International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Investigation of Signal Strength-Level Generated by Orient 94.4 FM Transmitter in Imo State, Nigeria

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Abstract: ***The study investigates the variation of signal strength generated by the 4.3 kW Frequency Modulation (FM) station of the Imo State Broadcasting Corporation (Orient 94.4FM), Owerri, Nigeria, within some selected routes in Imo State. The signal strength meter (SSM) used for this investigation was designed and constructed. The signal strength was measured at a distance of 5 km intervals field of view from the transmitter's antenna and in places within the selected pathways, till the signal faded totally. A travel distance application which uses global positioning receiver system (GPRS) was used to measure the distances of the study locations from the broadcasting station. The data gotten was plotted graphically to ascertain the difference in signal strength with distance along the routes, where the study was carried out. The results obtained from this study revealed that the strength of signal was stronger in locations close to and in the same direction with the antenna but was relatively weak at locations antipodal to the antenna. The overall results show that distance from the transmission is a major parameter to be contemplated on for better and effective FM propagation and reception. Other factors that affect the signal strength from the results of this study are time of broadcasting, temperature, height and direction of the receiving antenna and interference from nearby FM stations. It was recommended that a unidirectional antenna be acquired to enhance better transmission of the signal along the different routes of study.***

Keywords: Signal strength, Signal reception, Transmission, Antenna, Distance

1. Introduction

Poor reception in telecommunication is almost impossible to avoid or prevent because of both human and natural factors. Changes in signal strength received are greatly affected by atmospheric parameters [1]. Temperature appears to have a notable undesirable effect on signal strength generated, whereas high relative humidity may have certain effect on signal strength, most especially below 0◦C[2]. Other factors are noise, poor reception, **p**ower of the transmitter and receiver**, b**oosting i.e. the number of repeater stations, frequency/wavelength of the signal**,** height of the antenna [3]. Interference is presently the major obstacle to growing spectral effectiveness in cellular linkages and radio communication [4].

Orient 94.4FM, like every other Radio and TV station, has areas of poor signal reception. Some of these regions are not as a result of a technical deficit at the station; rather due to geographical structure such as mounds, mountains edifices and trees. To find out these areas with poor signal strength, a field strength meter was used to measure the signal strength generated by the transmitter.

This research is aimed at investigating the variation in signal generated by the 4.2 kW FM transmitter of the Imo State Broadcasting Corporation (Orient 94.4FM) Owerri, Nigeria, by using a constructed signal strength meter. It focuses on measuring using a range of 5 Km distance along some selected route from the transmitter of Imo State Broadcasting Corporation, Owerri and to identify the major causes of poor signal within the study area.

Altitude is a major parameter to be taken into cognizant for the reception of signals [5]. Although it has be observe that differences in signal do occur with respects to the angle of incidence amid the material and the transmitting antenna [6],radio transmission is affected by excess attenuation in sea water as just a little span is attainable even with small frequency [7]. Rainfall has a clear effect on different parts of the transmitting link for radio wave transmission in a torrid forest [8].

2. Study Location

Imo state is one of the thirty (36) state in Nigeria. It is situated at South East part of Nigeria. Imo state resides between the lower River Niger and the upper and middle Imo River. It share same boundary with Abia State, Anambra State, Delta State, River Niger and Rivers State. Imo State have a land mass of about 5,100 square kilometres and lies between longitude 6°50'E and 7°25'E and latitudes 4°45'N and 7°14'N [9].

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Figure 1: Map of Imo State [10]

3. Literature Review

Several models have been developed by engineers long ago to investigate telecommunication site positioning and plan for cellular networks. Because of some specific restriction in its application, final solution cannot be provided by some of the model developed [11]. The general radio wave transmission predicted processes based on computer empirical results or data base give only estimated analysis that is inappropriate for thorough planning of system. Radio wave transmission prognosis scheme effectiveness can be upgraded significantly with dominant proficiency using Isolated Detecting and Geography Information System techniques [11].

It has been observed that the problem of experimental radio system is exploiting secondary end user output while controlling interference forced on authorized users [12]. Thus, obtaining best transmitting timing approach, exact sensing and transmission methods are relevant in innovative radio network.

4. Methodology

The signal strength meter

The signal strength meter used in investigating the signal strength of the Orient FM was designed and constructed. The meter is made up of the following section: signal strength monitor, RF stage, IF stage and LCD, power amp as shown in Figure 2.

