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Impact Of the Environmental Noise Level and Its Effects on Fad Fm 93.1 Radio Signal Calabar in Cross River State, Nigeria

M. I. Anashie[a,*], F. I. Anyasi[b], F. P. Otosi[c], G. A. Fischer[d]

[a,b,d] Department of Electrical/Electronic Engineering, University of Cross River State, Nigeria
[c] Department of Computer Engineering, University of Calabar.

[*]Corresponding author: matildaipeh@gmail.com

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Abstract:
The increasing use of wireless devices, coupled with the rise in environmental noise, creates challenges for maintaining the quality of radio signals. This research investigates the environmental noise levels in Cross River State, Nigeria, and their effects on the signal strength of FAD FM 93.1, a local radio station. The research employs a comprehensive measurement procedure using a noise level meter and a CATV signal strength meter in six selected local government areas. Data collection spans four months, covering both rainy and dry seasons. The obtained results were evaluated based on study locations, times of day, noise level and signal strength. The findings of the study were analyzed to create a visual representation using MATLAB software. The signal strength transmitted by FAD FM during the study period was measured at 76.2 dB. Results reveal an inverse correlation between environmental noise and FAD FM signal strength, indicating that increased noise leads to decreased signal quality. Simulated results illustrate the impact of noise fluctuations on signal strength throughout the day, emphasizing peak traffic and industrial hours as critical periods. The study attributes poor signal performance to high noise levels, suggesting practical advice for noise reduction in the study locations. Additionally, a model is proposed to determine the efficiency of the signal strength received in these selected areas. In conclusion, the findings highlight the significance of addressing environmental noise to enhance radio signal reception. Recommendations include targeted noise reduction strategies, optimization of signal reception, and continuous monitoring. This work contributes valuable insights for radio signal analysis and offers a foundation for further research in noise reduction efficiency and signal quality enhancement.

Keywords: Wireless Devices, Noise, Radio Signals

I. INTRODUCTION

The use of wireless devices such as radio has increased significantly in the last decade, as has the number of sound recordings that are tainted with various types of audio noise disturbances [1]. This noise produces a wide range of harsh sounds, and the Signal-to-Noise Ratio (SNR) is negative. Any undesired signal, whether random or predetermined, that prevents a system from accurately reproducing the desired signal is considered noise in communications [2]. Noise, which is commonly referred to as unwanted sound, can be found in all areas involving humans, living things, or environmental activities [3]. The impact of environmental noise on telecommunication may differ depending on location, noise level, and noise source. The unwanted signal can be distinguished from the desired signal by random fluctuations in voltage or current that tends to conceal and mask the interfering signal. The maximum sensitivity and reception range of a radio transmission are determined by the degree of background noise in a certain area. If radio signals were not distorted by background noise, it would not matter how weak the sent signal was; a radio receiver with exceptional sensitivity could pick it up from practically

anywhere. Internal noise and external noise, which is sometimes known as "environmental noise," are the two primary categories of noise [4].

Speech signals from an uncertain environment may incorporate deterioration constituents in addition to needed speech constituents. Ambient noise, sound from other speakers, and so on; are examples of deteriorating constituents. Such noise degrades sounds, making direct listening complicated and resulting in poor quality in sound signal processing tasks such as speaker identification, speech recognition, speech coders, hearing aids, and so on [5]. As a result, deteriorated sound must be processed in order to improve signal quality. Sound enhancement is intended to increase the quality and clarity of degraded sound signals caused by environmental noise [6]. The primary goal of this signal analysis is to increase the perceived characteristics of sound signals, such as overall quality, coherence, and consumer discomfort. Improving sound quality and coherence decreases consumer discomfort and improves the effectiveness of hearing devices, sound coders, and many other sound systems. Signal distortion can be used to gauge quality, but coherence and pleasure are difficult to quantify using any statistical formulation. Cognitive quality and coherence are two distinct sound signal metrics that are a function of environmental noise [7].

Environmental noise, which includes noise from all sources excluding that produced by a reference system or equipment, is a collection of noise pollution. This noise, which degrades the quality and efficiency of radio signals, are caused by transportation, industrial, and recreational activities [8]. Using radio signals, cell phones, hands-free phones, video conferencing, and automated secure speech communication services are just a few of the many applications where noise reduction is advantageous [9]. Noise pollution, on the other hand, can cause annoyance, sleep disruption, anxiety, hearing damage, stress-related cardiovascular health concerns, and interference with speech or other desired sounds. The study of noise encompasses all aspects of sound production, propagation, and reception of sound signals, and it is frequently defined in terms of sound pressure, which is dependent on the power output of the noise source and the environment [10]. The ear has a unique capacity to process a wide variety of sounds. Sound, on the other hand, becomes a problem when it interferes with sound signals and other human activities such as sleeping, recreation, working, and so on. Changes in sound pressure are responded to by the human hearing mechanism in a comparable rather than quantitative form. This is why the decibel (dB) scale is used to measure sound pressure level (SPL). The threshold of hearing, which corresponds to 0 dB, is the weakest sound that the human ear can detect. The threshold of pain, on the other hand, corresponds to 120 dB and is the degree of sound pressure that will produce pain to the ears [11].

