Investigation on Effect of Homogenous Multiple Lines of Trees on Wireless Communication System

O. Olabisi, Ph.D.[1*]; A.O. Adeniran, Ph.D.[2]; A.G. Ebisemiju[1]; and S.O. Areo[1]

[1]Department of Science Laboratory Technology, Lautech Ogbomoso, Oyo State, Nigeria.
[2]Department of Physics, University of Uyo, Uyo, Akwa Ibom State, Nigeria.

E-mail: oolabisi@lautech.edu.ng*
adeniranadebayo@uniuyo.edu.ng
waleebby@gmail.com
areosamuel@gmail.com

ABSTRACT

The presence of homogeneous multiple lines of trees has significant effect on Wi-Fi systems. This work is carried out to investigate the effect of multiple lines of trees on a Wi-Fi system. In this work, a 2.4 GHz frequency band Tp-Link router was used as the transmitter and a GSP-730 spectrum analyzer is employed as the receiver. Also, a directional EM-6944 Log periodic antenna is connected to the receiver (spectrum analyzer) to receive from signal router.

The measurement is based on near field using line of sight method (LOS). The results obtained from the experimental measurements were analyzed using MATLAB to show the various spectra at different point. The level of attenuation was determined using Weissberger's model which showed that the received power level of the signal strength along multiple lines of tree has adverse effect on communication system. It can then be recommended that more access point should be deployed to several locations.

(Keywords: homogeneous, near field, LOS, line of sight, vegetation, communication systems, signal interference, path loss)

INTRODUCTION

Initially, wireless networks were oriented for indoor use as home automation and industrial controls [6] or medical applications [7], however, their use has been extended to outdoor networks [3]. It has been observed that signal strength and quality of an outdoor networks varies when measured under free space conditions, along a single line of trees, and along homogenous and heterogeneous multiple lines of trees.
From the open literature, considerable attention has been given to the effect of forests, free space, and single lines of tree on wireless communication systems. However, the effect of homogenous multiple lines of trees on wireless communication systems has not been thoroughly investigated [4].

In order to predict the effect of this system, an accurate propagation characteristic of the system must be known [5]. The propagation studies indicates that randomly distributed leaves, twigs, branches, and tree trunks on the trees plays a significant role on signal quality [6].

In this paper, we will be conducting a comprehensive review of the effect of multiple lines of trees on a wireless communication system. With the adequate developments in design and fabrication technologies for ubiquitous wireless connectivity and monitoring of physical and environmental parameters in vegetation environments have been gaining importance in recent years [5].

METHODOLOGY

The geometry of the propagation model is shown in Figure 1. As illustrated in the figure, the access point radiates a spherical wave that can reach a client behind a tree; r is the separation distance between the transmitting and the receiving antenna.

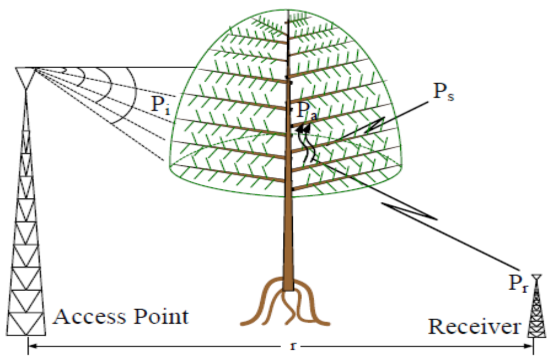

Figure 1: Geometry of Tree Canopy [3].

Experimental Set-Up

The experimental set-up for measuring the path loss and received power level under a homogeneous line of trees (Teak). *Tectona grandis* is a tropical hardwood tree species. The experimental measurements are based on near field method with both the transmitter and receiver placed inside the vegetation. At the transmitting section was a Tp-Link router that radiated directionally at a frequency of 2.4 GHz with transmitting power of 12 dB. The channel pathways laid homogeneous line of tree (Teak) which obstructs as shown in Figures 2 and 3.

Figure 2: Obstruction by a Single Tree [2].

The receiving section consisted of spectrum analyzer with a directional EM- 6944 Log periodic antenna the connection was made with a coaxial cable of 50 ohms for impedance matching. Also, the analyzer was connected to a USB cable Laptop with loaded by Aaronica test software for data logging.

Figure 3: Obstruction by Homogeneous Line of Trees [2].

The transmitter is stationary with receiver location varied with a distance of 10 m up to 100 m with a step height of 10 m. At the various spot during the reading the spectrum analyzer was set to a frequency 2.4 GHz at a sampling rate of RBW: 300 KHz Span: 100MHz, and Sweep: 800ms.

