© IJCIRAS | ISSN (O) - 2581-5334
December 2018 | Vol. 1 Issue. 7

PATH LOSS PREDICTION BY USING RSSI VALUES

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Abstract

In wireless communications, the RSSI signal is fluctuating overtime due to the multipath fading effects and obstacles as presented in a wireless medium, especially in an indoor environment. The constructed materials, building designs, furniture and building parameters affect the wireless performance while radio wave propagation. The development of accurate propagation prediction models for wireless communication environments is challenging and requires the development of innovative approaches. In this paper, the measurements were taken at Mandalay Technological University and the Rohde & Schwarz SMBV100A Vector Signal Generator and Rohde & Schwarz EMI ESL Test Receiver used as the transmitter and receiver with the frequency of 2.4 GHz. The accuracy of the system is validated by comparing the theoretical RSSI values and path loss values with the experimental data which are carried out at the indoor scenarios such as opened corridor at main building of Mandalay Technological University, the Republic of the Union of Myanmar.

Keyword: RSSI, Path Loss, Transmitter, Receiver, indoor

1. INTRODUCTION

In the present days, wireless communication system has become an essential part of various types of wireless communication devices that permit user to communicate even from remote operated areas. Wireless personal communications are intensely used in indoor environments. Some of the important applications are: Wireless Local Area Networks (WLANs), portable computers, wireless local loops and wireless access to the internet [1]. For the design and maintenance of indoor wireless services, the knowledge of the signal propagation in different environment is demanded. To improve the performance of an indoor Wireless Local Area Network (WLAN), it is very important to analyze signal attenuation [2]. Therefore, it is necessary to the signal power distribution in the indoor environment of certain building. Signal attenuation in wireless network for indoor communication system depends on the influence of working frequency, antenna height, type of antenna, wall characteristics, floor partitions and the type of floor construction materials between antennas.

In optimization of indoor radio wave propagation model, it is firstly necessary to choose indoor radio wave propagation model, propagation mechanism and environmental region for conducting experiments. And then, all experiments are conducted for each wireless communication environment with the operating 2.4 GHz.

On the other hand, the received signal strength values are estimated using the signal model. After that, the results of the experiments and estimation are compared to recognize how much difference between them. According to the analysis of the experimental and estimated results, their received signal strength indicator values are significantly different. Therefore, the least mean square algorithm is needed to enhance the estimation of receive signal strength for indoor radio wave transmission

In wireless communications, multipath is the propagation phenomena that results in radio signals reaching the receiving antenna by two or more paths [3]. A signal travels from transmitter to receiver over a multiple reflection path; this phenomenon is called multipath propagation and causes fluctuations in the receiver signal's amplitude and phase. The performance of the wireless communication systems depends on the radio wave transmission path between the transmitter and the receiver. The constructed materials, building designs, furniture and building parameters are also affected the wireless performance while radio wave propagation takes place in indoor environment. These materials or indoor obstacles can cause multipath propagation such as reflection, diffraction and scattering.

2. BACKGROUND THEORY

The received signal strength indicator is the relative received signal strength in a wireless environment. Usable strength of the radio wave is expressed in decibels between 0 dBm (strongest) and -120 dBm (weakest). Normal range of RSSI for wireless communication is -45 dBm to -87 dBm. RSSI can vary due to multipath, interference or other environmental effects and it may not give a true indication of communication performance or range. RSSI values decrease with the increase of distance according to the log-distance path loss model [4]. RSSI value is easily affected by the imperfect omni-directional antenna pattern, as well as by the indoor conditions such as obstructions and human activities that cause multipath fading and shadowing. Propagation path loss models play an important role in the design of wireless communication.

