ENHANCING RADIO FREQUECY SIGNALS RECEPTION FOR TECHNICAL VOCATIONAL EDUCATION AND TRAINING ACTIVITIES

Mathew T. O.[1] & Aiyelabowo O. P.[2]
[1,2]Department of Electrical/Electronic Engineering
The Federal Polytechnic, Ilaro, Ogun State
Timothy.mathew@federalpolyilaro.edu.ng
peter.aiyelabowo@federalpolyilaro.edu.ng
0706851419

Abstract

Availability and sustainability of the internet is required for the deployment of technical, vocational education and training (TVET). GSM and Wifi are the popular technologies deployed for internet provision. These technologies transmit radio frequency (RF) signals. RF signals passing through a non-transparent medium to a free zone experiences penetration loss, which weakens the strength of the signal. A renowned type of this penetration loss is the building material penetration loss. In this paper, a system that enhances RF signal reception is presented. Two types of dipole antennae, for transmission and reception, were designed. The receiving antenna picks up the transmitted RF signal from source. It also incorporates an amplifying circuit built on a LM386 IC. The transmitting antenna radiates the enhanced RF signal to the users. The system output was tested with a RF Signal Speed Detector Application Software. The signal strength of the enhanced RF signal was improved when compared with the non-enhanced signal, improvements over the four identified locations are 37.5%, 65.6%, 78.78% and 164.7% respectively.

Keywords: Radio frequency, transmitting, receiving, antenna and amplifying circuit.

Introduction

Day in day out, mobile and wireless infrastructures are taking a prime place in modern economics. Wireless communication is used for various form of applications ranging from medicine, entertainment, telephony (fixed and mobile), multimedia etc. These activities are vital to the development of technical, vocational education and training (TVET). Ramadan et al., (2018) opined that ICT integration into TVET system should be approached with urgency as it is a tool to prepare technical schools and artisans for the desired technological development. Furthermore, applying ICT in TVET will change the entire focus of manpower needs of the world from skilled-based to ICT-capable workforce Saud et al., (2011) The communication component of the ICT is driven by radio frequency signals. Radio frequency signals, signals in the frequency ranges of Mobile phone is used everywhere, outdoor and indoor (Onwuka et al., 2018). In these environments, customers demand a good coverage and quality of service. The advantages of good telecommunication signal reception is enormous and it offers great ease in doing business to its users ranging from surfing the internet to efficient phone calls and other GSM usages.

Users of radio frequency (RF) signals are faced with the challenges of quality network, when indoor, due to signals obstructions caused by building materials. RF signals passing through a non-transparent medium to a free zone experiences penetration loss. A renowned type of this penetration loss is the building material penetration loss which affects the signal strength received inside the building. (Outdoor-to-indoor reception) (Elechi, 2015). Building penetration loss accounts for the increase in attenuation of the received signal observed when the mobile is moved from outside to inside a building.

According to Elechi & Otawosie, (2016), Elechi, (2015), and Elechi et al., (2017), the signal strength of Radio Frequency (RF) signal received in a building is affected by;

- *Frequency of Transmission*
- *Height*

- *Building Structure and Internal Layout*

The effect of the aforementioned results in signal losses. These losses can be attributed to two principal factors; the height of the building and the penetrating material of buildings. For this reason, wireless systems are accustomed to weak signal receptions due to lack of adequate boosters and bad environmental conditions like foliage weather conditions, trees and high-rise buildings.

Several works have been done in literature to ameliorate this effect on RF signals. A cell phone booster, an electronic device was designed to increase the signal strength for a cell phone in Aliyu et al., (2017). Another author implemented an antenna booster which operates at the 2.4GHz and 5GHz band of the frequency spectrum to improve the RF signal. Antenna based boosters are typically designed to replace stock antennas on wireless routers. In this paper, an electronic component is configured to serve as an amplifying circuit to boost the transmitted RF signal from the RF source. Thus, the system picks up the obstructed/attenuated signal, amplifies it and resend to the various users.

