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Problems Associated with the Modulation and Demodulation of Transmission of Information

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Abstract: The problems associated with modulation and demodulation of information was investigated using NTA channel 43, Abakaliki. The research showed that the major problems in the cause of these modulation and demodulation include electrical equipment interference, radio communication interference, weather/atmospheric interference, co-channel interference, impulse interference, near/far problem, ghosting, distorted "S" sound, twittering or discordance and background sizzling. These problems affect the nature and brightness of the signals which results to weak signal, mismatch, loss of colour and moving wavy pattern of signal and sometimes break in transmission which may last for quite a long period of time. This is not healthy to the receiver especially if important information is being received. The solutions to these problems were suggested to improve the transmission stations of this country, Nigeria to meet international standard.

Key word: Interference · Mismatch · Investigation · Modulation and demodulation

INTRODUCTION

Information transmission is otherwise known as communication and this is achieved by the process modulation and demodulation [1]. Within a communication system, the information transfer is frequently achieved by superimposing or modulating the information in an electromagnetic wave, which acts as a carrier for the information signal. The modulated carrier wave is then transmitted to the required destination by the antenna where it is received and the original information signal obtained by demodulation or detection process [2]. Modulation can be defined as the process by which a low frequency signal (i.e. audio frequency, AF) which contains the intelligence is combined with a high frequency signal (i.e. radio frequency, RF) resulting to a modulated carrier wave which is more compatible with the application and in the desired part of the spectrum. Modulation takes place at the transmitter station [3, 4].

In the other hand, demodulation is the act of recovering or detecting or separating the intelligence signal from the modulated carrier wave and this takes place at the receiving end [5-9].

Carrier Wave Equation: The sinusoidal carrier wave equation is represented by

$$V = V_c Sin\,(W_c + \emptyset) \quad (1)$$

$$= V_c Sin\,(2nf_c + \emptyset) \quad (2)$$

Where
V_c is the amplitude of the wave.
f_c is the carrier frequency

In commercial transmitter, modulation is achieved by varying any of the three parameters stated above in accordance with the signal while keeping the remaining two parameters strictly constant [10, 11, 12 and 13].

Types of Modulation: Basically, three types of modulation exist:

- Amplitude Modulation, (AM)
- Frequency Modulation, (FM)
- Phase Modulation [4, 6, 13].

Amplitude Modulation (AM): In amplitude modulation, the amplitude of the carrier wave is varied in proportion to the instantaneous amplitude of the information bearing signal or the audio signal, keeping constant the frequency and the phase. In amplitude modulation, a voltage proportional to the signal is added to the carrier amplitude and this is expressed mathematically as

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$$V_{(t)} = V_c + e_m(t)\cos(2nf_c t + \emptyset) \quad (3)$$

The term $(V_c + e_m(t))$, describes the envelope of the modulated wave and $e_m(t)$ is the added component of the voltage [3, 4].

Most domestic AM broadcast services use the medium wave band from 550 to 1600 KHz while international AM broadcasts take place in several of the high frequency (HF) bands scattered from 1600 kHz to 15 MHz. The mode of transmission in AM broadcast is doubled sideband full carrier, with an audio baseband range of 5 kHz [3, 4].

Frequency Modulation (FM): Frequency Modulation, FM is the act of varying the frequency of the modulated carrier wave while its amplitude is kept constant. The modulating signal $V_c + e_m(t)$ is used to vary the carrier frequency. FM broadcasting takes place in the very high frequency (VHF) band from 88 kHz to 108 kHz and it uses a wider baseband of 50Hz to 15 kHz with a maximum allowable deviation of ±75kHz. FM is resistant to noise than AM which is greatly affected by it, hence anyone who has tuned an FM receiver noticed the 'quieting' of background noise characteristics of FM reception and this makes FM more preferable than AM [3] and [4].
The instantaneous carrier frequency is equal to:

$$f_i(t) = f_c + Ke_m(t) \quad (4)$$

Where f_c = modulated carrier frequency
K = constant, known as frequency deviation
FM and Phase Modulation are closely related and are sometimes referred to as angle modulation. In frequency modulation:

$$\text{Signal} = \cos[w_c t + K\int f(t)dt] \quad (5)$$

Phase Modulation (PM): Phase modulation is the act of varying the phase of the modulated signal instead of its frequency while the amplitude is constant [3, 4].

The phase of modulation signal is written as

$$\emptyset(t) = \emptyset_c + Ke_m(t) \quad (6)$$

Where $\emptyset_c$ = Phase, K = deviation constant
In phase modulation, the signal is of the form[2,-4]

$$\text{Signal} = \cos[w_c t + Kf(t)] \quad (7)$$

Why Modulation: Modulation is necessary in information transmission due to the following reasons:

- To match the signal to the transmitter medium
- For efficient radiation without necessarily using large antenna, which so costly.
- To reduce noise and interferences
- Used for channel assignment, selection and separation of several broadcasting station.
- Used in multiplexing, so that different signal can be sent simultaneously between the same two points.
- Used to overcome equipment limitation [2-4, 10].

