002:

BASIC MULTIMEDIA CONCEPTS

INTRODUCTION TO MULTIMEDIA:- AUDIO

TuK

Bachelor Information Technology/Communications and Computing
Networks Year 4 Semester 1

MULTIMEDIA APPLICATIONS / SYSTEMS AND APPLICATIONS

SUBJECT CODE: ECCI/ECII 4102

OVERVIEW

1. Lecture Introduction & Attendance Registration
2. Lecture Aims & Objectives
3. Lecture 1 Outline
4. Recommended Chapter from Recommended Reading List
5. Lecture 1 Topic
7. Q&A

LECTURE AIMS & OBJECTIVES

1) To introduce students to Multimedia text, graphic, sound, video & animation theories.
2) To equip students with the knowledge to develop and use multimedia text, graphics, sound, video, animation skills
3) To develop students' expertise in the use of Multimedia text, graphics, sound, video & animation tools and techniques
4) To design multimedia text, graphics, sound, video &animation applications
5) To implement the design, and maintain the implemented multimedia text, graphics, sound, video & animation systems while also supporting users
6) To enable graduates to find a wide variety of career opportunities in information technology related areas in both private and public sectors

BASIC MULTIMEDIA CONCEPTS

INTRODUCTION TO MULTIMEDIA

SOUND/AUDIO

http://elearning.tukenya.ac.ke

RECOMMENDED CHAPTER FROM RECOMMENDED READING LIST

Chapter 1-3 from

"Multimedia Foundations: Core Concepts for Digital Design" Costello; Vic, Focal Press, 2016

"Multimedia: Making It Work" Vaughan; Tay,McGraw-Hill Education, 9th Edition, 2014

"Multimedia-based Instructional Design: Computer-Based Training; Web-Based Training; Distance Broadcast Training; Performance-Based Solutions", Lee; William W, Owens; Diana L, Pfeiffer, 2004

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

DEFINITION

- **macroscopic longitudinal pressure wave phenomenon**
- Formed by **compressing molecules of air then expanding them under the action of a physical device**
- Measured in **frequencies** using a transducer
- **Detected by** measuring pressure levels at a location
- Utilises **continuous values** with a finite range

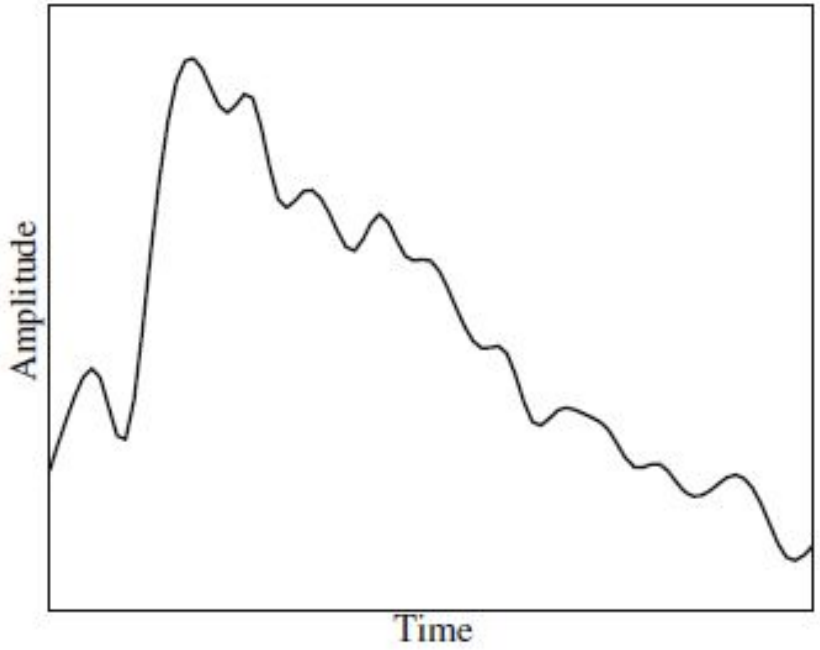
INTRODUCTION MULTIMEDIA: BASIC MULTIMEDIA CONCEPTS, TEXT, GRAPHICS, SOUND, VIDEO & ANIMATION IN A SINGLE APPLICATION

