Analysis and Comparison of Various Path Loss Prediction Model

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***Abstract* - A In this article we aim to adopt a propagation model for Rourkela in which we examine the applicability of Okumura-hata model in Rourkela in GSM frequency band. We accomplish the investigation in variation in path loss between the measured and predicted values Through MATLAB graph was plotted between path loss verses distance. The mean square error (MSE) Was calculated between measured path loss values and those predicted on basis of Okumura-hata model for a sub-urban area.**

***Keywords* - Path Loss, Hata Model, Okumura Model, Propagation delay**

I. INTRODUCTION

Since the mid 1990's the cellular communications industry has witnessed rapid growth. Wireless mobile communication networks have become much more pervasive than anyone ever imagined when cellular concept was first developed. High quality and high capacity network are in need today, estimating coverage accurately has become exceedingly important. Therefore for more accurate design coverage of modern cellular networks, measurement of signal strength must be taken into consideration, thus to provide efficient and reliable coverage area. In this clause the comparisons between the theoretical and experimental propagation models are shown. The more commonly used propagation data for mobile communications is Okumura's measurements and this is recognized by the International Telecommunication Union (ITU).
The cellular concept came into picture which made huge difference in solving the problem of spectral congestion and user's capacity. With no change in technological concept, it offered high capacity with a limited spectrum allocation. The cellular concept is a system level idea in which a single, high power transmitter is replaced with many low power transmitters. The area serviced by a transmitter is called a cell. Thus each cell has one transmitter. This transmitter is also called base station which provides coverage to only a small portion of the service area. Transmission between the base station and the mobile station do have some power loss this loss is known as path loss and depends particularly on the carrier frequency, antenna height and distance. The range for a given path loss is minimized at higher frequencies. So more cells are required to cover a given area. Neighbour base stations close are assigned different group of channels which reduces interference between the base stations. If the demand increases for the service, the number of base stations may be increased, thus providing additional capacity with no increase in radio spectrum. The advantage of cellular system is that it can serve as many number of subscribers with only limited number of channel by efficient channel reuse.

II. COMPARISON OF PATH LOSS MODEL

The mechanisms behind electromagnetic wave propagation are large it can generally be attributed to scattering, diffraction and reflection. Because of multiple reflection from various objects, they travel along different paths of varying lengths. Most cellular radio systems operate in urban areas where there is no direct line-of-sight path between the transmitter and receiver and where presence of high rise buildings causes severe diffraction loss. Basically propagation models are of two types: 1. Free space propagation 2. Plane earth propagation Free space propagation: The wave is not reflected or absorbed in free space propagation model. The ideal propagation radiates in all directions from transmitting source and propagating to an infinite distance with no degradation. Attenuation occurs due to spreading of power over greater areas. Power flux is calculated by,

$$Pd = Pt / 4\pi d^2$$

Where Pt is transmitted power
Pd is power at distance d from antenna.

The power is spread over an ever-expanding sphere if radiating elements generates a fixed power. As the sphere expands the energy will be spread more thinly.

The power received can be calculated from the antenna if a receiver antenna is placed in power flux density at a point of a given distance from the from the radiation. To calculate the effective antenna aperture and received power the formulas are shown in equation. The amount of power captured by the antenna at the required distance d, depends on the effective aperture of the antenna and the power flux density at the receiving element. There are mainly three factors by which the actual power received depends upon by the antenna: (a) the aperture of receiving antenna (b) the power flux density (c) and the wavelength of received signal. For isotropic antenna effective area is given by,

"Comparison of Path Loss Prediction Models and Field Measurements for Cellular Networks in Turkey".
Cellular network design for a specific area requires precise knowledge of the propagation characteristics of the radio channel in that area. This paper discusses the applicability of some well known theoretical models to the specific conditions in Izmir, Turkey. Three path loss models were used to predict the path loss in three different frequency bands. Advanced Okumura-Hata, Advanced Walfisch-Ikegami and Algorithm 9999 were used to predict the path loss in certain areas of Izmir, Turkey. The simulation results were compared to real signal strength measurements obtained from live GSM and WCDMA cellular networks and it was concluded that Algorithm 9999 performs best in the dense urban, urban and suburban environments of Izmir.