The construction started by sketching a simple plan of each section which shows the manner in which the various components are arranged agreeing to the circuit diagram. On conclusion of the design, the components were fixed on a Vero board of 24 continuous lines. The order used for arranging the different components includes mounting the IC sockets first, followed by resistors, then the capacitors and lastly the soldering of thin copper wires (jumper). After which, the surface to be solder was clean to make the surface free of grease and oxide films in order to produce a good soldering contact. The different sections were cautiously connected together as shown in Figure 2. The circuit where finally housed in a plastic container. Figure 2, reveals the different section of the meter. Fig 2 reveals the different section of the signal strength meter (SSM). This designed wide range bands signal strength meter MK1 have a single power that relies on the dry cell. The life of the battery can be recycled by charging it, although it can be terminated when it is suffocated, over charged or when the battery is damaged.

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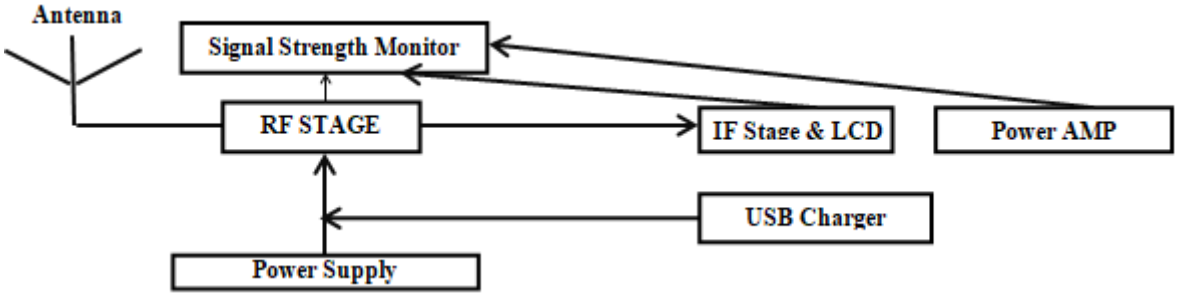

Figure 2: Block diagram of field strength meter

Measurement procedure

Measurement of signal strength of the Orient 94.4 FM of the Imo State Broadcasting Corporation, Owerri, Imo State, was outwardly carried out along some selected pathway in Imo State from Base station by means of a constructed signal strength meter (SSM). The different routes feature is as shown in Table 1. The location of transmitter's aerial of the station along Chief AchikeUdenwa Avenue, New Owerri Road, Owerri, was made the point of reference using the Global Position receiver system for all the selected routes. A travel distance application that uses global positioning receiver system (GPRS) was used to measure the distance of the study locations from the Base station.The field of view of the Base station transmitting antenna was observed during the drive from the different routes of signal strength measurement.

The investigations were carried out at 5 km intervals from the transmitter and in places within the selected pathway, till the signal faded totally. All measurements were made using the receiving antenna for reception of the horizontally polarized signal under elevation of 4m above ground level. At the measuring location a check was made to determine whether the strongest signal arrived from a direction other than from the transmitter. The antenna was oriented so that the sector of its response over which maximum gain is realized was on the direction of the transmitter. Arrangement was made with the management Orient 94.4 FM towards ensuring that propagation characteristics remained the same during measurements as shown in table 2.

Some of the factors which affect the signal strength obtained were recorded. The factors include height and types of foliage, edifices, landscape, barriers, climate, and other local parameters. Measurements were taken in different months, on different days, and at different time of the day and different temperature. The average results of these measurements were then taken and the data obtained from the measurements were plotted in a graph to ascertain the variation in signal strength along the different routes.

Table 1: Pathway description used for the research

Routes	Pathway/Description	Distance from transmitting station (Km)
A	Owerri – Onitsha Road	84.5
B	Owerri– Orlu Road	45.5
C	Owerri–Okigwe Road	61.3
D	Owerri – Aba Road	68.9
E	Owerri – Port Harcourt Road	94.5
F	Owerri – Nekede	23.6

Table 2: Properties of the investigated station

Serial No.	Characteristics	Description
1	investigated station position	Long. 7.04° Lat. 5.45°
2	Base station's transmitting power	4.2 KW
3	Base station frequency (MHz)	94.4 MHz
4.	Transmitter in use	ZHC 10 KW
5	Height of transmitting mask	304.8 m
6	Elevation of propagating aerial	15.24 m
7	Propagating aerial gain	30.02 m
8	Height of receiving antenna	Inbuilt

5. Result and Analysis

The results obtained from the field were grouped according to the routes where measurements took place. The values of the signal strength obtained from the field measurements were tabulated and plotted against distance to produce the equivalent signals strength summaries for each routes where the measurements was carried out. Table 3 shows signal strength variation with distance along route A, B and C while table 4 shows signal strength variation with distance along route D, E and F.