INTRODUCTION TO MULTIMEDIA SOUND

- **Simplest** type of multimedia data.
- Crucial for presentations
- Sound (inc.speech) is **analogue** in nature i.e. **continuous analog signals**
- needs **digitising**

ANALOG SOUND

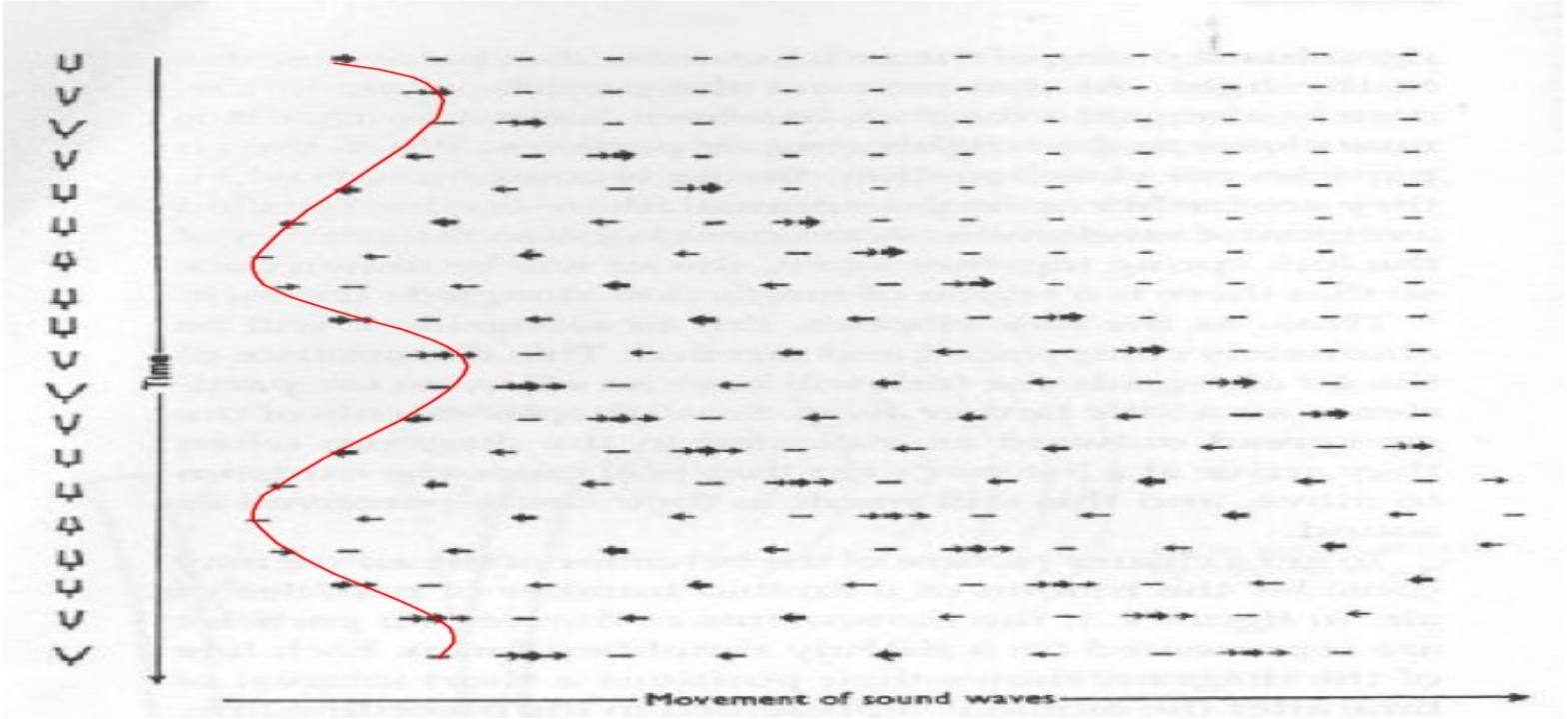
Fig. 6.2 An analog signal: continuous measurement of pressure wave



