen or a digital smart TV. In everyday practice, digital video content such as TV shows and movies also includes a digital audio soundtrack.

Digital videos are classified depending upon the pixel rate. Full HD and half HD are the most common used terms in digital video field.

Full HD pixel rate is 1080 pixels per inch whereas half HD pixel rate is 720pixels per inch.

Like the digital image system, digital videos are also stored or encoded into different formats. Some of these formats are mpeg4,



H.264, CCIR etc. Each encoding format resembles the compression rate of the video signal.

Unit summary



Summary

This unit introduced the image and its types. Described the various resolutions of image and also discussed what an image is made up of.

It also gave brief knowledge about Colour and its type.

Along with images it also introduced videos; its different types of signals and format. Also explained how video signals are carried or transmitted.

Assessment



Assessment

1. What is an image?
2. What are different types of images?
3. Differentiate between raster and vector images.
4. What is a pixel?
5. Name some of the image formats.
6. What is colour?
7. What is aspect ratio?
8. What is a video? Discuss the various format of video.
9. What are the different types of analogue videos?



Unit 3

Film and Digital Photography

Introduction

In this unit you will learn the art & science of photography. It will introduce the basic knowledge and fundamental techniques of photography with both film/analogue & digital cameras. It will elaborate all techniques, camera function/parts, composition rules, lighting and other important aspects of photography which are prerequisite to taking a better photograph. Based on these techniques, you will learn how to apply them to various situations. While you go through the unit step by step, you will be able to acquire basic understanding of how to take better photos. You will also learn about the difference of analogue and digital photography medium.

Outcomes



Outcomes

Upon completion of this unit you will be able to:

- Exhibit knowledge about is photography.
- Utilize the various composition & lighting techniques for better photography.
- Differentiate between film and digital photography.
- Understand different lighting patterns.



Terminology



Terminology

- Photography:** It is the art or process of producing images by the help of any radiant energy and especially light on a sensitive surface (as film or an optical sensor).
- Composition:** **Composition** is the presentation of visual elements in an image, especially the placement of the subject in relation to other objects.
- Lighting:** This is the deliberate use of light to achieve a practical or aesthetic effect to create an image as per requirement.

What is “Photography”?

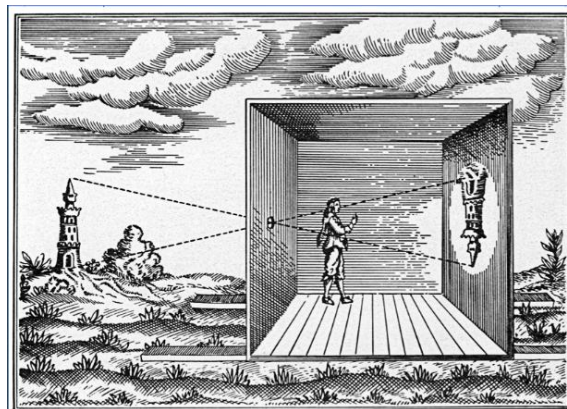
The term *photography* means the science and practice of creating long lasting images by recording light or other electromagnetic radiation. This could be done electronically with help of an image sensor, or chemically by means of a light-sensitive material such as photographic film.

Basically, a *lens* is used to focus the light reflected or emitted from objects onto a light-sensitive surface inside a camera with a timed exposure. When an *electronic image sensor* is used, it produces an electrical charge, which is electronically processed and stored in a digital image file for subsequent display or processing. In case of *lightsensitive films* the image is captured as hidden image which is then further developed by chemical process to get the visible image. A negative image on film is traditionally used to photographically create a positive image on a paper base, known as a *print*, either by using an enlarger or by contact printing.

Overview of photography

The discovery of photography started with the principle of camera *obscura*. The camera obscura was first used in ancient China. Leonardo da Vinci discovered that natural camera obscura is formed by dark caves on the edge of a sunlit valley. A hole in the cave wall acts as a *pinhole camera* which allows light to project a laterally reversed, upside down image on a piece of paper. So means of photography then evolved with inventing means to capture and keep the image produced by the camera, mirrors, lenses, telescopes, microscopes, etc. and natural objects and phenomena, such as the human eye or water.

Around the year **1800**, the *first attempt to capture image on any light sensitive substance* was made by **British inventor Thomas Wedgwood** with a camera obscura. He used paper or white leather treated with silver nitrate. Around **1802** it was found that *"the images formed by means of a camera obscura have been found too faint to produce, in any moderate time, an effect upon the nitrate of silver."* The shadow images eventually darkened all over.



Title-Fig 3.1 Camera Obscura/Pin-hole Camera

Attribution- King James

Source- prezi.com

Link- https://prezi.com/1fluj_abvwsv/camera-obscura-pinhole-cameras/



Technology of Photography

The most widely used photographic process is the *black-and-white negative–positive system*. When light is projected with the help of camera, the lens projects an image of the scene being photographed onto a film coated which is covered with light-sensitive silver salts, such as silver bromide. The camera *shutter* allows light reflected from the scene for a given time to produce an invisible but developable image in the sensitized layer, thus exposing the film.

While the development process (in a darkroom) the *silver salt crystals* that have been struck by the light are converted into *metallic silver*, forming a visible deposit or density. The more light that reaches a given area of the film, the more silver salt is converted into black portion which marks the exposed area and the denser the silver deposit that is formed there. An image of various brightness levels thus yields a picture in which this brightness are tonally reversed—a negative. The brighter the subject its details will be recorded as dark or dense areas in the developed film and the portions which are not so bright or don't reflect much light will be marked as light portion.

Once the film is developed the film is treated with a *fixing bath* that dissolves away all undeveloped silver salt and so prevents subsequent darkening of such unexposed areas. After these process when all the silver salts are washed away the invisible image becomes visible as a permanent negative silver image within the *gelatine* layer.

A *positive picture* is obtained when this negative image is again exposed through light by the help of a device called *Enlarger* onto a light sensitive paper. As in case of exposure of films the paper also when gets exposed creates a latent image. This image can be further developed through chemical process to achieve the final image. In contact printing the negative film and the paper are placed face to face in intimate contact and exposed by diffused light shining through the negative. The dense (black) portions of the negative image result in little exposure of the paper and, so, yield light image areas; thin portions of the negative let through



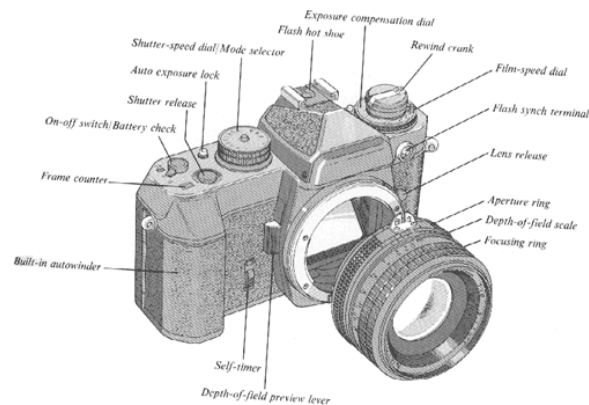
more light and yield dark areas in the print, thus re-creating the light values of the original scene.

Whereas in *digital photography* the principle is almost the same but the light sensitive film is replaced by light sensitive electronic sensors also called *CCD* (charge coupled device). The light rays fall on these *CCD* and the *CCD* creates an electronic signal which is recorded on a storing device as image.