However, in the course of the modulation and demodulation of this signal (i.e. information) transmission, lots of problems are experienced.

Aims and Objectives of the Research: This research is aimed at investigating the problems associated in the course of modulation and demodulation of information transmission and remedies to reduce these problems are being suggested.

Problems Associated with Modulation and Demodulation of Information Transmission: From the research, it was discovered that these problems includes weak signals being received by the transmission system, interferences and sometimes too strong signals reaching the transmission system.

Interference Problems: These problems occur when unwanted signals, which can come from a range of source, are picked up by communication stations (i.e. a television or radio broadcasting or telecommunication system). This leads to the reception quality being adversely affected. Also, interference problems can result to any undesired signal that diminishes the quality of voice or data traffics over the radio frequency or air interface. This interface is often regarded as noise, which causes dropped calls noisy in case of Global System Mobile phones (GSM) or land phones. These problems can be fixed by installing more base station capacity, improving the capacity of the transmitter and using modem digital transmitters in our transmission stations.

Sources of Interferences: The sources of interferences in both television and radio can be attributed to the following reasons:

- Electrical equipment interference
- Radio communication interference
- Weather and atmospheric condition

Electrical Equipment Interference: This interference result by the electrical equipments used in transmission. The effect of this interference in television or radio broadcasting results to:

- Ragged moving horizontal pattern
- Random or dots of flashes and
- Buzzes or cracks on the sound

Radio Interference: This is caused by equipments that emits radio waves and is used by taxis and emergency services, amateur and citizen band radio and mobile phone service. This can also be caused by equipments connected to that TV such as video, DVD player/recorder or signal boaster. This problem has effect on radio and they include;

- moving wavy pattern
- 'S'pattern
- a waffle effect
- toss of colour

Weather/atmospheric Condition Interference: This type of interferences include:

- Co-channel interference
- Impulse interference
- Inter-modulation harmonics
- Near-far problem

Co-Channel Interference: These results when signal from different transmitter overlap, which leads to high air pressure; allowing signals to travel further than normal. In this case, television or radio receives different signals at the same time. This interference is caused by unusual atmospheric condition that allows signals from distant transmitter that uses the same channel to be picked. This type of problem is Communication systems can be designed to be robust in terms of impulse noise.

Near/Far Problem: In this case, as the signal gets further from transmitter, such as base station, they get weaker. The radio/television receiving such weak and distant signal can be de-sensed by nearby strong signals. The strength of the received signal is a function of the strength of the transmitter, distance from the transmitter and numerous environmental factors relating to the medium

Ghosting: This type of interference occurs when the television signal is reflected by obstacles, such as a building or mountain or when the antenna or antenna lead wire is in poor condition. In this case, the pictures are then superimposed, because the main signal and the reflected signal do not arrive at the receiver at same time. The problem can be solved by simply rotating the antenna. Also, if the problem is from behind the television antenna, the ghost image could be reduced or eliminated by using a yagi antenna or rear-screen antenna. Poor short term phenomenon and one can wait for the condition to improve. But if the problem persists, the direction of the antenna can be changed to better the reception of the desired station.

Impulse Interference: This is common to a wide range of frequencies generated by large power pulse. Impulse noise could result from electrical disturbances, lightening or welding machinery or industrial equipments, installation of antenna can also cause reflected ghost images.

Weak Signals: These problems results when one is too far from transmitter station or if there are obstacles between the transmitter and antenna. The effect is the same if the antenna is faulty or not pointed in the right direction. The television pictures are much likely to be affected than the sound. Hence, better reception is obtained from near windows or upstairs than down stairs.

Distorted Sound: This is caused by the transmitter signals traveling to the listener's radio receiver through more than one path. This is as results of signals been reflected off hills or tall buildings. Then the reflected signals arrive at the aerials a moment later than the direct signal because it has traveled very far and hence the reflected. This is best minimized by using directional rooftop antenna, which will only pick up signal from the transmitter and rejects signals that arrive at the back or side of the antenna.

Twitting or Discordance: This effect is caused by too strong signal reaching the TV/radio system. Overloading

causes uneven and discordance reception; and this can cause background twittering sound. The problem is solved by using attenuator.

Background Sizzling: This can be caused by abnormal weather condition which results to interference on TV and FM radio reception.

CONCLUSION

The problems associated in modulation and demodulation of information transmission was investigated and possible solutions to such problems were suggested. The problems include interferences of all kinds, near/far problems, ghosting, weak signals, distorted 'S' sound, twittering and background sizzling.

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Recommendation: Communication Stations in Nigeria should be equipped with modern equipments with digital transmitter and antenna with high radiating power as to overcome most of these problems identified and to meet intentional standard.

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