INTRODUCTION MULTIMEDIA: BASIC MULTIMEDIA CONCEPTS, TEXT, GRAPHICS, SOUND, VIDEO & ANIMATION IN A SINGLE APPLICATION

INTRODUCTION TO MULTIMEDIA-SOUND

- **WHAT DO AIR PARTICLES DO IN SPEECH?**



SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

DEFINITION

PROPERTIES AND BEHAVIOURS:

- **Reflection, refraction, diffraction etc**

- **Surround sound** consist of measurable pressure at any 3D point

QUALITIES:

- **Pitch and harmony**

INTRODUCTION MULTIMEDIA: BASIC MULTIMEDIA CONCEPTS, TEXT, GRAPHICS, SOUND, VIDEO & ANIMATION IN A SINGLE APPLICATION

INTRODUCTION TO MULTIMEDIA AUDIO

- **Important differences between audio, video and image**

IMAGE	VIDEO	AUDIO
possible to drop a pixel or a vector from a picture and still make an educated guess behind its meaning	Customary to drop a video from stream to facilitate viewing speed	Not possible to dop audio from stream

INTRODUCTION MULTIMEDIA: BASIC MULTIMEDIA CONCEPTS, TEXT, GRAPHICS, SOUND, VIDEO & ANIMATION IN A SINGLE APPLICATION

NATURE AND FORMAT

ANALOG SOUND

- large in size & needs digitising
- Creates **mood, interest, etc.**
- Must be **captured from Input devices,** digitised and stored
-

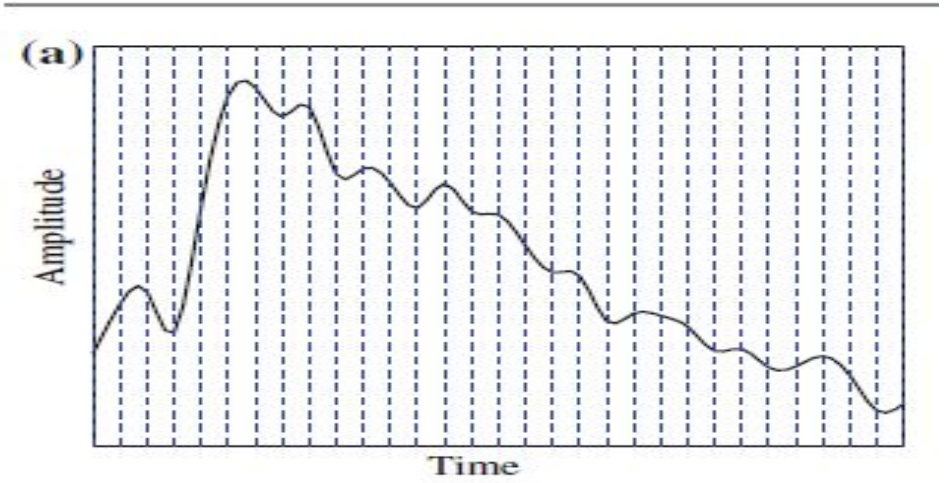
SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