Figure 4: Tp - Link Router.

Figure 5: GSP-730 Spectrum Analyzer.

Figure 6: EM-6944 Log Periodic Antenna.

RESULT AND DISCUSSION

Radio wave propagation measurements through the homogeneous line of tree at frequency 2.4 GHz were carried out beside Olusola Oke Library (School library) Ladoke Akintola University of Technology, Ogbomoso, Oyo State. Figures 5, 6, 7, 8, and 9 depict spectrum at various points between the transmitter and receiver. The spectra show the reduction in number of peaks at the distance increases. The graphical representation on MATLAB at an interval of 20 m, 40 m, 60 m, 80 m, and 100 m corresponds to the figures as listed above.

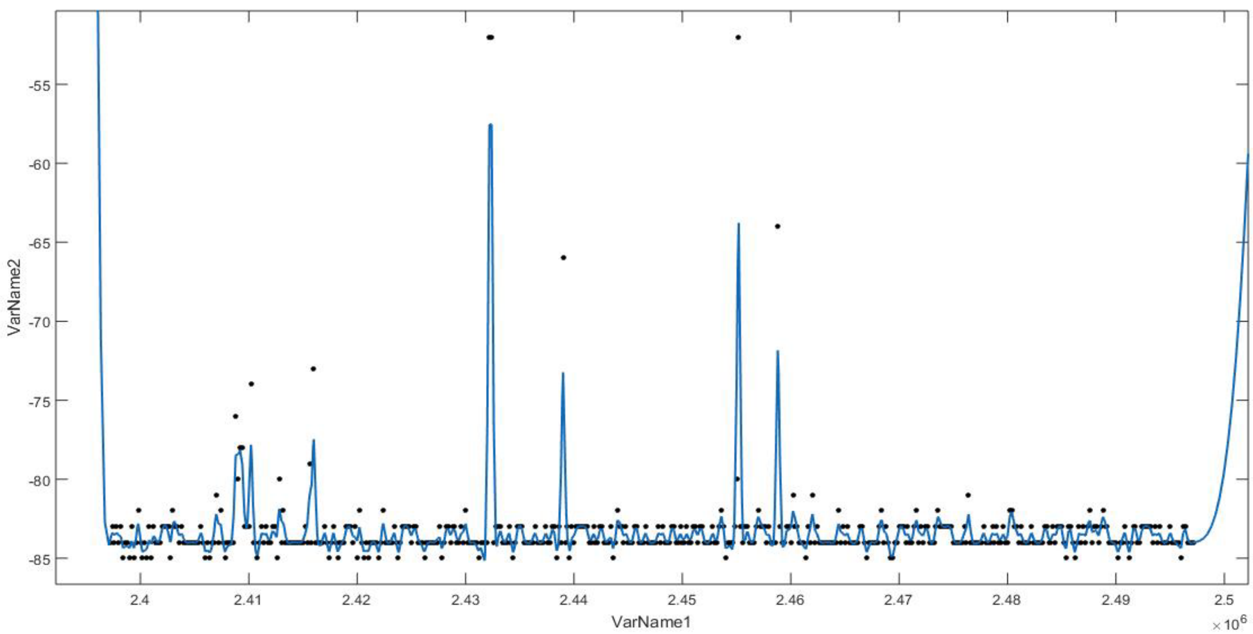

Figure 7: Graphical Display at 20 m using MATLAB.

