PATH LOSS ON DIFFERENT CHANNEL MODELS ON DIFFERENT MODULATION SCHEMES

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ABSTRACT

Modulation plays a vital role in wireless communication systems by converting digital information into analog signals suitable for transmission over the wireless channel. Wireless communication systems heavily rely on understanding the impact of various channel models and modulation schemes on path loss.This project report investigates the effects of different channel models and modulation schemes on path loss, aiming to provide valuable insights for optimizing wireless communication performance.The study begins by exploring commonly used channel models, including Hata okamura, and Walfish Ikigami model. These models are essential in analyzing the behavior of wireless signals in different environments. Additionally, the characteristics of different modulation schemes, such as amplitude shift keying (ASK), frequency shift keying (FSK), and phase shift keying (PSK), are thoroughly examined.Simulations and measurements are conducted to quantify path loss under each channel model using different modulation schemes.

INTRODUCTION

In wireless communication the losses occurred in between transmitter and receiver is known as propagation path loss. Path loss is the unwanted reduction in power single which is transmitted. We measure this path loss in different area like rural, urban, and suburban with the help of propagation path loss models.Wireless communications provide high-speed high-quality information exchange between portable devices located anywhere in the world. These models can be broadly categorized into three types; empirical, deterministic and stochastic. Empirical models are those based on observations and measurements alone. These models are mainly used to predict the path loss, but models that predict rain-fade and multipath have also been proposed.

DIFFERENT TYPES OF PATH LOSS

1) HATA OKAMURA MODEL

The Hata-Okumura model, also known as the Hata model or the Okumura-Hata model, is a widely used empirical model for predicting path loss in urban and suburban environments. It was developed by the Japanese researchers Yasushi Hata and Yoichi Okumura and has been extensively adopted for radio wave propagation analysis and system planning. The Hata-Okumura model provides a simplified representation of the effects of distance, frequency, and other factors on path loss in urban and suburban areas. It takes into account the characteristics of both the transmitter and receiver antennas, as well as the surrounding environment. The model is particularly suitable for frequencies ranging from 150 MHz to 1500 MHz, which includes many cellular communication bands. The Hata-Okumura model defines path loss in terms of the following equation:

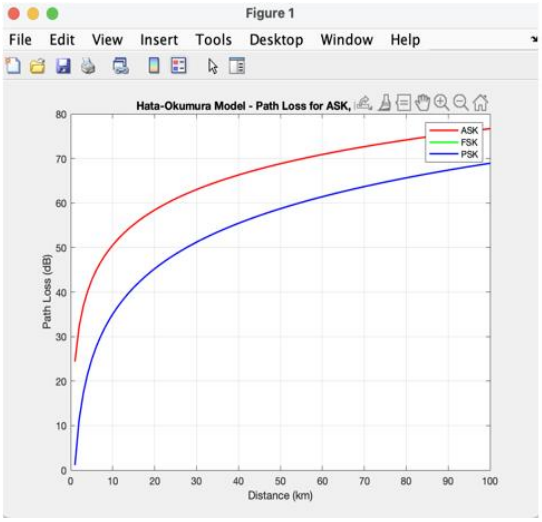
L(dB) = A + B * log10(d) + C

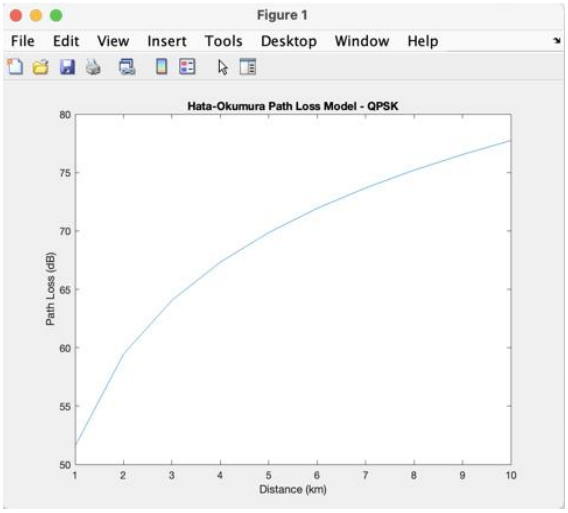
A, B, C are the factors depends on the frequency of transmission, antenna heights and type of environment.