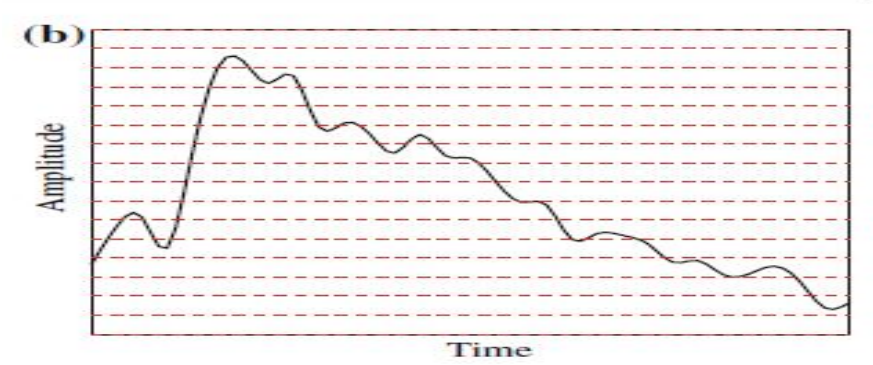
CONVERT ANALOG TO DIGITAL

DIGITISING SOUND:

- **A stream of numbers—** 1's and 0's for computer storage
- **Readable by electronic instruments**
- Full digitization requires sampling in 2 dimensions i.e.
  - Time sampling (frequency) rate of sampling in time dimension is known as **sampling frequency.** Frequency **is uniform sampling**
  - Amplitude sampling (quantization).rate of sampling in amplitude dimension is known as **Quantization frequency.** Quantization is **non-uniform sampling.**

CONVERT ANALOG TO DIGITAL





SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

CONVERT ANALOG TO DIGITAL

DIGITISING SOUND:

- Sample is to measure at evenly spaced intervals
- Sampling in time involves measurements at evenly spaced time intervals(**time is an** independent variable)
- Amplitude is a continuous quantity whose value changes **over time;** (**amplitude is a** dependent variable)

CONVERT ANALOG TO DIGITAL

DIGITISING SOUND:

- Non-uniform sampling is only used for quantization (over time)

- Typical standard quantization and frequency rates are
  - 8-bit (divides the vertical axis into 256 levels)
  - 16-bit(divides the vertical axis into 65,536 levels)

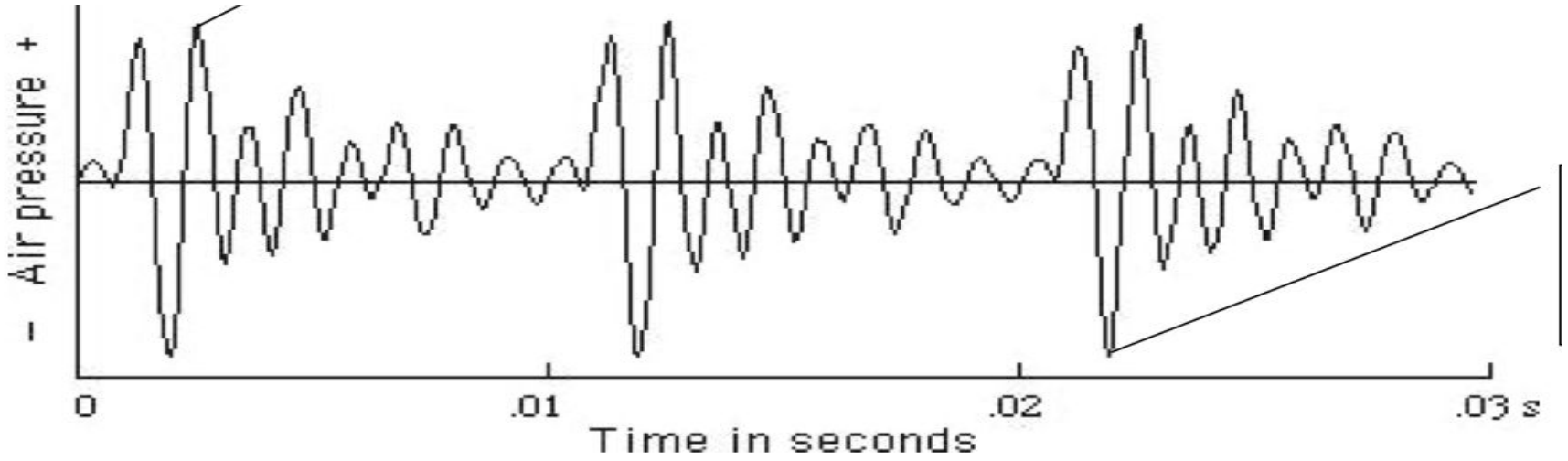
- To digitize or not to digitize:
  - What is the sample rate?
  - How finely is the data to be quantized?
  - Is the sampling uniform or non-uniform?
  - How is audio data formatted? (i.e. what is the file format)