Camera and lenses

To gain the knowledge about photography we have to firstly be familiar with the main device needed for photography i.e. the camera.

In its simplest form, the camera is a light-tight container carrying a *lens*, a *shutter*, a *diaphragm*, a *device for holding* (and changing) the *film in the correct image plane*, and a *viewfinder* to allow the camera to be aimed at the desired scene.



Title- Fig 3.2 Parts of a Camera

Attribution-

Source-

Link-<https://sites.google.com/site/tyshonharrisphoto/photography-basics/camera-parts-functions>

The **lens** projects an inverted image of the scene in front of the camera onto the film in the image plane. The image is sharp only if the film is located at a specific distance behind the lens. This distance depends on the *focal length* of the lens and the distance of the object in front of the lens. All the cameras have a

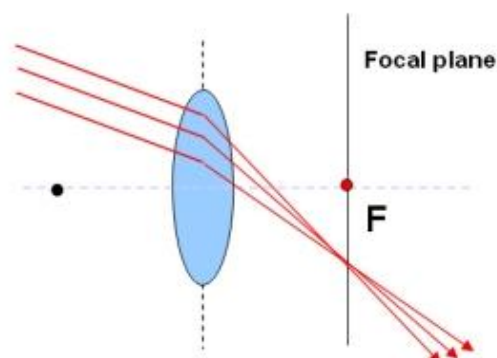


mechanism to adjust the distance between the lens and focal plane to capture near and far away objects to create sharp images. In some cameras focusing adjustment is achieved by moving only the front element or internal elements of the lens, in effect modifying the focal length.

The **shutter** consists of a set of metallic leaves mounted in or behind the lens or a system of blinds positioned in front of the film. The shutter is made to be open and close for a desired time to expose the film to the image formed by the lens according to the availability of light. The amount of light can be controlled by two things that are the *timing* and *speed of shutter* and second is the *aperture* which is the amount of opening of the lens diaphragm. The diameter of the aperture is adjustable. The combination of the diaphragm opening and exposure time is the photographic exposure. To obtain a film image that faithfully records all the tone gradation of the object, this exposure must be matched to the brightness (luminance) of the subject and to the sensitivity or speed of the film. Light meters built into most modern cameras measure the subject luminance and set the shutter or the lens diaphragm to yield a correctly exposed image.

Focal plane

The *focal plane* of a camera is the region inside the camera where the lens converge the entire light ray to create an image. The point where a sharp image is created is called the *focal point*. It is the point where the film roll or the ccd is located.





Title- Fig 3.4 Focal Plane

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Source-

Link- <http://astronomy.swin.edu.au/cosmos/F/Focal+Plane>

Viewfinder

The *viewfinder* is a small lens located above the focal point. It helps the photographer to see through and compose the frame. Whatever is seen through the viewfinder will be captured on the film.



Title- Fig 3.5 Viewfinder of a Camera

Attribution- [Bladeor](#)

Source- [wikimedia.org](https://commons.wikimedia.org/wiki/File:Nikon_D90_Viewfinder.JPG)

Link- https://commons.wikimedia.org/wiki/File:Nikon_D90_Viewfinder.JPG

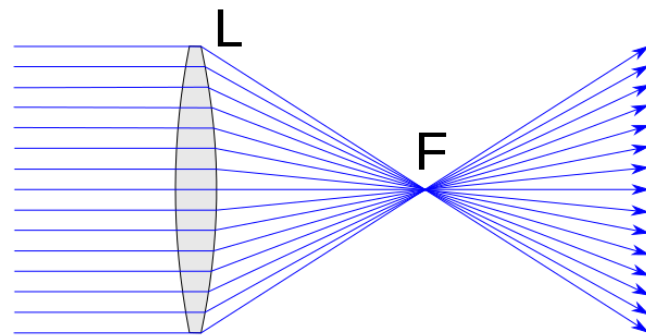
Lens

The *lens* is the main and inseparable part of a camera. The lens is a transparent piece of glass which has the ability to bend light ray to create an image on a plane.

There are two types of lens; *convex and concave lens*.

Convex lens

A convex lens is a converging lens. When parallel rays of light pass through a convex lens the refracted rays converge at one point called the *principal focus*. The distance between the principal focus and the centre of the lens is called the *focallength*.



Title- Fig 3.6 Convex Lens

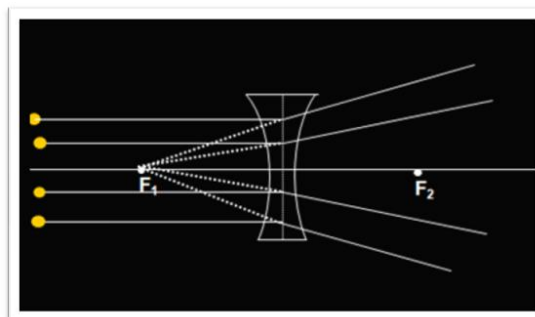
Attribution- [Chetvorno](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Convex_lens_-_perfect.svg

Concave lens

Concave lenses are thinner at the middle. Rays of light that pass through the lens are spread out (they diverge). A concave lens is a diverging lens. When parallel rays of light pass through a concave lens the refracted rays diverge so that they appear to come from one point called the principal focus.



Title- Fig 3.7 Concave Lens

Attribution- [Kvr.lohith](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Concave_lens-diverging_rays.png

Camera lenses are made with a wide range of focal lengths. They range from extreme wide angle to extreme close magnification. Each lens is designed to suit a certain type of photography. The extreme wide angle may be preferred for architecture because it has the capacity to capture a wide view of a building. The normal lens which mostly has a wide aperture is often used for street

and documentary photography. The telephoto lens is useful for sports and wildlife but it is more susceptible to camera shake. The camera lens serves a dual purpose of *focussing* and *zooming/magnification* of a subject.

A camera lens can be made up of one or more lenses according to the need. The lens which are made up of only type of lens either convex or concave are called block lens. The lens which contains more than one lens is called telephoto lens. It mostly contains two or more convex and concave lenses.



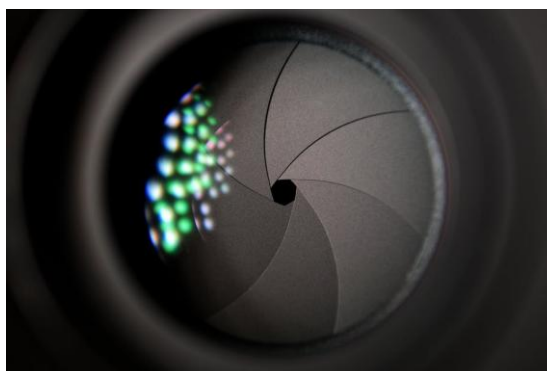
Title- Fig 3.8 Camera Lens

Attribution- [Multimoty](#)

Source- [wikimedia.org](#)

Link- <https://commons.wikimedia.org/wiki/File:24mm-Fixed-focal-SLR-lens.jpg>

A camera lens also contains a mechanism to control the amount of light entering through the lens and falling on the film plane. This mechanism or opening is called *aperture*. The aperture is denoted as “f” and it is counted in stops. Every stop is a next multiple of the previous. The aperture opening starts from f/1.4 then f/2 likewise f/2.8, f/4 and up to f/22. The smaller the stop the bigger the opening and the more the amount of light will be passed through.