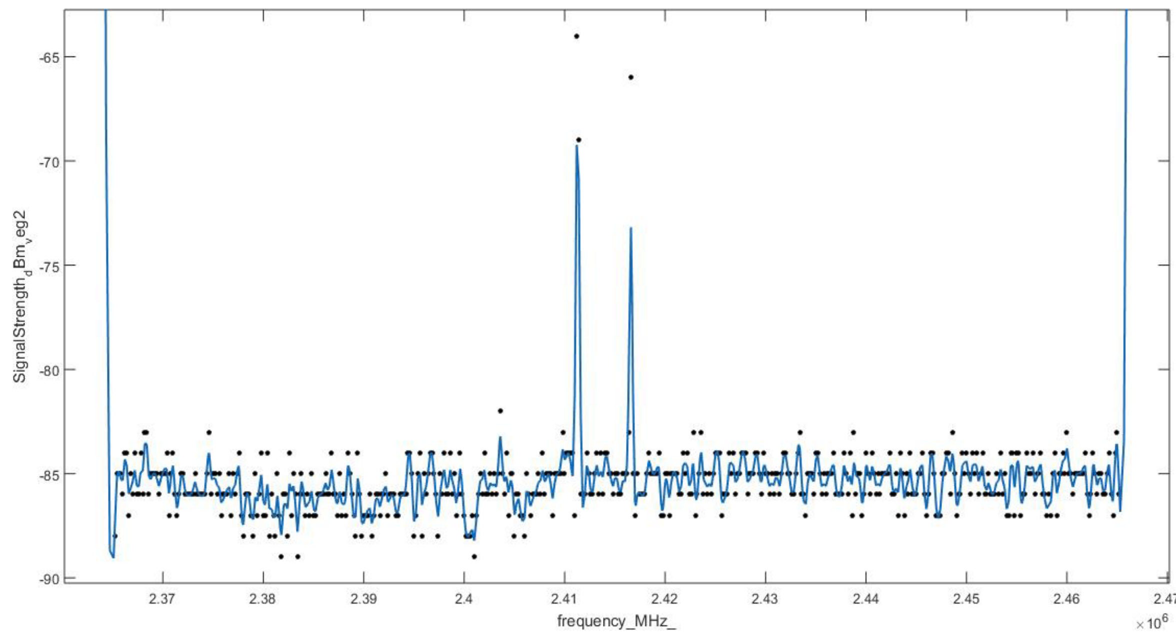

Figure 8: Graphical Display at 40 m using MATLAB.

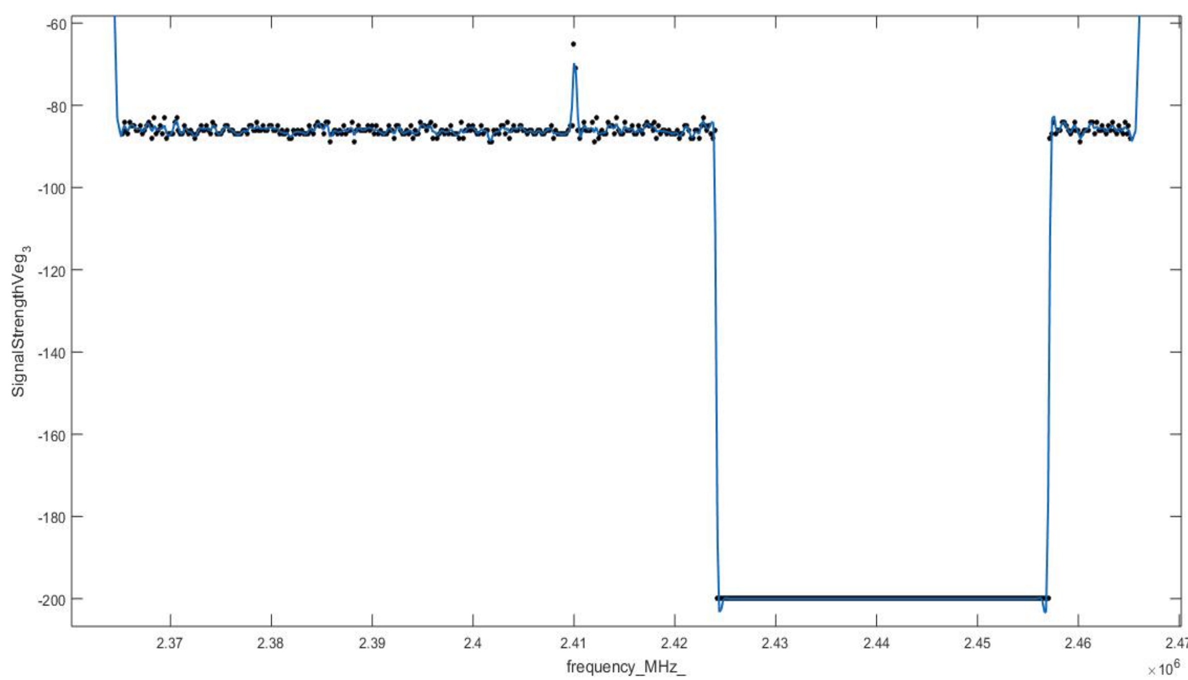

Figure 9: Graphical Display at 60 m using MATLAB.