Methodology

The system design follows two-fold pattern, the site survey and the hardware implementation. The site survey involves these activities; The layout structure of the environment was observed and considered, access points to provide signal boosting to the desired coverage area were identified, the physical access points placement (i.e. antenna placement) were marked, high attenuation prone areas, physical construction, environmental challenges and foliage were observed and the system installation location was marked and cabling distance were measured. RF Signal Speed Detector Application Software was deployed for the measurement of signal strength in the identified areas. Figure 1 shows the display of the various signal strength measurements

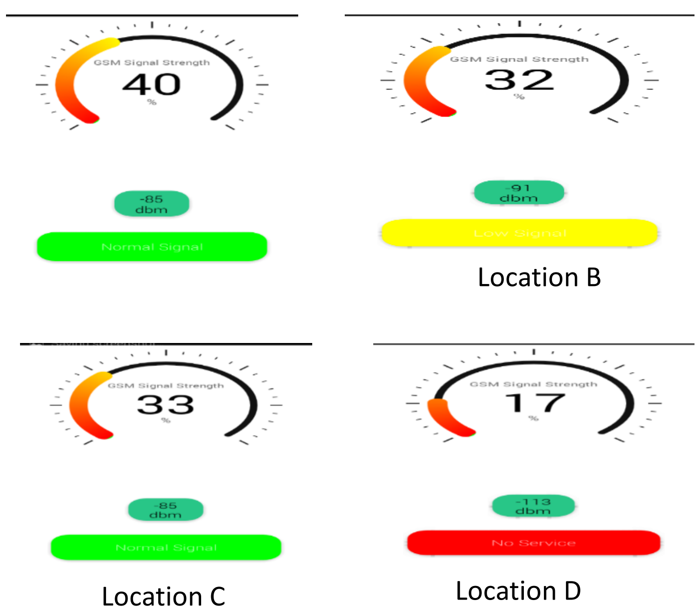


Figure 1: Readings taken at survey

Hardware Implementation

The various units that constitutes the system is as shown in Figure 2. The units include, receiving antenna, signal splitter, amplifying circuit, transmitting antenna and power supply.

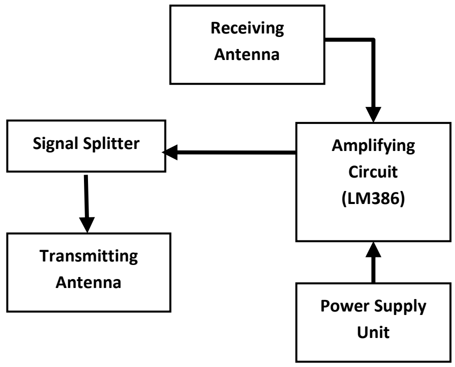


Figure 2: System block diagram

Power Supply

This unit is responsible for powering the amplifying circuit. It incorporates a 220/12 V transformer, a bridge rectifier, rectifying capacitors and power regulators. The rectifying capacitors served as filtering component, removing the ripples from the pulsating dc of the bridge rectifier. The regulator used is a LM7812, it regulates the output of the bridge rectifier to 12 V which drives the amplifying circuit

Antenna Design

To compensate for the needed efficiency of receiving signals from different directions, omni-directional antennae were implemented. The omnidirectional antenna is a wireless transmitting or receiving antenna that radiates or intercepts (RF) electromagnetic fields equally well in all horizontal directions in a flat, two-dimensional (2D) geometric plane.

The receiving antenna is an omnidirectional antenna, that picks up the signal from the RF transmitting source and feeds the amplifying circuit. The transmitting antenna is also an omni-directional which radiates the output of the amplifying circuit to the immediate environment. The deployed antennae are as shown in Figures 3 and 4 respectively.

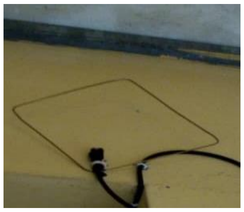


Figure 3: Receiving antenna

Figure 4: Transmitting antenna

Amplifying Circuit

This circuit is built on an amplifying integrated circuit, LM386, a power amplifier designed for use in low voltage consumer applications. The IC is an eight (8) pin packaged component (Semiconductor, 2000) as shown in Figure 5. The gain of the amplifier was determined by the selection of resistors and capacitor for pins 1, 2 3 and 8. A 4.7 KΩ resistor was connected between pins 2 and 3 while a 10 μF capacitor connected between pins 1 and 8. A 4700uF, 25V capacitor was connected between pin 6 and ground. This is done to further filter and compensate for the dc supply from the power supply unit. A 12 V supply is applied to pin 6 to drive the stage.