Title- Fig 3.9 Aperture in a camera

Attribution-

Source- [pixabay.com](#)



Link- <https://www.pexels.com/photo/aperture-art-blur-camera-414781/>

Shutter

In camera, a *shutter* is a device that allows light to pass for a determined period for exposing photographic film or a light-sensitive electronic sensor in order to capture a permanent image of a scene. But in case of projector, shutter can also be used to allow rays of light to pass outwards to project images. A shutter of variable speed is used to control exposure time of the film. The shutter is so constructed that it automatically closes after a certain required time interval. The speed of the shutter is controlled by a ring outside the camera, on which various timings are marked.

The shutter speed determines the time for which the amount of light will pass through lens and fall on the film plane. The shutter speed varies according to what amount of one second they open and close.

The shutter speeds are denoted as 1/250, 1/500, 1/1000. These indicate that the shutter plate opens and close within 1000th of a second and else wise.

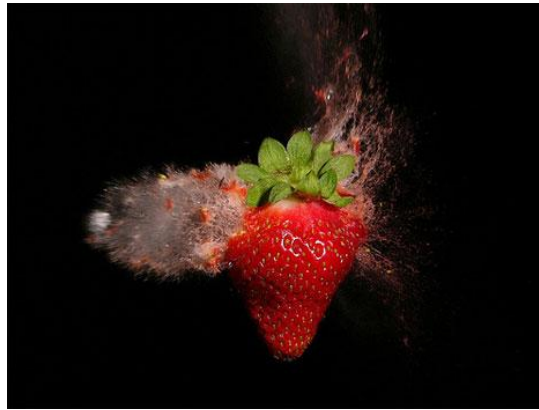
If one wants that the shutter should be remain open for as much time he wants he can click and hold the shutter button as long he wants. Nowadays self-click cameras are also available which are timed for the desired timing and the camera will do the rest.

Techniques of photography

Photography is not just point and shoots. There are many principles and techniques which should be followed and included through regular experimentation to achieve a breathtaking and perfect photograph.

High Speed Photography

High speed photography is the technique of capturing highly speed moving object so that it could be seen by the human eye. Mostly subjects like bullet or a speed moving vehicle can be captured using this technique. For this the highest possible shutter speed available in a camera is used. It could vary from 1/1000 to 1/4000.



Title- Fig 3.10 High speed photography

Attribution-

Source- [elakiri.com](http://www.elakiri.com)

Link- <http://www.elakiri.com/forum/showthread.php?t=1594950>

Motion-blur Photography

Motion blur is the art of capturing a moving subject. This technique is often used in *sports photography*, but can also be used to create interesting images with light or fast moving objects. The background gets blurred but the main subject looks like frozen in time. To create motion blur effect, slowing down the shutter speed and holding the camera still while panning the camera from the opposite direction of the subject motion would result perfectly timed picture.



Title- Fig 3.11 Motion-blur photography

Attribution- [E01](#)

Source- [wikimedia.org](http://commons.wikimedia.org/wiki/File:London_bus_and_telephone_box_on_Haymarket.jpg)

Link-

https://commons.wikimedia.org/wiki/File:London_bus_and_telephone_box_on_Haymarket.jpg



Macro Photography

When we photograph something very small we call it *macro photography*. Shooting small things poses great challenges and comes with high rewards. When we talk about macro photography we tend to think about small things that we shoot from a close distance.

Macro photography is extreme close-up photography, usually of very small subjects and living organisms like insects, in which the size of the subject in the photograph is greater than life size according to some definitions, a macro photograph is one in which the size of the subject on the negative or image sensor is life size or greater. However, in other uses it refers to a finished photograph of a subject at greater than life size.



Title- Fig 3.12 Macro Photography

Attribution- [Endervale](#)

Source- [pixabay.com](#)

Link-

https://commons.wikimedia.org/wiki/Category:Macro_photography#/media/File:Aphaenogaster_spinosa_testa.jpg

Long exposure photography

Long exposure photography as the name suggests is technique of photography by using longer exposure times than needed to obtain a correctly exposed photograph, either during daytime deliberate intent to create an effect on any moving object that is typical for long exposure photographs. Effects like blurred skies



with streaks of clouds, smoothed out water like if it was frozen, blurred ghostlike people, star trails, moon trails and light trails can be achieved by this technique.

Not only the duration of the exposure that qualifies it as a long exposure photograph, but also when intentionally capturing moving objects with longer exposure times than necessary that makes it a long exposure photograph.



Title- Fig 3.13 Long Exposure Photography

Attribution- [Diego Delso](#)

Source- [pixabay.com](#)

Link-

https://commons.wikimedia.org/wiki/File:R%C3%ADo_Moscova,_Mosc%C3%BA,_Rusia,_2016-10-03,_DD_16-17_HDR.jpg

Composition

Composition, the act of composing the image through viewfinder, is a visual process of organizing the elements and individual details of a scene into a balanced and pleasing arrangement. Because what one person finds pleasing, someone else will not, composition is largely a matter of personal taste.

In simple words, composition is including what and how much of the elements in a frame so that the photograph appears attractive or meaningful.

A photograph is mostly rectangular in shape in the ratio of 4:3 as it is believed that the area covered by our naked eye is rectangular. So the frame in the camera is also meant to be rectangular. So when composing a subject we have to include what we want to shoot and how much we want to shoot within that frame. While



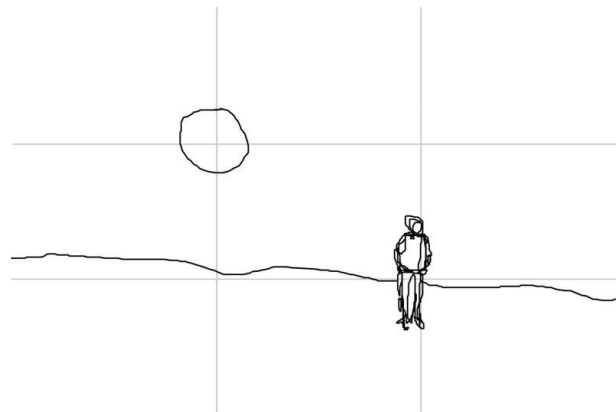
shooting we can just compose whatever is in front of us with just looking at the viewfinder and making the desired frame or else we can arrange other elements if it is a staged photography in the way we want to create the composition we want.

There are some basic rules of composition which we have to keep in mind which can help us creating good photographs.

Rule of thirds

The *rule of thirds* is one of the most useful composition techniques in photography. It's an important concept to learn as it can be used in all types of photography to produce images which are more engaging and better balanced.

The rule of thirds involves mentally dividing up your image *using 2 horizontal lines and 2 vertical lines*, as shown below. You then position the important elements in your scene along those lines, or at the points where they meet.



Title- Fig 3.14 Composition Rule: Rule of Third

Attribution- [CIngre~commons/wiki](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Rule_of_thirds.jpg

When framing a photo, imagine the scene divided up as above. Think about what elements of the photo are most important, and try to position them at or near the lines and intersections of the grid. They don't have to be perfectly lined up as long as they're close.



You may need to move around to get the best composition. This forces you to think more carefully about the shot, and is a good habit to get into whether you're using the rule of thirds or not. But it is advisable to keep the main part of the composition in the centre of the grid which is called the golden rectangle. The human eye tends to look at the centre first.

To help you out, some cameras have a setting which overlays a rule of thirds grid onto your photo. This removes all guesswork and helps you get your positioning even more accurate.