Table 3: Signal strength variation with distance along route A, B and C

Distance (Km)	Signal Strength (dB)		
	Route A	Route B	Route C
05	80	80	80
10	75	70	60
15	70	60	40
20	68	40	36
25	66	30	28
30	60	20	20
35	52	10	00
40	40	00	00
45	35	00	00

Table 4: Signal strength variation with distance along route D, E and F

Distance (Km)	Signal Strength (dB)		
	Route D	Route E	Route F
05	80	75	60
10	40	36	32
15	38	30	20
20	22	10	00
25	00	00	00
30	00	00	00

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Analysis of the effect of distance on the strength of radio signal

Fig.3 below shows how signal strength variation with distance along route A, B and C. Why fig. 4 shows the graph of Signal strength variation with distance along route D, E and F.

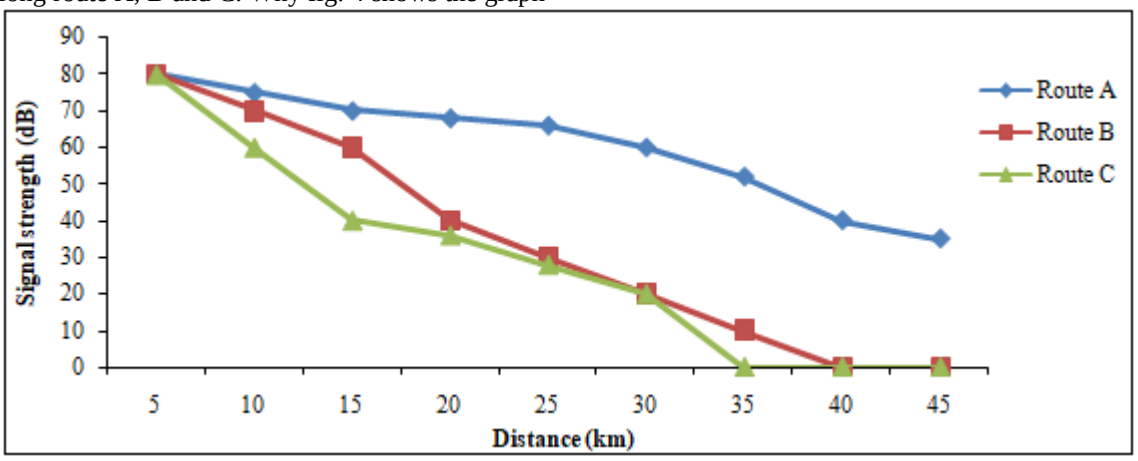

Figure 3: A graph of Signal strength variation with distance along route A, B and C

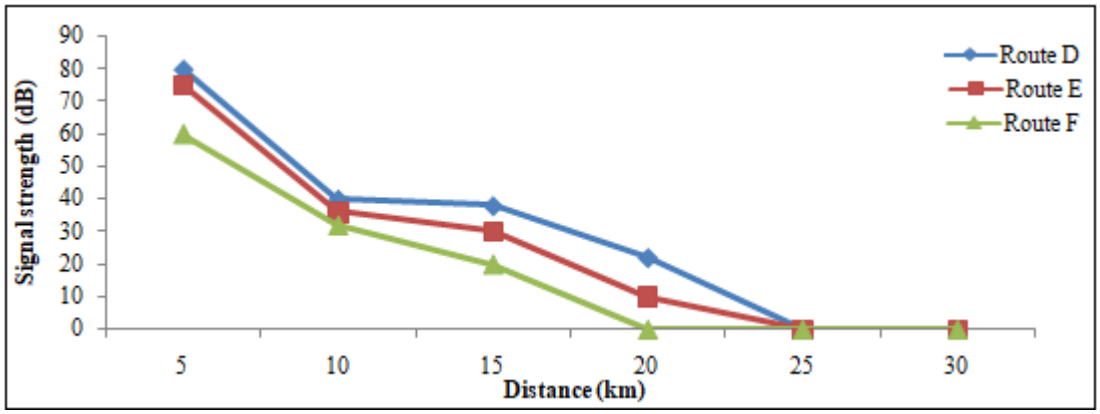

Figure 4: A graph of Signal strength variation with distance along route D, E and F