Environment	$a(h_m)$	C
Open	$[1.1log_{10}(f_c)-0.7]h_m-[1.56log_{10}(f_c)-0.8]$	$-4.78[log_{10}(f_c)]^2+18.33log_{10}(f_c)-40.98$
Suburban		$-2[log_{10}(f_c/28)]^2-5.4$
Small/medium city		0
Metropolitan ($f_c \leq 200\,MHz$)	$8.29[log_{10}(1.54h_m)]^2-1.1$	0
Metropolitan ($f_c > 200\,MHz$)	$3.2[log_{10}(11.75h_m)]^2-4.92$	0

Table of Parameters for Hata okumura model

RESULTS





Hata model is used to predict the path loss in suburban and urban area. In our calculation, we set the carrier frequency as 900 MHz, transmitter antenna height 30m, Mobile station height as 1.5m and plotted for different distances. The left figure shows Path loss in urban environment when we use modulation schemes ASK, FSK, and PSK respectively. Since ASK has the empirical formula which has greater constants than PSK and FSK, it has higher path loss than other two modulation schemes. The graphs concludes that Path loss seems directly proportional to distance as in urban area the obstacles are more such as buildings, towers etc, so it effects the transmission of the signal and affects signal strength.
Hata-Okumura's model has a 10-14db empirical standard deviation between the path loss predicted by the model and path loss associated with one of the measurements used to develop the model. This model is fully based on measured data and doesn't provide any analytical explanation. This model is not good in rural area and it is fairly good in urban and suburban area because of its slow response to the rapid changes in the terrain.

2) WALFISH IKIGAMI MODEL

The Walfish-Ikegami model, also known as the Walfish-Ikegami propagation model, is an empirical model for predicting path loss in urban and suburban environments. It was proposed by Marvin E. Walfish and Tetsuro Ikegami in 1972 and has since been widely used in radio wave propagation analysis and system planning.
The model takes into account the effects of various factors, such as frequency, distance, base station antenna height, mobile station antenna height, and environment characteristics. It is primarily designed for frequencies above 800 MHz and is often used in the analysis of cellular communication systems. This model is most suitable for flat suburban and urban areas that have uniform building height .
The equation of the proposed model are expressed in

$$L(dB) = A + B * \log10(d) + C * \log10(h)$$

Where: L(dB) is the path loss in decibels (dB), d is the distance between the transmitter and receiver in kilometers, h is the base station antenna height or mobile station antenna height in meters, A, B, and C are frequency-dependent parameters.

The model allows for improved path loss estimation by consideration of more data to describe the character of the urban environment, namely:

- height of transmitter h_{tx}
- height of receiver h_{rx}
- mean value of building heights h_{roof}
- mean value of widths of roads w
- mean value of building separation b
- road orientation with respect to the direct radio path