Balancing of elements

Placing your main subject off-centre, as with the rule of thirds, creates a more interesting photo, but it can leave a void in the scene which can make it feel empty. You should balance the "weight" of your subject by including another object of lesser importance to fill the space.

Symmetry and patterns

We are surrounded by *symmetry* and *patterns*, both natural and man-made. They can make for very eye-catching compositions, particularly in situations where they are not expected. Another great way to use them is to break the symmetry or pattern in some way, introducing tension and a focal point to the scene. Keeping proper balance in the pattern is very necessary.

Depth

Because photography is a two-dimensional medium, we have to choose our composition carefully to convey the *sense of depth* that was present in the actual scene. You can create depth in a photo by including objects in the foreground, middle ground and background. Another useful composition technique is overlapping, where you deliberately partially obscure one object with another. The human eye naturally recognises these layers and mentally separates them out, creating an image with more depth.



Types of shots

Every photograph or photographic composition is called *a shot*. But each shot cannot be same all the time. It would vary depending upon the mood of the photographer and the availability of the subject.

So the composition or framings are divided into various types of shots which deliver different kind of mood and information.

Extreme long shot

An *extreme long shot (ELS)* is also known as extreme wide shot. It covers a very wide area which shows the whole figure of the subject as well as its surroundings. It also provides a context for the scene, which means the viewer could locate where the subject is placed. Very less detail about the subject is available in this type of shot.



Title- Fig 3.19 Extreme long shot photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

Long shot

A *long shot (LS)* also known as full shot is closer to the subject than the ELS. It frames the whole figure of the subject. A smaller portion of the surrounding is seen in context to the subject. The

point of focus is the main subject. This type of shot catches the action rather than the emotion.



Title- Fig 3.20 Long Shot Photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

Medium long shot

Medium Long Shot (MLS) is also known as a three-quarters shot. While shooting a person it frames the subject from head to knee. It is just in between composition of long shot and medium shot.



Title- Fig 3.21 Medium Long Shot Photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

Medium shot

Medium shot (MS) also known as mid shot is a camera shot in which the subject is in the middle distance, permitting



some of the background to be seen. In this shot both emotion and action of the subject can be captured.



Title- Fig 3.22 Medium Shot Photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

Medium close shot

Medium close covers the subject from head and cuts off around mid-chest. The focus is on the subject. It reveals only little of the surroundings. It focuses the facial expressions of the subject.



Title- Fig 3.23 Medium Close Shot Photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

Close Shot

Close shot (CS) frames a subject's face and cuts off mid-neck, showing the face and entire head. The subject fills almost the entire frame. It captures facial expressions and emotions.



Title- Fig 3.24 Close Shot Photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

Extreme Close Shot

Extreme close shot frames only some part of the subject which photographer wants to shoot very closely. In case of person or animal it maybe only the eyes, ears or lips etc. mostly only the strong emotions are captured in this shot.



Title- Fig 3.25 Extreme Close Shot Photograph

Attribution- [Justin Dise](#)

Source- bhphotovideo.com

Link-<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>

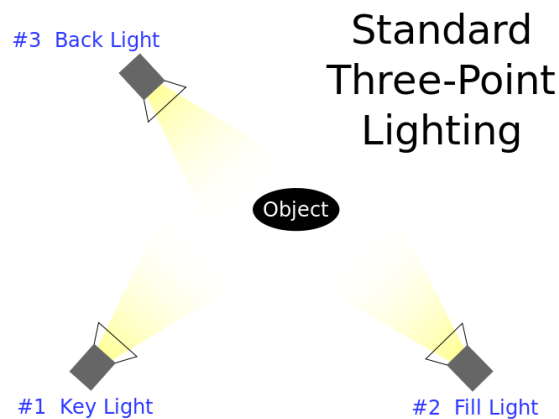
Lighting

Lighting is an essential tool for enhancing the video image. The subtle use of light creates atmosphere and mood, dimension, and texture. It can help to convey a plot line, enhance key elements



such as set color or skin tone, and signals the difference between comedy and drama, reality and fantasy.

The subject in a planned shoot can be lit up using various lighting techniques to achieve desirable result. In this section we will discuss about these lighting techniques.



Title- Fig 3.26 Types of Lighting

Attribution- [Theonlysilentbob](#),

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:3_point_lighting.svg

Lighting, as with nearly every other aspect of Film & TV, is an essential part of the filmmaking process. Light can sculpt and describe a scene or character, it can hide or reveal key areas of your frame, and it can enhance suspense & evoke emotion. It is as critical in directing the audiences' attention or influencing their emotions as camera movement, acting, music and editing. Ignore it at your own loss.

Key light

The *key light* is considered as the foremost important light that a photographer, cinematographer, lighting cameraman, or other scene composer will use in a lighting setup. The purpose of the key light is to highlight the form and dimension of the subject. The key light is always not a necessary; without the key light we can get a silhouette effect. Many key lights may be placed in a scene to illuminate a moving subject at opportune moments.



The key light can be "hard" (focused) or "soft" (diffused), and depending on the desired setup can be placed at different angles relative to the subject. When part of the most common setup—three-point lighting—the key light is placed at a 30–60° angle (with the camera marking 0 degrees). In addition to the horizontal angle, the key light can be placed high or low producing different effects. The most common vertical position for the key light is at a 30° angle (i.e. slightly above the eye line; the nose should not cast a shadow on the lips).

A key light positioned low appears to distort the actor's features, since most natural or ambient light is normally overhead. A dramatic effect used in horror or comedy cinematography is a key light illuminating the face from below. A high key light will result in more prominent cheek bones and long nose shadows.

In many cases, the key light is a stage light for indoor scenes, or sunlight for outdoors. A lighting instrument may also be used outdoors to supplement sunlight or as the primary light source with sunlight or skylight serving as fill lighting. Actual lamps, lighting fixtures, can serve as key lights, provided they are of sufficient brightness. They may also appear within the scene as props — in which case they are called "*practical's*." Similarly, fire, candles and other natural sources of light can be used.

The key light can be divided into various categories as discussed below.

Flat lighting: The first key (or primary/main) common lighting pattern that you should be familiar with is flat lighting. Flat lighting faces directly into the subject from the angle of the lens. Flat lighting is the least dramatic lighting pattern because it casts the least amount of shadows on the subject's face.



Title- Types of Lighting: Flat Key Light

Attribution- Darlene Hildebrandt

Source-

Link- <https://digital-photography-school.com/6-portrait-lighting-patterns-every-photographer-should-know/>

Butterfly lighting: Butterfly Lighting (or Paramount Lighting) comes directly in front and above the subject's face. This creates shadows that are directly below the subject's facial features. The most notable shadow, and where this lighting pattern gets its name, is a butterfly shaped shadow just under the nose. It is also called "*ParamountLighting*" because this lighting pattern was used heavily in the Paramount movie studio of old Hollywood.

The only difference between flat lighting and butterfly lighting is the height and angle of the Key Light. This creates the same flattering features as flat lighting but includes shadows underneath the nose and chin.



Title- Types of Lighting: Butterfly Lighting

Attribution- Darlene Hildebrandt

Source-

Link- <https://digital-photography-school.com/6-portrait-lighting-patterns-every-photographer-should-know/>

Loop lighting: Loop lighting is probably one of the most common key lighting patterns. We see that it falls right in the middle between flattering flat light to dramatic split light. Loop Light is such a condition, where most of the face is still in light but you still have enough shadows to bring in some definition. It brings out a three dimensional effect of the subject.