Aside from the conventional factors that affect radio signal strength, such as transmitter power, transmitting antenna height, distance, reflection, refraction, diffraction, interference, receiving antenna height, scattering, noise is an important factor that affects radio wave signals [12]. This noise is most prevalent in densely populated areas, industrial zones, commercial complexes, market places, motorable routes, and so on. Normally, human activities that take place in these areas generate noise, which can interact or tamper with radio signals [13].

In these locations, electrical machines that operates do generate electromagnetic waves. These electromagnetic waves generated by such machines inhibit and significantly affect radio wave signals. Cross River state, particularly Calabar and other urban areas, has the characteristics of a region with high environmental noise. The ability to move with wireless communication devices such as radios, televisions, and mobile phones may cause changes due to how they are used and positioned, as well as when utilized in noisy surroundings, influencing the efficiency of radio wave transmission, reception, and measurements [14]. Thus, the main purpose of this research is to investigate environmental noise levels and their effects on wireless propagation signals in Cross River State, Nigeria.

The rate at which noise pollution is increasing and its impact require careful examination, particularly in Cross Rivers State, Nigeria. This increase in noise can be attributed to the state's rising levels of economic affluence, population density, and increased vehicular and machine usage. Noise depreciates the value of our environment and is known to have numerous negative effects on both structures and humans. This noise has also been shown to affect electromagnetic waves generated by wireless communication systems such as radios. Some studies have been conducted to determine the noise levels produced by aircraft, vehicles, and event centers, as well as noise prediction metrics and the effects of noise on structures and the human body. Although studies on noise have been conducted, none of these studies have critically examined environmental noise levels in Cross River State and the impact on radio wave signals. Furthermore, none of these studies has been conducted to investigate the effects of environmental noise on signals generated by FAD FM, a radio station in Calabar, Cross River State, Nigeria.

II METHODOLOGY

The research was conducted within 6 local government areas in cross river state; Akamkpa, Odukpani, Calabar south and municipal, Bakassi and Akpabuyo. The areas of focus within these locations were marketplaces, churches, roads with traffic, industrial areas etc. These areas were selected due to proximity to transmission base station, dense population, industrial areas etc.

Data collection spanned between a period of 4 months which included rainy and dry seasons. Using an SM 100 digital noise level meter and a Cable TV digital strength meter. Measurements were taken concurrently. The readings were taken between the hours of 7am and 6pm, 6 readings were recorded within an hour and the average taken to get a more precise value. MATLAB was used to visualize the data and analyze the impact. The results were evaluated based on study locations, noise level, signal strength and times of the day.

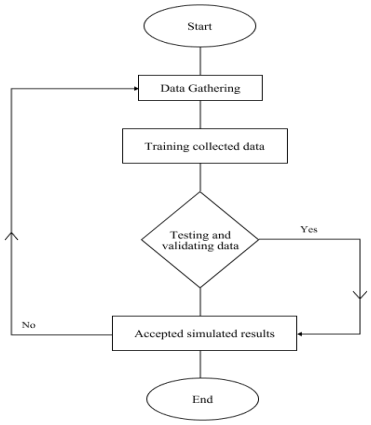

Figure 1.0: Flowchart of methodology

III RESULTS

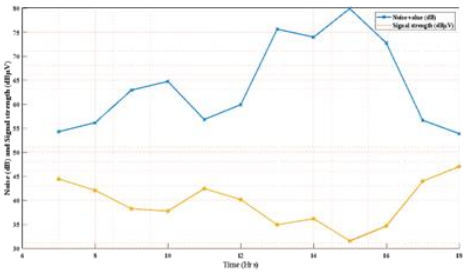

Figure 2.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Timber market, Calabar.