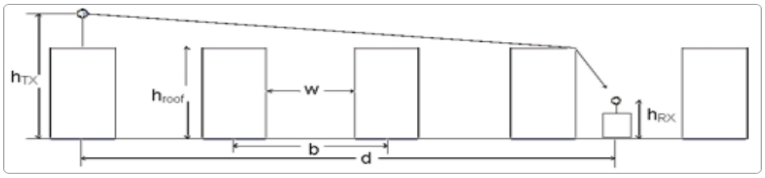
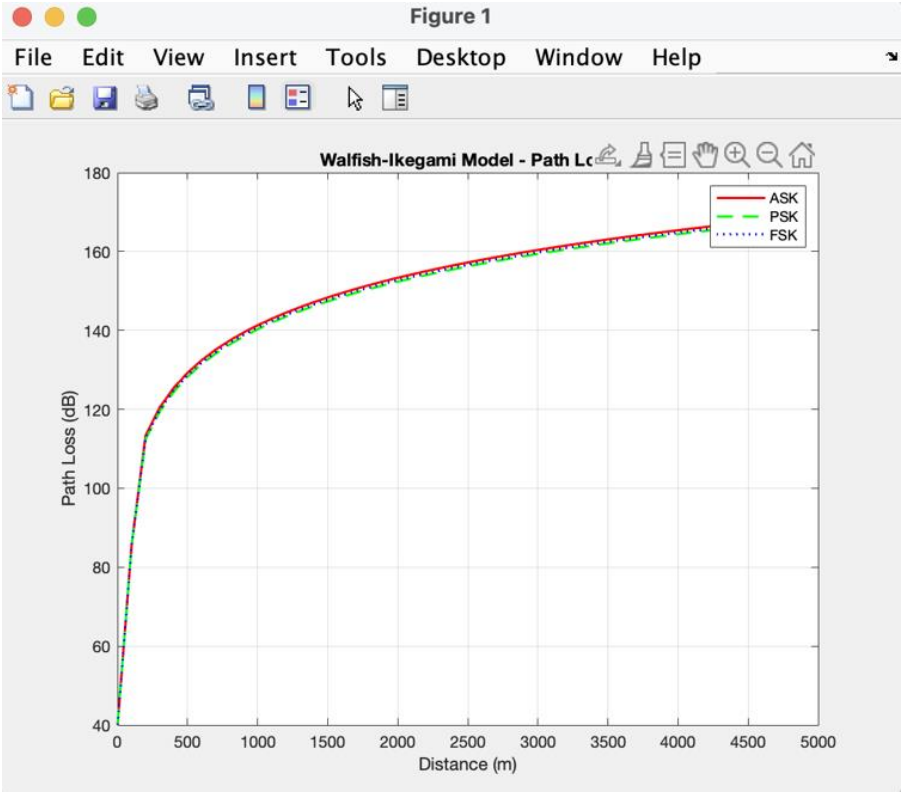


Figure 1. Urban propagation scenario using the COST 231 Walfisch-Ikegami Model

RESULTS



The simulation graph shows that the path loss for rural areas for walfish ikigami channel model on three different modulations ASK, FSK and PSK respectively as so much same. It is because the rural areas has not much obstacles between the transmission channel.

CONCLUSIONS

In conclusion, this project report investigated the impact of different channel models and modulation schemes on path loss in wireless communication systems. The objectives were successfully achieved by analyzing various channel models, including the Hata-Okumura model, and studying modulation schemes such as amplitude shift keying (ASK), frequency shift keying (FSK), and phase shift keying (PSK).
Through simulations, we can predict that the different modulation schemes works differently on different channel models. The main difference come to their aspects is on the parameters taken such as antenna height, transmitter and receiver distances, frequency of operations. This accounts to different results with changing the parameters.
Overall, this project report contributes to the understanding of path loss in different channel models and the role of modulation schemes in wireless communication. The insights gained can guide system planners and engineers in selecting the most suitable modulation scheme for efficient and reliable data transmission in various channel conditions.

REFERENCES

1) Manju Kumari, Tilotma Yadav, Pooja Yadav ,Purnima K sharma ,Dinesh Sharma **"Comparative Study of Path Loss Models in Different Environments"** April 2011, IJEST

2) Vishal D. Nimavat, 2Dr. G. R. Kulkarni **"Simulation and Performance Evaluation of Different Propagation model under Urban, Suburban and Rural Environments for mobile communication"** ,August 2011, IJERT

3) Yazan A. Alqudah , **"On the Performance of Cost 231 Walfisch Ikegami Model in Deployed 3.5 GHz Network"**, May 2013, TAEECE

4) Abraham Deme1, Danjuma Dajab , Buba Bajoga , Mohammed Mu'azu , Davou Choji3 **"Hata-Okumura Model Computer Analysis for Path Loss Determination at 900MHz"** 2013, Mathematical modeling and theory