Title- Types of Lighting: Loop Lighting

Attribution- Darlene Hildebrandt

Source-

Link- <https://digital-photography-school.com/6-portrait-lighting-patterns-every-photographer-should-know/>



Split lighting: Split lighting simply “splits” the subject’s face, lighting half of your subject’s face while leaving the other half in shadow. Because of the angle of light, there is no Rembrandt triangle, only shadow.

When the key light is set up 90° directly, to the right or left side of the subject’s face. The line separating light and shadow will be down the middle of the nose and chin. This creates the most dramatic light and the least flattering light to use.

Half-light: half-light is a condition of portrait photography when the subject is *half illuminated* and *half in shadow*. The light is held in such a manner that only half of the subject is lighted. This creates a very magical effect.

Fill Light: As per the name it is used *to fill a gap of light and darkness*. If there is a contrast of dark and over exposed portions on the subject, then a soft light can be used to supply a little amount of exposure on the subject. It thus fills the gap and subject looks normal to the eye. The amount of fill light can be used as per the resolution of recording medium.

The most common source of natural omnidirectional fill light is the sunlight. It is mostly used while shooting outdoor. A fill light is used against the axis of the direct light. Hence it cuts off any hard shadows created by the direct light upon the subject. The positioning of the fill affects the overall appearance of the lighting pattern. When a centred fill strategy is used the ratio is created by overlapping the key light over the foundation of fill. A key source of equal incident intensity to the fill, overlapping the even fill, will create a 2:1 reflected ratio (1 key + 1 fill over 1 Fill) = 2:1.

Back Light: while studying about the lighting design, *backlighting* is the process of illuminating the subject from the back. In other words, the lighting instrument and the viewer face each other, with the subject in between. The viewer can see the source of light from behind the subject. This creates a glowing effect on the edges of the subject, while other areas are darker. The backlight can be a natural or artificial source of light. While using artificial



source, the back light is usually placed directly behind the subject in a 4-point lighting setup.

The back light is sometimes called *hair or shoulder light*, as it helps make the edges the subject's hair glow if the hair is fuzzy. This can create an angelic halo type effect around the head. Television productions often use this effect in soap operas.

Ambient Lighting: Ambient light means the light that is already present in a scene, before any additional lighting is added. It usually refers to natural light, either outdoors or coming through windows etc. It can also mean artificial lights such as normal room lights.

Ambient light can be the photographer's friend and/or enemy. Clearly ambient light is important in photography and video work, as most shots rely largely or wholly on ambient lighting.

Unfortunately ambient light can be a real nuisance if it conflicts with what the photographer wants to achieve. For example, ambient light may be the wrong colour temperature, intensity or direction for the desired effect. In this case the photographer may choose to block out the ambient light completely and replace it with artificial light. Of course this isn't always practical and sometime compromises must be made.

On the other hand, many of history's greatest photographs and film shots have relied on interesting ambient light. Unusual lighting can turn an otherwise ordinary shot into something very powerful.

Motivated Lighting: The light in a scene which appears to have a source such as a window, a lamp, a fireplace, so on. In some cases the light will come from a source visible in the scene and in some cases, it will only appear to come from a source that is visible in the scene.



Unit summary



Summary

In this unit you learned the Basic of photography, composition and lighting. We discussed about the necessary things for shooting a picture. We also learnt the rules for a better photographic composition and the lighting conditions that are used for photography.

Assessment



Assessment

1. What is a lens?
2. Difference between convex and concave lens.
3. What is a composition?
4. Discuss different rules of composition?
5. What is mid long shot?
6. Define extreme long shot.
7. How close shot is different from extreme close shot?
8. What is lighting?
9. What are different types of lighting?
10. Discuss three point lighting.

Resources

1. www.merriam-webster.com, Wikipedia.org, srlounge.com, www.asu.edu



Unit 4

Introduction to Printing Technology

Introduction

Printing is a process for reproducing text and images using a master form or template. This unit will introduce the different types of printing processes and developing technologies used and adapted in various fields including photography. It will discuss about the materials and equipment required for printing, as well as about other aspects of printing in different fields.

Outcomes



Outcomes

Upon completion of this unit you will be able to:

- Get acquainted to various kinds of printing process and its equipment.
- Know how to print and develop a photograph.
- Recognize the fields where printing is required.

Terminology



Terminology

- Printing:** It is a process for reproducing text and images using a master form or template.
- Etching:** This is a process of printing on metallic objects by help of acids by the open and covered area design.
- Lithography:** This is the printing process using stones on the basis of oil water repelling system.



What is “printing”?

Printing is a process for reproducing text and images using a master form or template. Sometimes it may not be possible to preserve or circulate the original template among mass. So it will be wiser and easier to make printed copies of the actual template. This process of making same copies out of the original template on surface like paper, cloth or synthetic material is called *printing*.

History of printing

The history of printing dates back from the **T'ang Dynasty** when the Chinese developed *woodblock printing*. The principle of woodblock printing was that the matter which was to be printed was carved on a wooden block and it was dip in an ink and that was pressed on a piece of paper to create an impression of the carving. The invention of the printing press depended on the invention and refinement of paper in China over several centuries. The Chinese had developed "rag" paper, a cheap cloth-scrap and plant-fibre substitute for cumbersome bark and bamboo strips and for precious silk paper, by A.D. 105. Chinese prisoners passed a mature technology on to their Arab captors in the eighth century.

The Europeans felt the importance of press printing for printing books, newspaper and magazines etc. in massive amount. Although the European innovations came much later, European culture certainly felt the impact of print more dramatically than the Chinese did, as their alphabet employs thousands of visually specific ideograms. The Europeans further developed *movablepress* prints. The Europeans developed standard characters for the press and it used movable components to reproduce the elements of a document (usually individual letters or punctuation) usually on the medium of paper.



Title- Fig 3.1 Woodblock Printing

Attribution- [John Hill](#)

Source- [wikimedia.org](#)

Link-

https://commons.wikimedia.org/wiki/File:Woodblock_printing,_Sera,_1993.JPG

The world's first movable type printing press technology for printing paper books was made of ceramic porcelain china materials and invented in ancient China around **1040 AD** by the Han Chinese innovator Bi Sheng (990–1051) during the Northern Song Dynasty (960–1127). In 1377, currently the oldest extant movable metal print book, Jikji, was printed using Chinese characters in the Goryeo dynasty of Korea.

Around **1450**, in Europe, **Johannes Gutenberg** made another version of *a metal movable-type printing press*, along with innovations in casting the type based on a matrix and hand mould. The important factor was how much number of characters was needed for European languages. Gutenberg was the first to create his type pieces from an alloy of **lead, tin, and antimony**—and these materials remained standard for 550 years.



Title- Fig 3.2 Gutenberg's Metal Movable Type

Attribution- Gutenberg, Johann

Source- [wikimedia.org](#)



Link-

https://commons.wikimedia.org/wiki/File:Gutenberg_Bible_WDL7782.jpg

Movable-type page setting was quicker than woodblock printing in case of alphabetic scripts. The metal type pieces that were used were more durable and the lettering was more uniform which led to the creation of typography and fonts. The high quality and relatively low price of the Gutenberg Bible (1455) established the superiority of movable type press in Europe. This was thus established by the Gutenberg Bible (1455) which was high in quality and low in price and the use of printing presses spread rapidly. The printing press may be regarded as one of the key factors fostering the Renaissance and due to its effectiveness, its use spread around the globe.