"Multipath Delay Measurements and Modelling for Inter floor Wireless Communications"
This paper presents a comprehensive three-dimensional (3-D) ray-tracing model for inter floor wireless communication systems, and measurements of power delay profiles in a typical two-floor environment. The model takes into account all possible reflections/transmissions between/through walls, floors and ceilings including possible scattering from nearby buildings, as well as diffractions from corners and edges of building structures, and also subsequent reflections/transmissions from such diffracted signals. Propagation paths involving successive diffractions at the edges of window frames at different floors of the building and their subsequent reflections/transmissions from such diffracted signals are also included. The model is based on a uniform theory of diffraction (UTD) formulation, multiple image and 3-D ray launching concepts to include all the major propagation paths. Comparisons between results from theoretical models and measurements have shown good agreement for power delay profiles, root-mean-square (rms) delay spreads and signal path loss.

"Prediction of Received Signal Power and Propagation Path Loss in Open/Rural Environments using modified Free-Space Loss and Hata Models"
This paper describes a modification of the Free-Space and Hata formulae for the prediction of received signal power, PR and propagation path loss, L , in two Cellular Mobile Radio Systems (CMRS), in the Northern Nigeria. Measurements of P s were taken with a Cellular Mobile Radio test receiver (Sagem OT 160), in some selected open/rural environments, when the receiver was being moved away from the base stations along the propagation paths. L P R s were then obtained from values of m easured P s using an appropriate expression. A close comparison of measurement values and computed values from the Free-Space and Hata formulae revealed that direct application of these formulae is inappropriate for the prediction of these parameters in the region of investigation, as computed values fell short significantly from the corresponding measured values. Consequently, some correction factors have been introduced to both models and these have produced results which closely matched the measured values.

"A Hata Based Model Utilizing Terrain Roughness correction Formula"
This paper proposes a new terrain based formula to correct propagation loss model originally proposed by Hata for the 900 MHz band. This formula consists of an estimator of the standard deviation (s) along the measuring path in west of Amman city, Jordan. The estimator is calculated by a quadratic regression formula to reflect terrain roughness of the path taken. This estimator is used as a correction factor added to the urban formula proposed by Hata, for both urban and open areas categories. It is reported that the new estimator has less RMSE by an amount of 2.60 dB and 2.78 Db compared to Hata model for urban and open areas, respectively. Such an outcome illustrates the need for a terrain based correction formula in any accurate propagation model.

"Effect of Path Loss Model On Received Signal: Using Greater Accra, Ghana As Case Study"
Globalization has been greatly supported by wireless applications and as a result, African countries have connectivity to other parts of the world through satellite for instance. On a national level, wireless applications have proved to be invaluable where mobile services can be the means by which lives can be saved. In a developing country such as Ghana, mobile services are used not only in entrepreneurial activities, but al'e a means for enhancing the quality of life. Whereas wireless transmitters and receivers can be designed based on specifications, the structures of buildings considering parameters such as height and slopes of roofs vary considerably from place to place. It therefore becomes imperative to evaluate the propagation through the radio space particularly in places where such differences are observed in close proximity.

This paper presents a study of propagation in the Greater Accra region of Ghana where some sections have structures of relatively similar heights close to al'eas where building heights greatly vary. The study is done employing the Rata-Okumura model which is widely used in telecommunications industry, particularly in West Africa. A comparative study on path loss between Rata-Okumura model, and measurement data using the received power obtained from Base station in a Code Division Multiple Access-2000 (CDMA2000®) cellular network in Ghana has been carried out.

The analysis shows that Rata-OIwmura pl'ediction for suburban area (University of Ghana) response achieved is close to the measurement plot. Rata-Okumura prediction models applied in urban (medium city) and rural (open) areas for the selected areas such as Osu and Tema respectively in Greater Accra (GA) region show a little agreement. Osu and Tema are each more densely populated and have buildings that have more variation in height than the suburban area of University of Ghana.