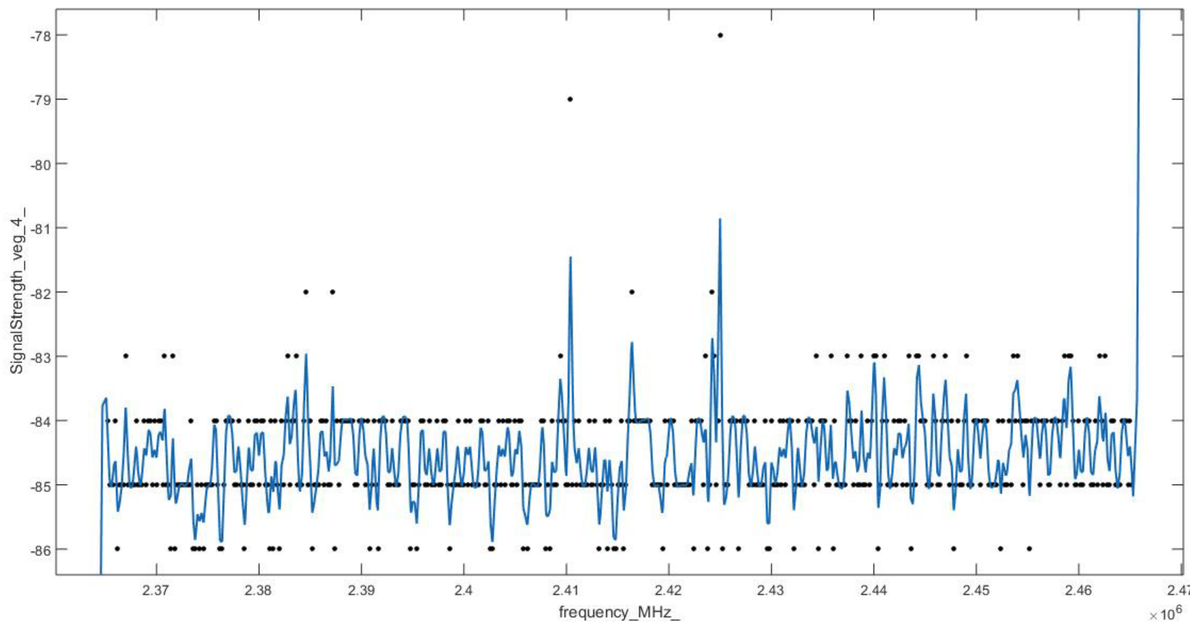

Figure 10: Graphical Display at 80m using MATLAB.

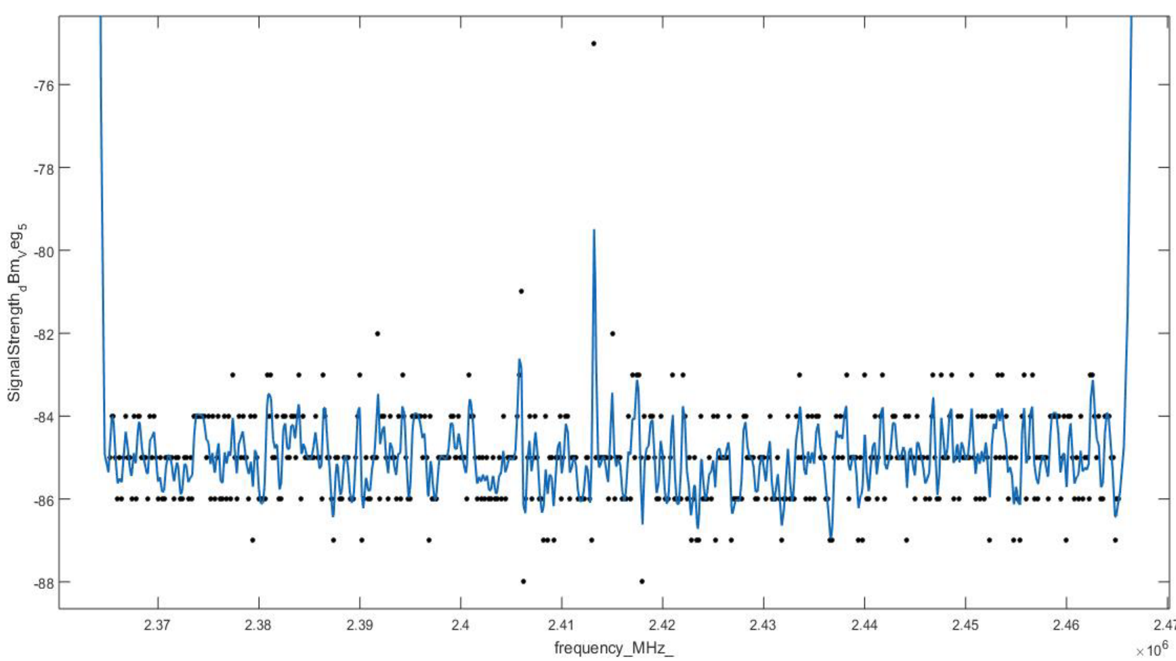

Figure 11: Graphical Display at 100 m using MATLAB.