Title- Fig 3.3 Metal Movable Types

Attribution- Willi Heidelbach

Source- <http://www.sxc.hu/photo/238776>

Link- https://commons.wikimedia.org/wiki/File:Metal_movable_type.jpg

Relief printing is a process where protruding surface faces of the printing plate or block are inked; recessed areas are ink free. Printing the image is therefore a relatively simple matter of inking the face of the matrix and bringing it in firm contact with the paper. A printing-press may not be needed as the back of the paper can be rubbed or pressed by hand with a simple tool such as a brayer or roller.

The *matrix* in relief printing is classically created by starting with a flat original surface and then removing (e.g., by carving) away areas intended to print white. The remaining areas of the original surface receive the ink.



The relief family of techniques includes **woodcut, metal cut, wood engraving, relief etching, linocut, rubber stamp, foam printing, potato printing, and some types of collagraph.**

Traditional text printing with movable type is also a relief technique. This meant that woodcuts were much easier to use as book illustrations, as they could be printed together with the text. Intaglio illustrations, such as engravings, had to be printed separately.

Relief printing is the oldest form of printmaking. The most common form of relief printing is woodcut. An ink drawing is made on a wood block. The artist cuts away uninked areas, leaving inked areas raised. Printing ink is applied to the raised surface and a sheet of paper is laid on the block to take an impression by hand or a press.



Title- Fig 3.4 Woodblock Printing/Relief Printing

Attribution- [E1E2L3](#)

Source- [wikimedia.org](#)

Link-

https://commons.wikimedia.org/wiki/File:Endi_Poskovic_inking_a_color_wood-relief_block.jpg

Woodcut printing on paper was first adopted in the seventh century China, where drawing and text were reproduced on the same block. A hundred years after paper reached Europe, the use of woodcut in the development of printing was established in the late fourteenth century Germany. Albrecht Durer explored the technique of the medium of woodcut, elevating it as an independent form of art, not only a way of printing text. Hundreds



years later in 1905 a handful of German painters formed themselves into a revolutionary group, The Bridge. One of the group's most successful ventures was the revitalization of woodcut. They produced a great deal of woodcut of originality, from which modern relief printing began.

Another printing process which have not yet discussed is the photographic printing. This process is different from all other processes because in this the master template or the thing which is to be printed does not come into direct contact with the material on which it is to be printed. Only the ray of light does its work.

Etching is a method of printing from a metal plate, usually *copper*. The design is incised by acid. The copperplate is first coated with an acid-resistant substance, called the *etchingground*, through which the design is drawn with a sharp tool. The ground is usually a compound of beeswax, bitumen, and resin. The plate is then exposed to nitric acid or Dutch mordant, which eats away those areas of the plate unprotected by the ground, forming a pattern of recessed lines. These lines hold the ink, and, when the plate is applied to moist paper, the design transfers to the paper, making a finished print.

Etching is used since old days as a method of engraved printing to create master prints which is still widely used today. In a number of modern variants such as *micro-fabrication etching* and *photochemical milling* it is a crucial technique in much modern technology, including circuit boards.

Lithography is an ancient Greek method of printing using stones. The main formula which was used for printing was the property of immiscibility of oil and water. The technique was invented in **1796** by German author and actor **Alois Senefelder** as a cheap method of publishing theatrical works. Lithography can be used to print text or artwork onto paper or other suitable **material**.

Originally Lithographic prints used an image drawn with oil, fat, or wax onto the surface of a smooth, level lithographic limestone plate. The stone was first treated with a mixture of acid and gum. After that the portions of the stone that were not protected by the grease-based image were etched. After the stone was subsequently moistened, these etched areas retained water; an oil-based ink could then be applied and would be repelled by the water, sticking only to the original drawing. The ink would finally be transferred to a blank paper sheet, hence producing a printed page. This traditional technique is still used in some fine art printmaking applications.



Lithography uses simple chemical processes to create an image. For instance, the positive part of an image is a water-repelling substance, while the negative image would be water-retaining. Thus, when the plate is introduced to a compatible printing ink and water mixture, the ink will adhere to the positive image and the water will clean the negative image. This allows a flat print plate to be used, enabling much longer and more detailed print runs than the older physical methods of printing.

In modern lithography, the image is made of a polymer coating applied to a flexible plastic or metal plate. The image can be printed directly from the plate, or it can be offset, by transferring the image onto a flexible sheet (rubber) for printing and publication.

Rotary press is a printing press that prints on paper passing between a supporting cylinder and a cylinder containing the printing plates. It may be contrasted to the flatbed press, which has a flat printing surface. It is primarily used in high-speed, web-fed operations, in which the press takes paper from a roll, as in newspaper printing. Many of these large presses not only print as many as four colours but cut and fold and even bind in a cover—in one continuous automatic process. Paper passes through some presses at nearly 20 miles (30 km) per hour, the speed limited partly by the tensile strength of the paper; large presses can print up to 60,000 copies of 128 standard-size pages in an hour.

In its simplest form a rotary press consists of two cylinders turning in opposite directions, with the plate cylinder having curved printing plates attached to its surface and the impression cylinder working to press the paper to the inked plates as the paper passes between the cylinders. A simple two-colour rotary press uses two plate cylinders in succession, each bearing a different type form and each having its own inking system. The same side of the same sheet of paper receives two successive impressions of two different colours as it passes through the press. Printing on both sides of a sheet of paper and printing in three, four, or even five colours can be achieved in a rotary press by using different combinations and successions of plate and impression cylinders.

Extremely high rates of production can be achieved in very large, highly automated roll-fed rotary presses. These machines have cylinders with a circumference large enough to accommodate two or more plates, so that with each revolution the cylinder prints two or more copies of the same page. Similar arrangements enable a cylinder to print eight copies of the same page in a single revolution.



Offset Printing

Offset printing is a commonly used printing technique in which the inked image is transferred (or "offset") from a plate to a rubber blanket, then to the printing surface. When used in combination with the lithographic process, which is based on the repulsion of oil and water, the offset technique employs a flat image carrier on which the image to be printed obtains ink from ink rollers, while the non-printing area attracts a water-based film (called "fountain solution"), keeping the non-printing areas ink-free. The modern "web" process feeds a large reel of paper through a large press machine in several parts, typically for several metres, which then prints continuously as the paper is fed through.

The first rotary offset lithographic printing press was created in England and patented in **1875** by **Robert Barclay**. This development combined mid-19th century transfer printing technologies and **Richard March Hoe's 1843 rotary printing presses**—a press that used a metal cylinder instead of a flat stone. The offset cylinder was covered with specially treated cardboard that transferred the printed image from the stone to the surface of the metal. Later, the cardboard covering of the offset cylinder was changed to rubber, which is still the most commonly used material.

One of the most important functions in the printing process is *prepress production*. This stage makes sure that all files are correctly processed in preparation for printing. This includes converting to the proper *CMYK* colour model, finalizing the files, and creating plates for each colour of the job to be run on the press.

Offset lithography is one of the most common ways of creating printed materials. A few of its common applications include: **newspapers, magazines, brochures, stationery, and books**. Compared to other printing methods, offset printing is best suited for economically producing large volumes of high quality prints in a manner that requires little maintenance. Many modern offset presses use computer-to-plate systems as opposed to the older computer-to-film work flows, which further increases their quality.