2.1. Signal Model

The received signal strength indicator is the measurement of how much strong the radio signals are when they reach to their destinations. Higher RSSI values indicate the stronger signal. If the RSSI is too low, the wireless communications become intermittent or fail entirely. The movement and unstable statement of indoor obstacles are effected in estimating the RSSI value [4]. The receive signal strength power is described by Equation (1).

$$RSSI=-10n\log_{10}d+A \quad (1)$$

Where n is the path loss exponent which is calculated using linear regression method, d is the distance between the transmitter and receiver and A is the received power at one meter distance. In this paper, the linear regression method is used to estimate the value of path loss exponent (n).

$$n=\frac{\sum_{i=1}^{m}\{(PLm(d_i)-\overline{PLm(d_i)})\,(x_i-\overline{x_i})\}}{\sum_{i=1}^{m}(x_i-\overline{x_i})^2} \quad (2)$$

$$x_i=10\log_{10}(d_i) \quad (3)$$

Where, m is the number of measurement points, n is path loss exponent; PLm is measured path loss in dB and $\overline{PLm}$ is the average measured path loss in dB [5].

2.2. Path Loss

The prediction of path loss depends on the important factors (such as frequency, type of antennas and environmental region) to achieve satisfactory accuracy in wireless. The path loss caused by environment effects and attenuation usually appears along between transmitter and receiver when the radio wave is propagated over a particular environment. The path loss can be defined as in the following Equation (4).

$$PL(dB) = P_t + G_t + G_r - P_r \quad (4)$$

Where, PL is path loss, P_t is assumed as transmit power and P_r is receive power. The total transmitting power is the addition of path loss (PL) and receiving power (P_r). When there are no obstacles between transmitter and receiver (LOS communication), the path loss is only the free space loss and others can be neglected. However, for an indoor propagation, there are a lot of obstacles. Among the obstacles, some can absorb and scatter or reflect the radio wave and then next possible is the refraction. It is depending on the receiver location, some reflected and scatter waves can reach to the receiver and cause to be fading and attenuation [5].

2.3. Measurement Model

All experiments are conducted at the main building of Mandalay Technological University, the Republic of the Union of Myanmar. The type of construction material of the building is concrete type floors, brick walls and glass windows with wood frame doors. There are three corridors namely corridor 1, corridor 2 and corridor 3 on the first floor. All doors and windows are closed and people are not allowed to pass in this experimental region while conducting experiments. The dimension of main building of MTU is 90 m × 67 m and the distance between two floors is 4 m. There is free space out door composed at the middle of the building as shown in Figure 1.

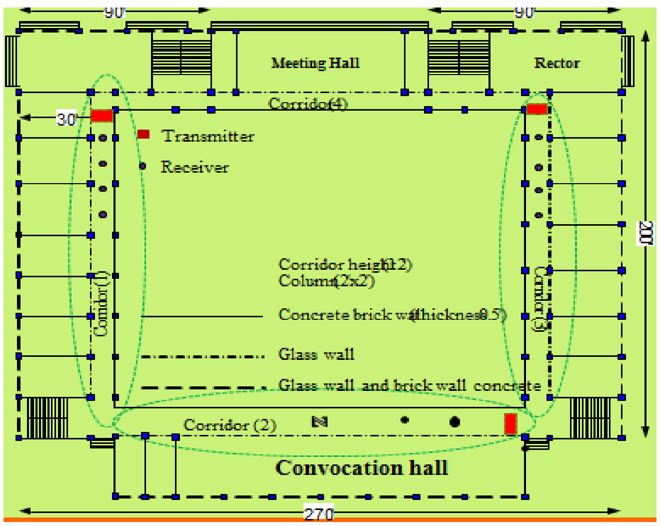

Figure 1. Building Layout in Measurements

2.4. Experimental Procedure

For the measurement set up, the Rohde & Schwarz SMBV100A Vector Signal Generator and Rohde & Schwarz EMI ESL Test Receiver are used as the transmitter and receiver for collection of experimental data and conducting experiments. And then, the placement of the signal generator and the test receiver with 3 dBi antennas are arranged. The height of desk on which both the generator and the receiver put is 0.6m respectively.

The experimental points mark as 1m from the transmitter at both the center and 1m distance from side wall of corridor 1, corridor 2 and corridor 3. To avoid the undesirable deviations of the received signal level, the received antenna of test receiver and transmitted antenna of the signal generator are tightly tilted. The similar experiments were carried out at different time on different days. The experimental set up of the signal generator and test receiver used in experiments is described in Table 1.