INTRODUCTION MULTIMEDIA: BASIC MULTIMEDIA CONCEPTS, TEXT, GRAPHICS, SOUND, VIDEO & ANIMATION IN A SINGLE APPLICATION

INTRODUCTION TO MULTIMEDIA AUDIO

- Multimedia computer generated sounds characteristics include file formats, compression and storage, sampling frequency, bit depth

•RECORDING AND GRAPHING SPEECH AIR PARTICLES



SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

CONVERT ANALOG TO DIGITAL

FIRST STEP:- AUDIO FILTERING SOUND

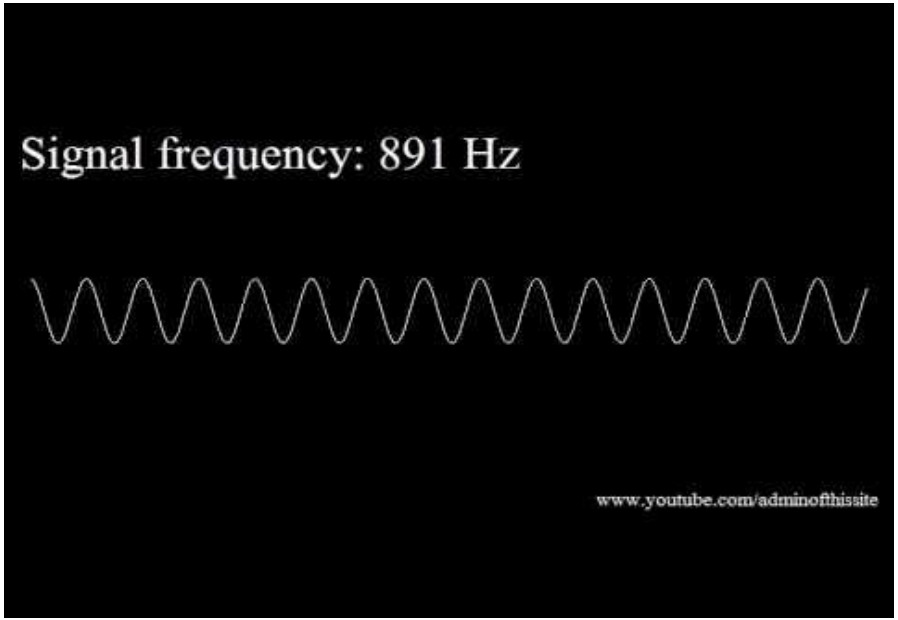
- Audio typically ranges from 20Hz to 20 kHz
- **The human ear can hear from 20Hz** to as much as 20kHz
- Above 20 kHz is ultrasound.
- The human voice can reach approximately 4 kHz

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

CONVERT ANALOG TO DIGITAL

FIRST STEP:- AUDIO FILTERING SOUND

- **Filtering** removes **unwanted frequencies.**
- Remaining frequencies kept usually **depends on the application**
- Typically 50Hz to 10kHz is retained