Screen printing

Screen printing is a printing technique which uses a mesh to transfer ink onto a substrate, leaving clean those parts which are

made impermeable to the ink by a blocking stencil. A blade or squeegee is moved across the screen to fill the open mesh apertures with ink, and a reverse stroke then causes the screen to touch the substrate momentarily along a line of contact. In this process the ink wets the substrate and is pulled out of the mesh apertures as the screen springs back after the blade has passed.

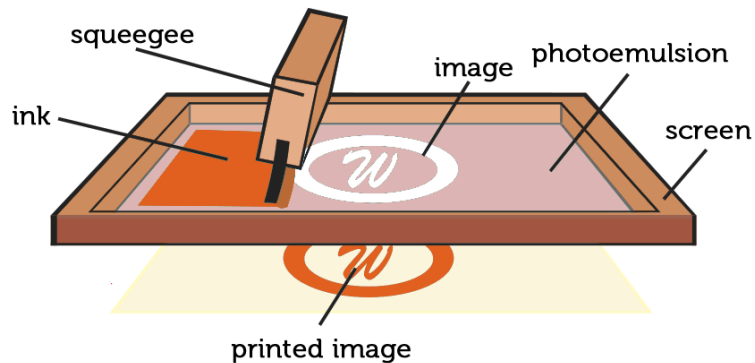


Fig 3.11 Screen Printing (Picture source: whizzprints.com)

Screen printing is also a *stencil method* of print making in which a design is imposed on a screen of polyester or other fine mesh, with blank areas coated with an impermeable substance. Ink is forced into the mesh openings by the fill blade or squeegee and by wetting the substrate, transferred onto the printing surface during the squeegee stroke. As the screen rebounds away from the substrate, the ink remains on the substrate. It is also known as **silk-screen**, **screen**, **serigraphy**, and **serigraph printing**. One colour is printed at a time, so several screens can be used to produce a multicoloured image or design.

Nowadays, synthetic threads are commonly used in the screen printing process. The most popular mesh in general use is made of polyester. There are special-use mesh materials of nylon and stainless steel available to the screen printer. There are also different types of mesh size which will determine the outcome and look of the finished design on the material.

Screen printing first appeared in a recognizable form in China during the **Song Dynasty (960–1279 AD)**. It was then adapted by other Asian countries like Japan, and was furthered by creating newer methods.



Screen printing was largely introduced to Western Europe from Asia sometime in the late 18th century, but did not gain large acceptance or use in Europe until silk mesh was more available for trade from the east.

Dot matrix printing

Dot matrix printing is type of printer that produces characters and illustrations by striking pins against an ink ribbon to print closely spaced dots in the appropriate shape. Dot-matrix printers are relatively expensive and do not produce high-quality output. However, they can print to multi-page forms (that is, carbon copies), something laser and ink-jet printers cannot do.

It is a type of computer printing which uses a print head that moves back-and-forth, or in an up-and-down motion, on the page and prints by impact, striking an ink-soaked cloth ribbon against the paper, much like the print mechanism on a typewriter. However, unlike a typewriter or daisy wheel printer, letters are drawn out of a dot matrix, and thus, varied fonts and arbitrary graphics can be produced.

Each dot is produced by a tiny metal rod, also called a "wire" or "pin", which is driven forward by the power of a tiny electromagnet either directly or through small levers (pawls). Facing the ribbon and the paper is a small guide plate named ribbon mask holder or protector, sometimes also called *butterfly* for its typical shape. It is pierced with holes to serve as guides for the pins. This plate may be made of hard plastic or an artificial jewel such as sapphire or ruby.

The portion of the printer containing the pins is called the *printhead*. When running the printer, it generally prints one line of text at a time.





Fig 3.12 Dot Matrix Printing (Picture source: youtube.com)

The common *serial dot matrix printers* use a horizontally moving print head. The print head can be thought of featuring a single vertical column of seven or more pins approximately the height of a character box. In reality, the pins are arranged in up to four vertically or/and horizontally slightly displaced columns in order to increase the dot density and print speed through interleaving without causing the pins to jam. Thereby, up to 48 pins can be used to form the characters of a line while the print head moves horizontally.

Inkjet printing

Inkjet printing is a type of computer printing that recreates a digital image by propelling droplets of ink onto paper, plastic, or other substrates. Inkjet printers are the most commonly used type of printer, and range from small inexpensive consumer models to expensive professional machines.

The concept of inkjet printing originated in the 20th century, and the technology was first extensively developed in the early **1950s**. Starting in the late 1970s inkjet printers that could reproduce digital images generated by computers were developed, mainly by Epson, Hewlett-Packard (HP), and Canon. In the worldwide consumer market, four manufacturers account for the majority of inkjet printer sales: Canon, HP, Epson, and Brother.

The emerging ink jet material deposition market also uses inkjet technologies, typically print heads using piezoelectric crystals, to deposit materials directly on substrates.

The technology has been developed and the "ink" can now also comprise living cells, for creating biosensors and for tissue engineering. There are two main technologies in use in contemporary inkjet printers: *continuous (CIJ)* and *Drop-on-demand (DOD)*.

The continuous inkjet (CIJ) method is used commercially for marking and coding of products and packages. In **1867 Lord Kelvin** patented the syphon recorder, which recorded telegraph signals as a continuous trace on paper using an ink jet nozzle deflected by a magnetic coil. The first commercial devices (medical strip chart recorders) were introduced in **1951 by Siemens**.

In CIJ technology, a high-pressure pump pumps liquid ink from a reservoir through a microscopic nozzle, creating a continuous stream of ink droplets. A piezoelectric crystal creates an acoustic wave as it vibrates within the nozzle and causes the stream of



liquid to break into droplets at regular intervals: 64,000 to 165,000 droplets per second may be achieved. The ink droplets are subjected to an electrostatic field created by a charging electrode as they form; the field varies according to the degree of drop deflection desired. This results in a controlled, variable electrostatic charge on each droplet. Charged droplets are separated by one or more uncharged "guard droplets" to minimize electrostatic repulsion between neighbouring droplets.

The charged droplets pass through another electrostatic field and are deflected by electrostatic deflection plates to print on the receptor material or allowed to continue on without deflection to a collection gutter for re-use.

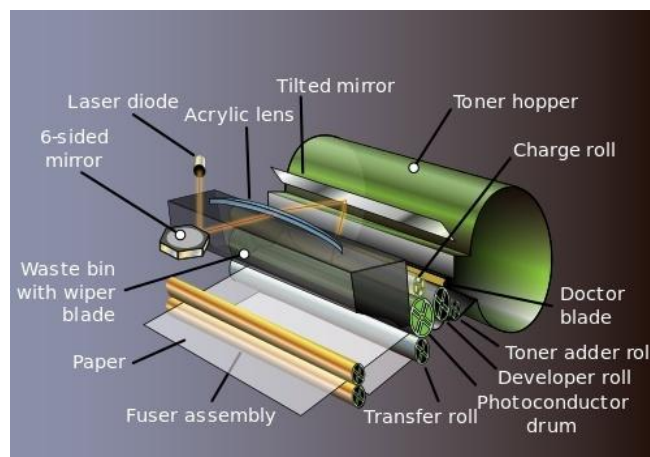
Thermal DOD In the thermal inkjet process, the print cartridges consist of a series of tiny chambers, each containing a heater, all of which are constructed by *photolithography*. From each chamber the droplets are released when a pulse of current is passed through the heating element causing a rapid vaporization of the ink in the chamber and forming a bubble, which causes a large pressure increase, propelling a droplet of ink onto the paper. The ink's surface tension, as well as the condensation and resultant contraction of the vapour bubble, pulls a further charge of ink into the chamber through a narrow channel attached to an ink reservoir. The inks involved are usually water-based and use either pigments or dyes as the colorant. As no special materials are required, the print head is generally cheaper to produce than in other inkjet technologies.