Table 1. Experimental Parameters

Parameter Name	Parameter Values
Frequency	2.4 GHz
Transmitter height	0.6 m
Receiver height	0.6 m
Transmitted power	10 dBm
Transmitter gain	3 dBi
Receiver gain	3 dBi

The sample experimental record photo of this system is shown in Figure 2.

Figure 2. Experimental Layout

The transmitter type used in the experiments is the omni-directional antenna. The gains of the transmitter antenna and the received antenna are 3 dBi. The height of the transmitter and the receiver is 0.75m each.

3. RESULTS

The experiments are conducted using the Rohde&Schwarz SMBV100A Vector Signal Generator and Rohde&Schwarz EMI ESL Test Receiver for indoor wireless communications. During the experiments, the transmitted power is set 10 dBm. The three portions for this research work for corridor 1, 2 and 3 are shown in Figure 3 to 8. Analysis of experimental data, analysis of theoretical data and the comparison results of these data can be performed in this section.

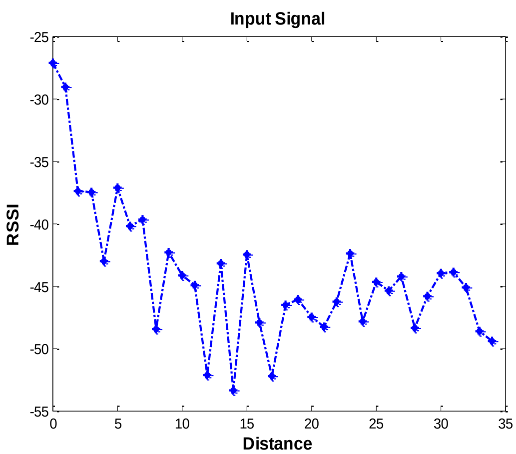

Figure 3.Experimental RSSI values for Corridor 1