Determination of Attenuation

Weissberger 's modified exponential decay model is given by [9]:

$L\ (dB) = 0.45F^{0.284}df$

Table 1: Showing the Attenuation using Weissberger's Model.

Distance (m)	Center Frequency (GHz)	Attenuation (dB)
20	2.4162	11.56
40	2.4142	23.12
60	2.4130	34.67
80	2.4070	46.20
100	2.4120	55.87

It was observed from Table 1 above with Weissberger's model, the signal loss increases as the depth distance increases.

CONCLUSION

This work has studied the effects of the obstruction of a homogeneous line of trees on a radio communication system. The study also revealed that one of the problems that hinders efficient performance of wireless networks is the presence of a homogeneous line of trees. This resulted in poor signal reception, delay in uploading and downloading of data, and fluctuation of signals.

The experimental measurements were analyzed using MATLAB. The results showed reasonable agreement with Weissberger's attenuation model due to presence of a homogeneous line trees. It was established from the results that attenuation of radio signal is proportional to the distance of separation. This study therefore recommends that the power levels of radio signals should be improved for efficient performance, more repeater stations should be deployed at various points, or migration to optical communication should occur.

REFERENCES

1. Adeniran, A.O., O. Olabisi, O.S. Ajao, and O.B. Ndeifrekeabasi. 2018. "Determination of Wireless (2.45GHz) Attenuation Loss through some Nigerian Frees and Foilages". *World Journal of Applied Science and Technology*. 10(1): 214-217.

2. Ly, P.L., T.A. Rahman, and M.K. Abu. 2010. "Investigation of Foliage Effects via Remote W Data Logging at 5.8GHz". *WSEAS Transactions on Communications*. 9(4): 237-247.

3. Nwawelu, N.N., A.N. Nzeako, and M.A. Ahmeku. 2012. " The Limitation of Campus Wireless Networks: A Case Study of University of Nigeria, Nsukka [LIONET]". *International Journal of Networks and Communications*. 2(5): 112-122.

4. Azpilicueta, L., P. Lopez-Iturri, E. Aguirre, I. Mateo, J.J. Astrain, J. Villadangos and F. Falcone. 2014. "Analysis of Radio Wave Propagation for ISM 2.4 Wireless Sensor Networks in Inhomogeneous Vegetation Environments". *Sensors*.14: 23650 -23672.

5. Meng, Y.S. 2010. "Investigation of Foliage Effect on Modern Wireless Communication System: A Review". *Progress in Electromagnetics Research*. 150: 313- 332.

6. Zakaria, Y. and L. Iuanele. 2016. "Propagation Modeling of Path Loss Models for Wireless Communication in Urban and Rural Environments at 1800 GSM Frequency Band". *Information and Communication Technologies and Services.* 14(2): 139-144.

7. Adewumi, A.S. and O. Olabisi. 2018. "Characterization and Modeling of Vegetation Effect on UHF Propagation through a Long Forested Channel". *Progress in Electromagnetic Research Letters.* 73: 6-9.

8. Sooksumrarn, P., C. Kittiyanpunya, P. Yoiyood, and M. Krairiksh. 2013. "Wireless Communication in a Tree Canopy". *Progress in Electromagnetic Research B*. 51: 329 -346.

9. Seybold, J.S. 2005. *Introduction to RF Propagation*. John Willey and Sons: New York, NY.

10. Olabisi O. and E.A. Oladeji. 2018. "Effect of Rain on Vertical and Horizontal Polarized Ku-Band Radio Propagation in Tropical Region". *International Journal of Computer Science Trends and Technology (IJCST)*. 6(1): 49-53.

11. Olabisi O., A.O. Adeniran, O.S. Ajao, and O. Adegboyega. 2018. "Design and Implementation of 4 Elements Circular Patch Antenna with Gain 3.0 GHz Application". *International Journal of Trend in Scientific Research and Development (IJTSRD)*. 2(2): 996-999.

12. Adeniran, A.O., O. Olabisi. and O.S. Ajao. 2020. "Spatial Coverage of FM Radio Signal Variation Measurement and Comparison of two Major Radio

Stations within Akwa Ibom State". *Journal of VLSI and its Advancement*. 3(3): 1-7.

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