Laser printing

Laser printing is an *electrostatic digital printing* process. High quality text and graphics are produced by repeatedly passing a laser beam back and forth over a negatively charged cylinder called a "*drum*" to define a differentially charged image. The drum then selectively collects electrically charged powdered ink (toner), and transfers the image to paper, which is then heated in order to permanently fuse the text and/or imagery. However, laser printing differs from analog photocopiers in that the image is produced by the direct scanning of the medium across the printer's photoreceptor. This enables laser printing to copy images more quickly than most photocopiers.

Invented at Xerox PARC in the 1970s, laser printers were introduced for the office and then home markets in subsequent years by IBM, Canon, Xerox, Apple, Hewlett-Packard and many others.

The *first commercial implementation of a laser printer was the IBM 3800 in 1976*. It was designed for data centres, where it replaced line printers attached to mainframe computers. The IBM 3800 was used for high-volume printing on continuous stationery, and achieved speeds of 215 pages per minute (ppm), at a resolution of 240 dots per inch (dpi). Over 8,000 of these printers were sold. The Xerox 9700 was brought to market in 1977. Unlike the IBM 3800, the Xerox 9700 was not targeted to replace any particular existing printers; but, it did have limited support for the loading of fonts. The Xerox 9700 excelled at printing high-value documents on cut-sheet paper with varying content.



Title- Fig 3.15 Laser Printing

Attribution- [KDS4444](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Laser_toner_cartridge.svg

All the above printing process are forms of two dimensional prints but now technology has evolved so much that we are now able to print in three dimension also. Which means the matter what we are printing can really be felt by one as it is real in the front of us. This is called *3D printing*.

3D printing

3D printing, also known as **additive manufacturing (AM)**, refers to processes used to create a three-dimensional object in which

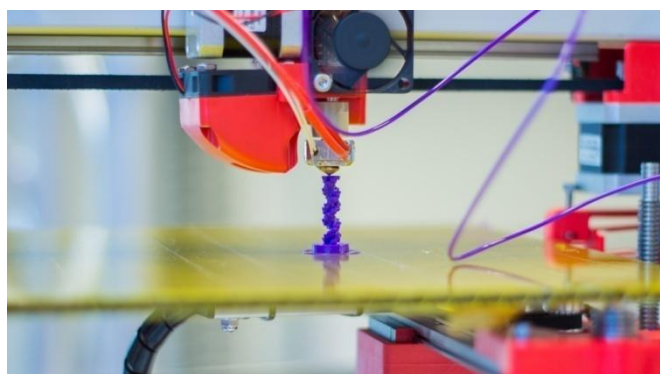


layers of material are formed under computer control to create an object. Objects can be of almost any shape or geometry and are produced using digital model data from a 3D model or another electronic data source such as an Additive Manufacturing File (AMF) file.

The technology was first invented in the **1980s**, and since that time has been used for *rapid prototyping* (RP). However, in the last few years, 3D printing has additionally started to evolve into a next-generation manufacturing technology that has the potential to allow the local, on-demand production of final products or parts thereof.

Already it is possible to 3D print in a wide range of materials that include thermoplastics, thermoplastic composites, pure metals, metal alloys, ceramics and various forms of food. Right now, 3D printing as an end-use manufacturing technology is still in its infancy. But in the coming decades, and in combination with synthetic biology and nanotechnology, it has the potential to radically transform many design, production and logistics processes.

3D printing encompasses a wide range of additive manufacturing technologies. Each of these builds objects in successive layers that are typically about 0.1 mm thin. The methods used vary significantly, but all start with a computer aided design (CAD) model or a digital scan. This is then processed by 'slicing software' that divides the object into thin cross sections that are printed out one on top of the other.



Title- Fig 3.16 3D Printing

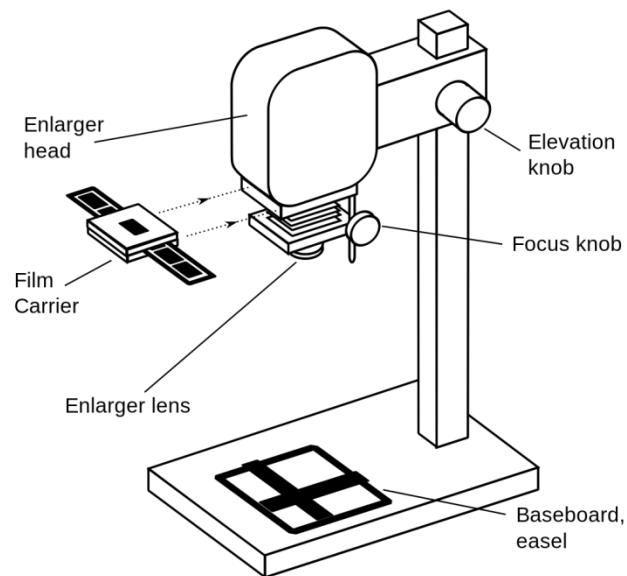
Attribution- [Jonathan Juursema](#)

Source- [wikimedia.org](#)

Link-https://commons.wikimedia.org/wiki/File:Felix_3D_Printer_-_Printing_Head.JPG

Photographic printing

Photographic printing is the process of producing a *final image* on paper for viewing through *light*, using *chemically sensitized paper*. When this paper is exposed to a *photographic negative*, through an *enlarger* or *digital exposure unit* such as a *LightJet printer* it creates an opposite print. That means the negative when exposed to light during photography creates black spot at those points but remains transparent at those places where it is not exposed to light. So when this negative is further used for printing, when the light through enlarger is allowed the light passes through the transparent areas to expose the paper and create the image which is opposite to the negative impressions. Alternatively, the negative or transparency may be placed atop the paper and directly exposed, creating a contact print. Photographs are more commonly printed on plain paper, for example by a colour printer, but this is not considered "photographic printing".



Title- Fig 3.17 Photographic Printing

Attribution- [Darkroom enlarger.svg](#)

Source- [wikimedia.org](#)

Link- https://commons.wikimedia.org/wiki/File:Darkroom_enlarger_en.svg



Unit summary



Summary

In this unit you learned about the various printing process. It introduced the invention of printing and also discussed about various types of printing processes starting from woodblock to photographic printing. It also discussed about the principles of the different processes and their usage in the day to day life.

Assignment



Assignment

1. Define Printing. What are the advantages of printing?
2. What is woodblock printing and where did it originate?
3. What is a printer?
4. What is movable type printer?
5. Define etching.
6. Describe lithographic printing?
7. What are two type of inkjet printing?
8. How does dot matrix printer work?
9. Write a short note on laser printing.
10. What is 3D printing?
11. How photographic printing process works?

Resources



Reading

1. Wikipedia.org,
2. Britannica.com