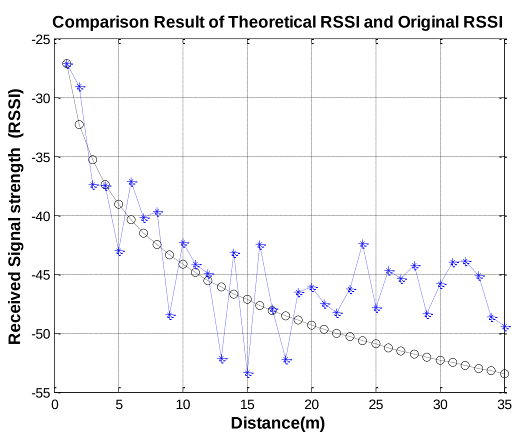

Figure 4.Comparison of Theoretical & Experimental RSSI values for Corridor 1

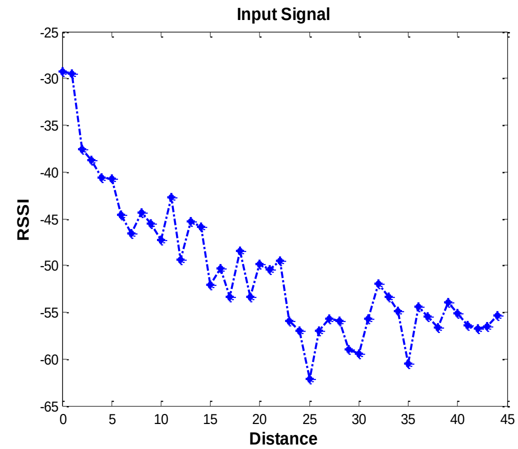

Figure 5.Experimental RSSI values for Corridor 2

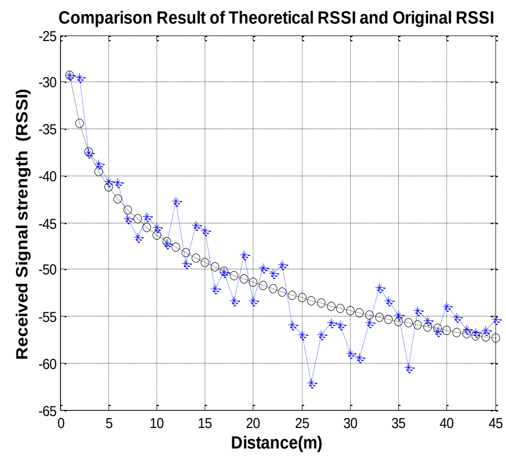

Figure 6.Comparison of Theoretical & Experimental RSSI values for Corridor 2

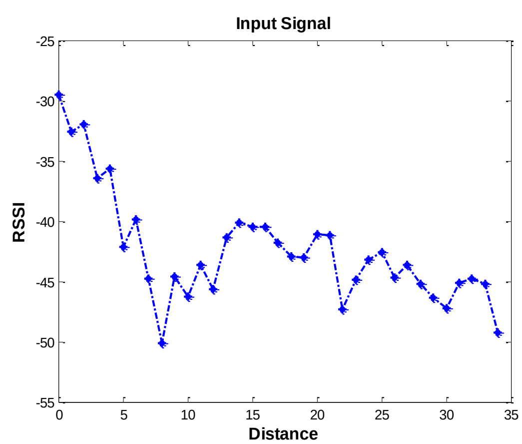

Figure 7.Experimental RSSI values for Corridor 3

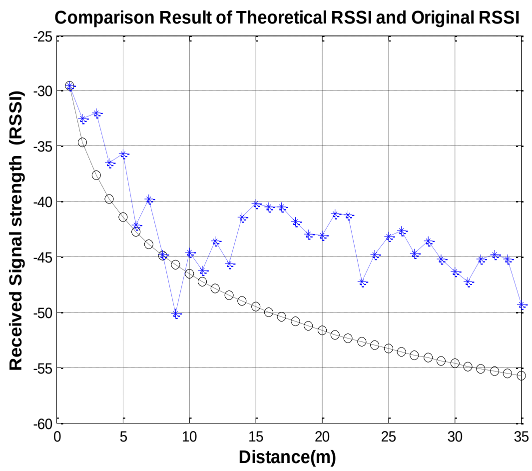

Figure 8.Comparison of Theoretical & Experimental RSSI values for Corridor 3

After analyzing RSSI values for the experimental results and theoretical results using signal model, we also analyze the path loss values for three corridors to investigate where the distance has the most loss such as receiving less signal strength. The path loss can be caused by environment effects and attenuation usually appears along between transmitter and receiver when the radio wave is propagated over a particular environment. The analysis of path loss for three corridors is described in the following figure.