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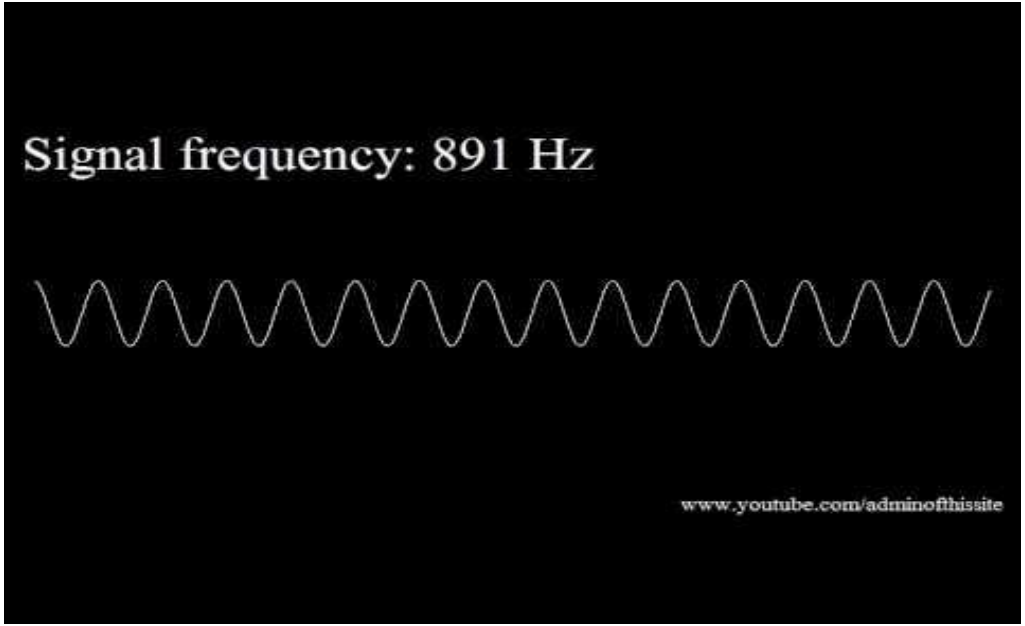
CONVERT ANALOG TO DIGITAL

FIRST STEP:- AUDIO FILTERING SOUND

- Frequencies outside this range will be removed

- Removing or blocking frequencies **is done using a BANDPASS FILTER** aka BAND-LIMITING FILTER

- Filters **screen out lower** and **higher** frequencies



SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

NYQUIST THEOREM

- **Nyquist Theorem states**,
  - ***f*alias = *f*sampling − *f*true, for *f*true < *f*sampling < 2 × *f*true**
- If a signal is band limited (lower limit *f1* and upper limit *f2* of frequency components) we need a sampling rate of at least 2 *(f2-f1)*
- If the sampling frequency is less than twice the true frequency and is greater than the true frequency, then the alias frequency = sampling frequency - true frequency.
- EXAMPLE: true frequency is 5.5Khz, sampling frequency is 8Khz, then alias frequency is 2.5Khz
- Nyquist frequency is the frequency equal to half the Nyquist rate. If sampling rate is fixed then the Nyquist frequency is half the sampling rate.

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

TO DIGITIZE OR NOT DIGITIZE:- CALCULATING NYQUIST

Example:

Calculate the file size of a CD quality audio that uses a sample rate of 44.1kHz with a 16-bit sample size

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

TO DIGITIZE OR NOT DIGITIZE:- CALCULATING NYQUIST

Example:

Calculate the file size of a CD quality audio that uses a sample rate of 44.1kHz with a 16-bit sample size

- STEP 1) To digitize or not to digitize Q&A
  - What is the sample rate?
  - How finely is the data to be quantized?
  - Is the sampling uniform or non-uniform?
  - How is audio data formatted? (i.e. what is the file format)

- **STEP 2) What is the Nyquist Theorem?**
  - ***f*alias = *f*sampling − *f*true, for *f*true < *f*sampling < 2 × *f*true**

What is the true frequency?

What is the sampling frequency? 44.1Khz,

What is the alias frequency?