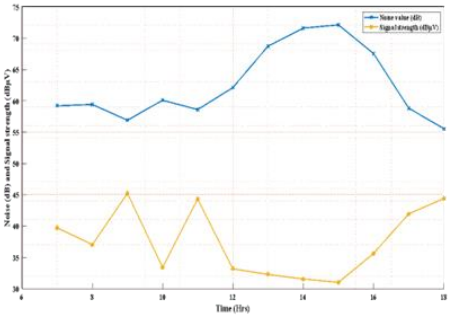

Figure 3.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Marian market, Calabar

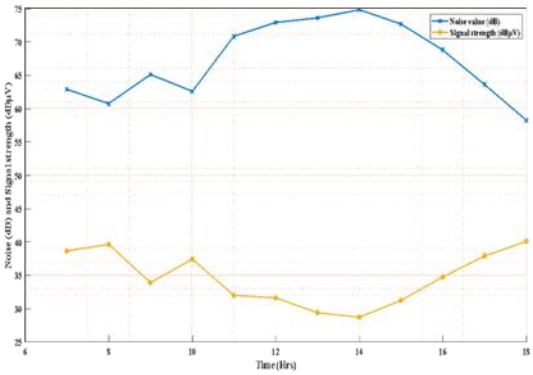

Figure 4.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Watt market, Calabar

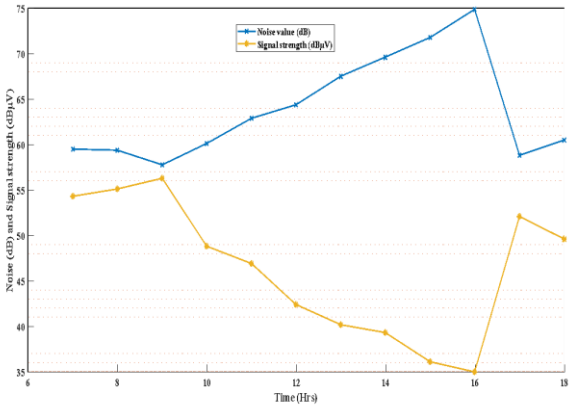

Figure 5.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Marian by Atekong, Calabar.

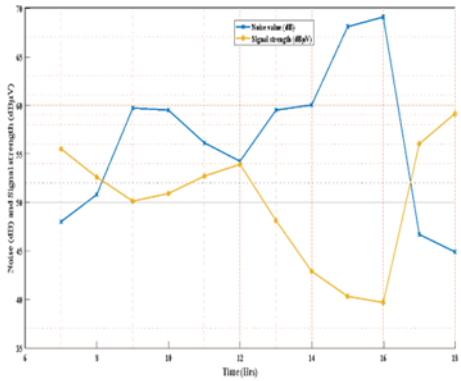

Figure 6.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Effio Ette Roundabout, Calabar.

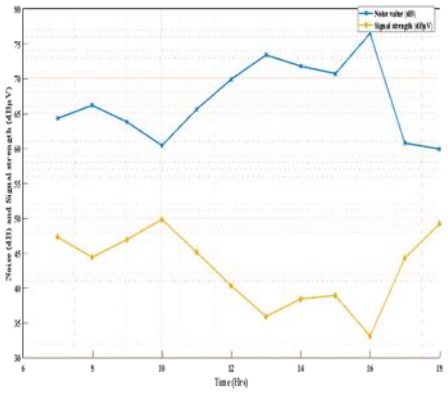

Figure 7.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Lafarge, Akampa.

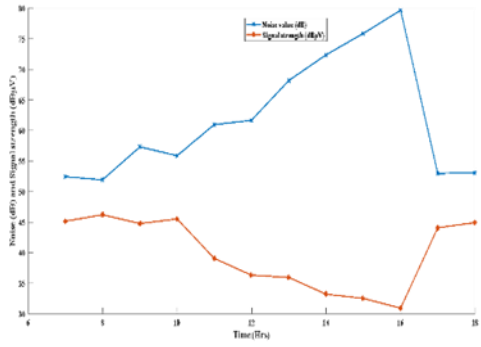

Figure 8.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Aurthur Jarvis University, Akpabuyo.

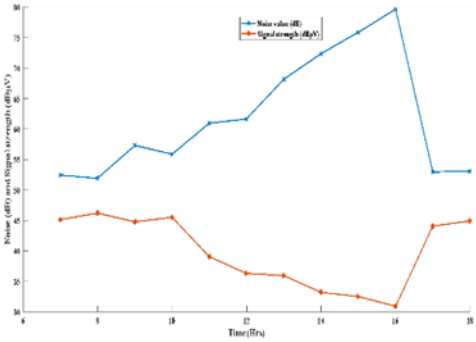

Figure 9.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Ikan Market, Bakassi.