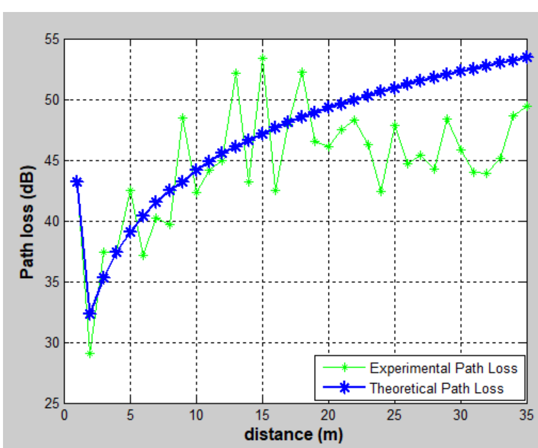

Figure 9.Path Loss Comparison for Corridor 1

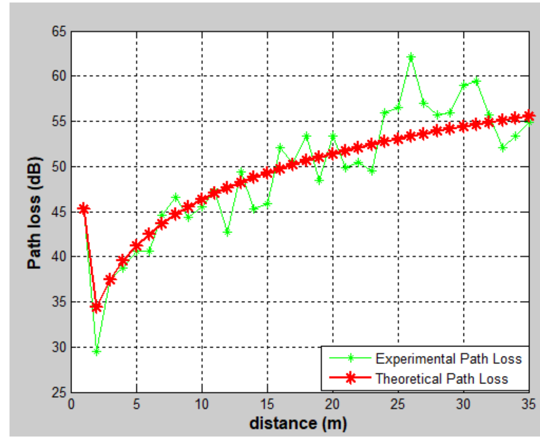

Figure 10.Path Loss Comparison for Corridor 2

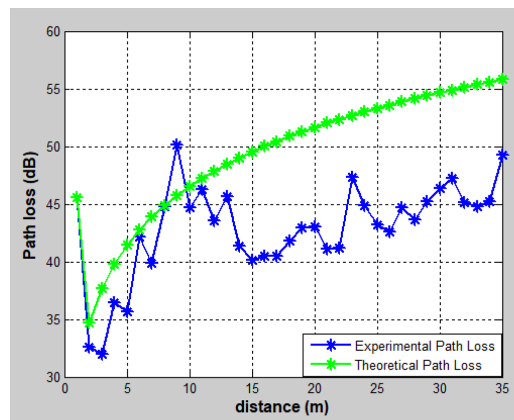

Figure 11.Path Loss Comparison for Corridor 3

4. Discussion and CONCLUSION

The experimental and theoretical RSSI values for three corridors are firstly described. And then, the experimental data and the estimated path loss values are compared. According to the results in Figure 4 for corridor 1, the largest difference between experimental and theoretical RSSI values is 8.54 dBm and 8.85 dBm at the distance of 32 m and 32 m. For corridor 2, there is only one largest different point at distance 26 m with the value of 8.74 dBm. The largest difference between experimental and theoretical RSSI values for corridor 3, there are total of 14 points between 9dBm and 11 dBm starting from the distance of 15 m until 34 m.

The path loss values obtained from measuring receive signal and theoretical path loss model using Equation (4) are analyzed. The path loss value for corridor 1 is over 8 dB at distance 31 and 32 m and nearly 8 dB at 33 m.

And then for corridor 2, there is only one highest path loss at 8.74 dB at 26 m because this point has largest different RSSI values between theoretical and experimental. For the corridor 3, it has too much path loss according to the analysis of RSSI values in above.

5. System Limitation and Further Extension

There are some limitations to use signal model in all types of indoor radio wave propagation. The path loss exponent (n) is calculated using linear regression equation to obtain the definite value. So the value of path loss exponent can vary depending on building layout. Estimating the path loss within a given real-world terrain/geography is a hard problem, and there are no easy solutions. It is impacted, among other things, by the height of the transmitter and receiver antennas, whether there is line-of-sight (LOS) or non-line-of-sight (NLOS) and any type of construction, and if so, the type of materials used in that construction, the height of the buildings, their distance, etc.

As further work, it is also needed to conduct all useful experiments in closed type corridor to estimate received signal power by varying the level of transmitted power. The various types of routers as a transmitter, various types of receiving mobile phone as a receiver, signal generator, signal analyzer machines and analyzer software will be used with this model for future experiments. The difference frequency ranges, the different types of walls at different buildings are also needed to use in conducting next various experiments.

6.ACKNOWLEDGEMENT

I thank to the Rector and Teachers from Mandalay Technological University for granting to measure the receive signal strength for Indoor WLAN at main building of Our University.

REFERENCES

[1]. T.Rappaport, "Wireless Communications: Principles and Practice", 2e. Prentice Hall, 2002.

[2]. PTZ.Tun, "Analyzing Radio Wave Propagation Model for Indoor Wireless Communication", International Journal of Advanced Research in Computer Engineering & Technology IJARCET (2013), Volume. 2, No. 4, pp. 1304-1308, April, 2013.

[3] PTZ.Tun, "Characterization of Prediction and Enhancement of Indoor Propagation Model with 2.4 GHz", International Journal of Scientific Engineering and Technology Research IJSETR (2014), Volume 3, No. 16, pp.3328-3332, July, 2014.

[4]. WW.Aung, PTZ.Tun, "Analysis of Received Signal Strength Indicator (RSSI) for Indoor WLAN", 10th Conference on Science and Engineering (NCSE 2017), Mandalay Technological University, Myanmar, 29-30 June, 2017.

[5]. PTZ.Tun, "Indoor Path Loss Prediction by Analyzing Propagation Models", Annual University Journal Innovative Research and Products, December 2018.