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FILE SIZE:-TO DIGITIZE OR NOT DIGITIZE & NYQUIST

Example:

Calculate the file size of a CD quality audio that uses a sample rate of 44.1kHz with a 16-bit sample size

- **Audio sample rates are 8kHz to 40kHz**
- Uncompressed digital audio signal for CD quality stereo sound is 10 mbs per minute
- Nyquist frequency = half the Nyquist rate (i.e. If sample rate is fixed then Nyquist frequency is half the sampling rate i.e 8 bits)

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STEREO Vs MONO

- Stereo sound is **2 independent channels**:- left and right signals which **give a sense of depth.**

- If two speakers are **supplied mono signals** there will be no sense of separation or depth.

- **If a mono signal is fed to both channels of a stereo amplifier** with a speaker on each channel the output will be mono

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

STEREO Vs MONO

- 'X', 'Y', and 'Z' =different audio sounds.
- Yellow letters are where they are being reproduced
- Red letters are where the signal appears to originate from

Mono with 1 speaker: -

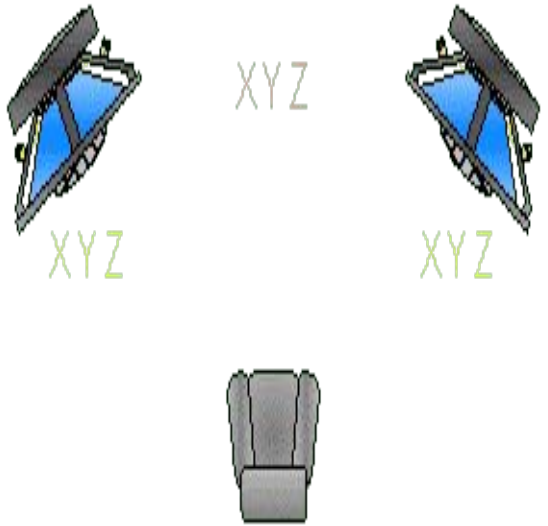
- Speaker is directly in front of listening position
- Audio appears to/does originate from speaker

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

STEREO Vs MONO

Mono with 2 speakers:-

- Red letters are where the signal 'appears' to originate (centre of speakers)
- Reproduced by both speakers.
- Signal content and level to each speaker is the same.



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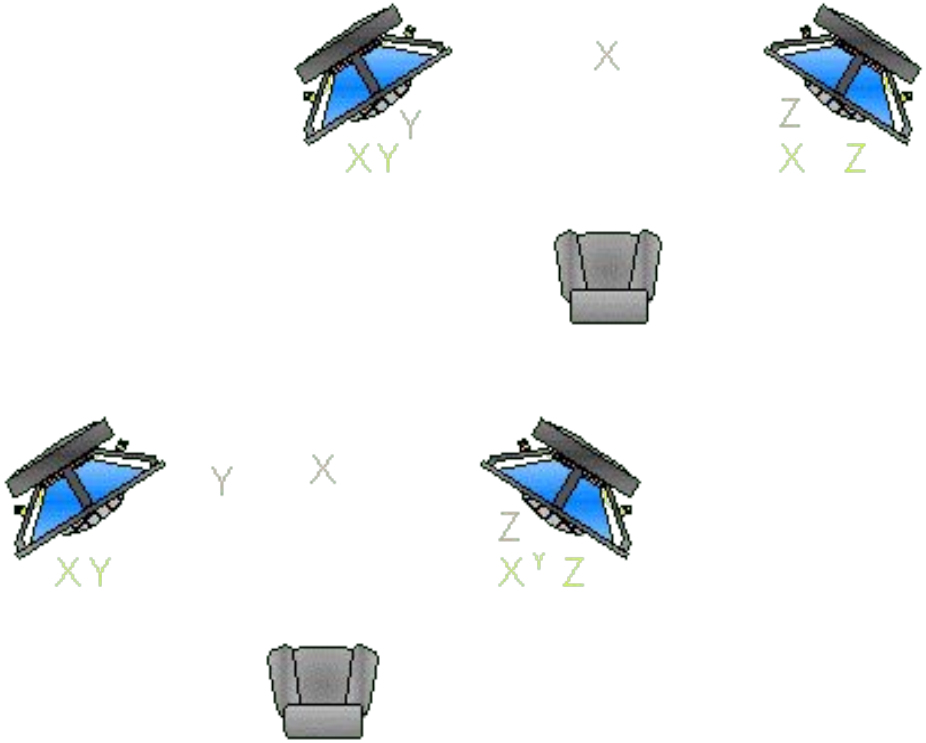
STEREO Vs MONO