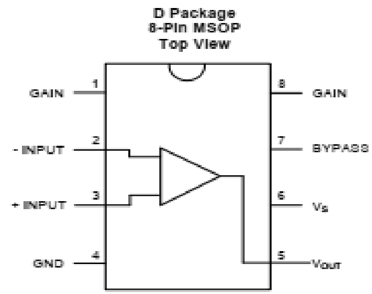


Figure 5: LM386 pin configuration

The schematic diagram of the RF enhancing system in shown in Figure 6.

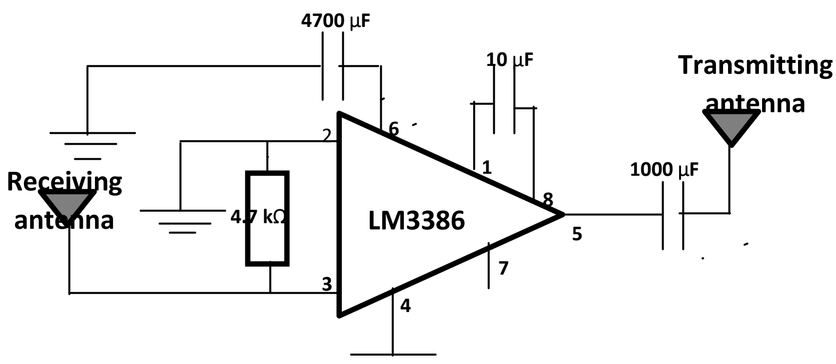
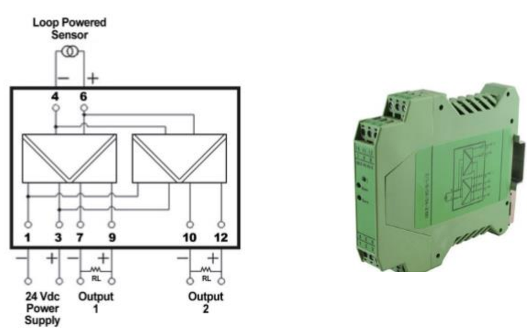


Figure 6: RF enhancing circuit

Signal splitter

This unit is a multichannel system (Splitter, 2005), responsible for splitting the amplifying circuit output signal into different channels or outputs. The implemented splitter is as shown in Figure 7.



a) Circuit b) Pictorial

Figure 7: Signal Splitter

Results and Discussion

The implemented circuit for the amplifying circuit is as shown in Plate 1, while the RF enhancing system implemented is shown in Plate 2.

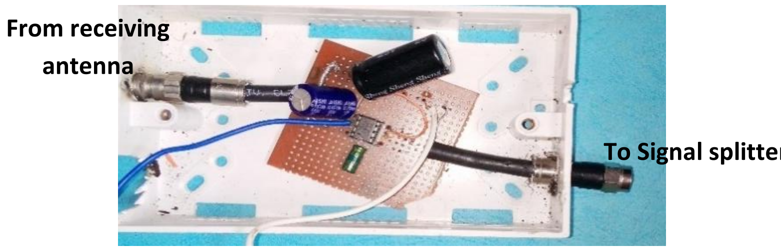


Plate 1: Amplifying circuit

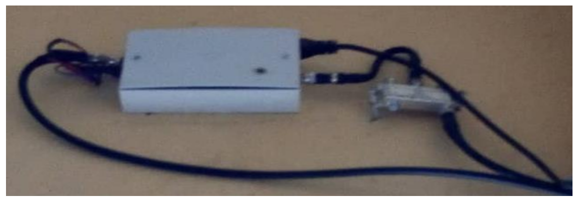


Plate 2: RF signal enhancing system

The transmitting antenna was installed on top of the highest building in the area under examination. The height is about thirty-five feet (35 ft). The receiving antenna was mounted at a height of sixteen feet (16 ft). The Radio Frequency Speed Detector (RFSD) and Network Cell Info (NCI) Lite application software was then deployed to measure the signal strength at the location A to D as in the survey. Figure 8 shows the readings.