"A measurement-based path loss model for wireless links in mobile ad-hoc networks (MANET) operating in the VHF and UHF band"

For the development of future mobile to-mobile communication systems, realistic channel models are required. Available models are aiming at broadcasting applications using high antenna towers and are therefore not applicable for mobile to-mobile applications like mobile ad-hoc networks (MANET). In this paper, measurements of the path loss using car-mounted receiver and transmitter antennas are presented. Based on the measurement results, a new path loss model is proposed. It is shown that this model provides a more realistic prediction of the path loss for MANET systems in the VHF and UHF band than the widely used Okumura Hata model.

"Empirical Correction of the Okumura-Hata Model for the 900 MHz band in Egypt"
This paper studies the performance of the Okumura-Hata model in the 900 MHz band. The results of several measurement campaigns carried out in different regions of Egypt show significant errors in the Okumura Hata model. The paper, hence, introduces correction to the Okumura-Hata model that suits the Egyptian 900 MHz cellular environment. The correction is evaluated empirically by fitting the received field strength to the corrected model in different terrains. The paper, also, gives better categorization for the different regions in Egypt in terms of the topography and the morphology. The study of the RMSE (root-mean-square error) shows that the error has been decreased from an average value of 65 dBμV/m to an average value of 9 dBμV/m. Location estimation using RSS measurements with unknown path loss exponents The location of a mobile station (MS) in a cellular network can be estimated using received signal strength (RSS) measurements that are available from control channels of nearby base stations.

Most of the recent RSS-based location estimation methods that are available in the literature rely on the rather unrealistic assumption that signal propagation characteristics are known and independent of time variations and the environment. In this paper, we propose an RSS-based location estimation technique, so-called multiple path loss exponent algorithm (RSS-MPLE), which jointly estimates the propagation parameters and the MS position. The RSS-MPLE method incorporates antenna radiation pattern information into the signal model and determines the maximum likelihood estimate of unknown parameters by employing the Levenberg-Marquardt method. The accuracy of the proposed method is further examined by deriving the Cramer-Rao bound. The performance of the RSS-MPLE algorithm is evaluated for various scenarios via simulation results which confirm that the proposed scheme provides a practical position estimator that is not only accurate but also robust against the variations in the signal propagation characteristics. Characterization of path loss and absorption for a wireless radio frequency link between an in-body endoscopy capsule and a receiver outside the body Physical-layer characterization is important for design of in-to-out body communication for wireless body area networks (WBANs). This paper numerically investigates the path loss and absorption of an in-to-out body radio frequency (RF) wireless link between an endoscopy capsule and a receiver outside the body using a 3D electromagnetic solver.

A spiral antenna in the endoscopy capsule is tuned to operate in the Medical Implant Communication Service (MICS) band at 402 MHz, accounting for the properties of the human body. The influence of misalignment, rotation of the capsule, and three different human models are investigated. Semi-empirical path loss models for various homogeneous tissues and 3D realistic human body models are provided for manufacturers to evaluate the performance of in-body to out-body WBAN systems. The specific absorption rate (SAR) in homogeneous and heterogeneous body models is characterized and compliance is investigated.

"A Study on path loss Analysis for GSM Mobile Networks for Urban, Rural and Sub-Urban regions of Karnataka state"
To establish any mobile network system, the basic task is to foresee the coverage of the proposed system in general. Many such different approaches have been developed, over the past, to predict coverage using what are known as propagation models. In this paper, measurement based path loss example and shadowing parameters are applied on path loss models. Here, the measurements are carried out in urban, rural and suburban areas considering non-line-of-sight terrains with low elevation antennas for the transceiver (Tx) and receiver (Rx). The impact of multipath are more emphasized in the rural context. This causes higher probability of RF signal errors. On the basis of observation and with the help of clutter, we can present models which give better understanding for urban, rural and suburban regions in Karnataka state at 940 MHz GSM frequency.

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