Stereo audio:

- 'x' audio is reproduced equally in both channels and appears to originate from the center of both speakers.
- 'y' audio is only in the left speaker and appears to originate from the left speaker.
- 'z' audio is only in the right speaker and appears to originate from the right speaker



SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

MIDI

SOUND FILE FORMATS

- Musical Instrument Digital Interface
- A scripting language—**it codes "events"** representing **production of certain sounds.**
- Useful for **inventing, editing, and exchanging** musical ideas encapsulated as notes
- Files are generally very small and include **values for the pitch of a single note, volume and what instrument sound to play (**MIDI file format extension is .mid or .midi.**)**

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

MIDI

SOUND FILE FORMATS

- Format for **making music notes and sending music information between electronic music devices** e.g. synthesizers, PC sound cards etc.

- Protocol for the electronic music industry

- Sounds created on one device can be played and manipulated on another and sound reasonably close.

- Computers have a special MIDI interface incorporated into most sound cards

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

MIDI

HOW MIDI WORKS

- Music is organized into tracks in a sequencer
- Each track **can be turned on or off on recording or playing back.**
- **A particular instrument can be associated with a MIDI channel.**
- **MIDI channels are used to separate messages**
- **There are 16 channels (0 to 15).**

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

MIDI

HOW MIDI WORKS

- Channels form last four bits (least significant bits)
- Each channel is associated with a particular instrument
  - channel 1 is piano
  - channel 10 is drums etc
- You can switch instruments midstream if desired
- Possible to associate another instrument with any channel.

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

MIDI

HOW MIDI WORKS

- Channels have messages and channel numbers

- Channel messages and numbers are sent together with system messages (i.e. general messages for all instruments indicating changes in tuning or timing)

- **Possible to send special messages to an instrument's channel e.g. allow many notes to be sent without specifying a channel**

- The way a synthetic musical instrument responds to a MIDI message is by simply ignoring any "play sound" message that is not for its channel.

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

STORAGE

Audio Storage

SAMPLING (method used to digitise sound) has 3 characteristics:

- ***Sampling rate:*** the number of times a sample (slice) is taken from the sound wave
- ***Sample size:*** (bit resolution) is the number of bits per sample. Most common sizes are 8-bit and 16-bit sound.
- ***Mono/Stereo:*** mono uses 1 channel; stereo uses 2 channels

Sampling Rate	Best uses
11 kHz	Recommended for speech and short segments of music
22 kHz	Better music playback
32 kHz	Broadcast audio standard
44 kHz	CD-quality audio playback
48 kHz	Digital audio tape (DAT) playback

SOUND: NATURE OF, DIGITISING, FILE FORMATS, REPRODUCTION, COMPRESSION/DECOMPRESSION

STORAGE

File size = sample rate x sample size x time (in seconds) **x channels**

Example:
Calculate the file size of a CD quality audio that uses a sample rate of 44.1kHz with a 16-bit sample size and a track that lasts for 3 minutes in stereo.

File size = sample rate x sample size x time (in seconds) **x channels**

File size = 44,100 x 16 x 180 x 2 bits

File size = 254, 016, 000 bits

File size = 31,752,000 bytes (1 byte = 8 bits)

File size = 30.28Mb (1Mb = 1,048,576 bytes)

QUESTION AND ANSWER SESSION

ANY

QUESTIONS

?

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