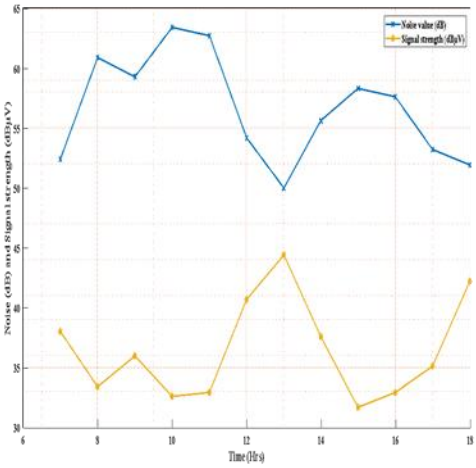

Figure 10.0: Noise (dB) and signal strength (dBμV) against Time (Hrs) at Main Road by Flyover.

IV DISCUSSIONS

The Figures presented show the research conducted on the effects of environmental noise on FAD FM signal strength in various local government areas. The simulated results considered parameters such as; location, time of day, noise level and signal strength. Through meticulous data collection and analysis across six study locations; Calabar Municipal, Calabar South, Akamkpa, Akpabuyo, Bakassi, and Odukpani Local Government Areas, notable patterns have emerged regarding the dynamic relationship between environmental noise fluctuations and FAD FM signal strength throughout different times of the day.

Figure 2.0 to 10.0 shows the relation between signal strength of FAD FM, Noise and time of the day for the six (6) selected LGA at Timber market, Marian market, Watt Market, Marian by Atekong, Effio Ette roundabout, Lafarge, Arthur Jarvis university, Ikan Market, Main road by flyover and flour mill. Different locations generate noise of varying intensity. It was observed that locations like; Calabar Municipal and Akampa which had industrial zones with loud machinery and operations had elevated noise levels compared to locations like Calabar South, Akpabuyo, Bakassi and Odukpani. Also, with the high traffic flow, like busy roads or market areas, in Calabar Municipal and Odukpani, higher noise levels were experienced due to vehicle movement and activity. This led to a more significant degradation of signal strength compared to quieter areas.

The results of the research on the effects of environmental noise on FAD FM signal strength as shown in Figure 2.0 – 10.0 revealed compelling insights into the intricate relationship between environmental noise levels and the broadcast efficiency of the radio station. FAD FM 93.1 radio signal strength exhibited fluctuations throughout the day. These fluctuations corresponded with variations in environmental noise level. Lower signal strength levels were observed during peak periods with higher noise levels. For instance, in Figure 1.0 (timber market, Calabar), when the noise level in dB is 54.2, the signal strength in dBμV is 44.4. When the noise level increased to values of 56.1 dB, 62.9 dB, 64.7 dB, the signal strength reduced to 42.0 dBμV, 38.2 dBμV, and 37.7 dBμV respectively. The signal strength of FAD FM increased to 42.4 dBμV and 40.1 dBμV when the noise level decreased to 56.8 dB and 59.9 dB respectively and decreased to 34.9 dBμV and 31.5 dBμV when the noise level increased to 75.6 dB and 79.9 dB respectively.

A similar pattern was observed for all local government areas within the research area, with fluctuations in environmental noise levels exerting a tangible influence on FAD FM signal strength. The data revealed that as the noise level surged, the signal strength became weaker, showing the inverse relationship between environmental noise and signal efficiency. The findings from this research, indicates a clear inverse relationship between environmental noise and the signal strength from the radio station. As the environmental noise increases, the signal strength of FAD FM radio station decreases and vice versa. Environmental noise is a significant concern as it can degrade the quality of radio signals which leads to reduced reception. However, this can be mitigated by collaborating with experts or relevant authorities to optimize the signal reception by implementing noise control regulations which may involve soundproofing techniques, noise barriers etc. [15] Adopting quieter technologies or vehicles to mitigate noise pollution. Additionally, strategic placement of radio transmitter/receiver stations away from high noise or urban areas and advancement in radio signal processing technologies such as noise cancellation algorithms can improve the impact of noise on FAD FM signal and strengthen the reception quality.

VI CONCLUSION

This study highlights the effects of environmental noise on FAD FM signals in Cross River State. It provides valuable insights into the relationship between noise levels and signal strength, suggesting noise reduction techniques and improvements to enhance the radio listening experience in the study locations. The study showed that as environmental noise increases, the signal strength of FAD FM decreases, and vice versa and also the linear relationship between the two environmental noise (N) and (S).

Additionally, the work proposes improvements to enhance the FAD FM signal quality, ensuring that listeners can enjoy their services when tuning in, especially in the study locations. These improvements may involve optimizing antenna placement, upgrading transmission equipment, and employing advanced signal processing techniques as illustrated in [16].

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