Figure 8: RF enhancing system reading

Figure 9 presents the comparison between the measured data at survey and measurement taken when the RF enhancing system was deployed in the environment under examination.

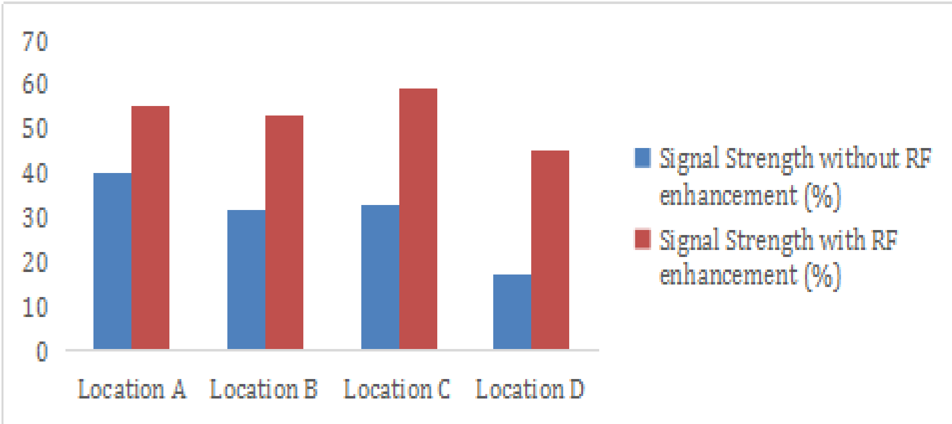


Figure 9: System performance chart

The RF enhancement system achieved these improvements over the four locations, 37.5%, 65.6%, 78.78% and 164.7% respectively.

Conclusion and Recommendations

The RF enhancing system designed and implemented improved the RF signal reception. This signal is germane in conduct of research as it will speed up the time of surfing the internet. It will also foster the accessing of information on the web for various usages. The frustration encounter as a result of poor RF signal reception will be put off. It is recommended that this system be massively deployed in all buildings with low or weak RF signals, particularly libraries, banks and classrooms where RF signal is required to carry out one task or the other. This is required to provide a seamless, uninterrupted and reliable data communication across long ranges without dead zones.

References

Aliyu, S. O., Onwuka, L., & Okwori, M. (2017). Development of a GSM Signal Booster for the 900 and 1800 MHz Bands using D HYHORSPHQW RI D GSM S LJQDO B RRVWHU IRU WKH 900 DQG 1800 MHz B DQGV XVLQJ BA-ANN. *2nd International Enhineering Conference (IEC 2017),* Federal University of Technology, Minna, Nigeria, 426–432.

Elechi, P. (2015). An Improved Signal Penetration Path Loss Model for GSM Network. *Global Summit on Electronics and Electrical Engineering*.

Elechi, P. and O. P. O. (2016). INVESTIGATION OF GSM SIGNAL LOSS IN MULTISTOREY BUILDING. *Proceedings of International Conference and Exhibition on ICT & Telecommunication*, 65–74.

Elechi, P., Orike, S., & Musah, E. S. (2017). Determination of GSM Signal Loss in Multi-Partitioned Buildings. *European Journal of Electrical and Computer Engineering*, *1*(3), 4–11.

N. Onwuka, E., Okwori, M., O. Aliyu, S., S. Oyewobi, S., O. Alenoghena, C., Bello-Salau, H., S. Makusidi, S., & Asuquo, V. (2018). Survey of Cellular Signal Booster. *International Journal of Information Engineering and Electronic Business*, *10*(6), 21–31.

Ramadan, A., Chen, X., & Hudson, L. L. (2018). Teachers' Skills and ICT Integration in Technical and Vocational Education and Training TVET: A Case of Khartoum State-Sudan. *World Journal of Education*, *8*(3), 31.

Saud, M. S., Shu, B., Yahaya, N., & Yasin, M. A. (2011). Effective Integration of Information and Communication Technologies (ICTs) In Technical and Vocational Education and Training (TVET) Toward Knowledge Management in the Changing World of Work. *African Journal of Business Management*, *5*(16), 6668–6672.

Semiconductor, N. (2000). *LM386 Low Voltage Audio Power Amplifier*. *August*, 1–9.

Splitter, A. S. (2005). *Analog Signal Splitter*. *717*.