The highest signal strength value in the State which is 82 dB was recorded at the base station. This signal strength level decreased as the transmitter's distance increased along the selected pathway; although few exceptions was recorded as shown in Figure 3 and Figure 4. Particularly, along route A, higher values of signal strength were recorded at a distance of about 30 km unlike distances closer to the transmitter along the other routes.

This exception was due to the angle of transmission of the transmitting antenna. At a distance of 5 km from the transmitter, the signal strength along route A, B and C was 80 dB. The signal strength was observed to reduce as the distance increases. Thus, at a distance of 10 km from the transmitter, the signal strength at route A was 75 dB, that of route B was 70 dB and the signal strength at route C was 60 dB.

The signal strength at route A, B and C for a distance of 15 km, was 70 dB, 60 dB and 40 dB respectively. The signal strength at route B and c dropped to zero at a distance of 40 km, while the signal strength at route A was 40 dB at same distance of 40 km. The variation in the signal strength was as a result of the alignment of the transmitter's antenna. The antenna of the Orient 94.4FM has eight (8) bays with six (6) of the bays directed towards the commercial city, Onitsha (route A); thereby causing signal strength along route A to be very high compared to other routes. The other two (2) bays of the Orient 94.4 FM antenna points towards the Imo State Government house located along route B.

Locations at Route D, Route E and Route F most often experiences weak signal strength because the routes are relatively opposite to the direction of the Orient 94.4 FM antenna. For instance, at a distance of 30 km from the transmitter, the signal strengths measured at routes D, E and F were zero (o) while the signal strength measured along route A at same distance of 30 km was 60 dB. This shows that places close or along the direction of the bays of this antenna always receive strong signals except when there are technical hitches. Observations from this study in comparison with other experimental results show that the angle of transmission affects the reception of signal. Figure 3 and figure 4 show that signal strength decrease with increase in distance (LOS) along the routes. Thus, the further the lines of sight distance from the transmitter the weaker the signal strength. This proves that signal strength is inversely proportional to distance, provided other transmission parameters are kept constant.

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6. Summary, Conclusion and Recommendation

6.1 Summary

In this study, the signal strength generated by Orient 94.4 FM was investigated by the use of a self-constructed signal strength meter. A travel distance application that uses global positioning receiver system (GPRS) was used to measure distances at 5 Km intervals along the different routes that the study was carried out. Data obtained were plotted graphically to ascertain the variation of signal strength with distance, time and temperature. The results of this study showed that signal strength decreased with increase in distance.

6.2 Conclusion

Signal strength generated by orient 94.4 FM transmitter, Owerri along six (6) different routes in Imo state, Nigeria, was investigated. It was observed that line – of - sight distance along the different routes of field measurements varied inversely with the signal strength generated by the Orient 94.4 FM transmitter.

6.3 Recommendation

Distance has been shown to affect signal strength generated by frequency modulated transmitters. The strength of the FM signal generated drops at a distance of 45km away from the transmitter of Orient 94.4 FM and also at a very high temperature. To better the signal strength within the areas experiencing poor signal strength, the power of the transmitter currently 4.2 kW should be increased to at least 10 kW for effective transmission. An omnidirectional antenna with many bays which will point towards all the axes in the state should be aquired to enhance the transmission of signals generated by the broadcasting station.

Based on the findings of this study, repeater stations should be created at Nekede, Okpala and Ohaji to ensure that the broadcast signals is received beyond these regions. A good signal monitoring policy should be evolved by broadcasting corporations to be able to correct existing mistakes and failures in signal propagation.

7. Suggestion for Further Research

Further research should aim at finding the percentage drop at the boundary axes of Imo State in order to suggest the required number of repeater stations necessary for better signal coverage.

8. Acknowledgement

We sincerely appreciate the management and staff of Imo State Broadcasting Corporation (Orient FM and TV) for their maximum cooperation during this work and for making available the required features of the investigational station.

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