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On Using Space Diversity Technique In Combating The Effect Of Signal Fading In A Topographical Terrain

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***Abstract*— The main aim of this paper is to implement receiver antenna diversity in a mobile radio terminal and to study the diversity performance of the diversity antenna system with the view to reducing the fading problems. However, in the new generation of wireless communication systems, high data rate transmission and low bit error probability. The issues of signal fading in a topographical environment still stand as a major problem but in this paper implementation of space diversity technique to combat the effect has been deployed.**

***Index Terms*— Path loss Exponent, Diversity, multipath, signal fading**

I. INTRODUCTION

In the new generation of wireless mobile communication, the aim of every subscriber is to have high transmission rate and low bit of error probability requirement [1]. The issue of signal fading in a multipath environment still stands as a major problem which can be overcome using space diversity antenna scheme. The implementation of space diversity can increase the channel capacity and reduce the multipath interference at the expense of adding extra spectrum is consumed. Two antennas functions in mobile communication terminals are most commonly introduced since it can be easily implemented in a real applications due to the demand of decrease of overall size of the mobile phone. Diversity gain is the most important characteristics in any space diversity system and it can be obtained from correlation coefficient and embedded element efficiency [3]. When the embedded element efficiency is not taken into consideration, apparent diversity gain is obtained [4]. Another important issue is to choose the proper type of antenna. In this our research work, PIFA antenna was chosen since they have attracted much interest due to their small size and good applicability for portable devices. The diversity antenna is designed for UMTS I Band (Rx 2112.4MHz-2167.6MHz). The performance and evaluation of the diversity performance have been conducted both in simulations and measurements. The measurement results compared well with those from simulation cases using computer program. The simulation tools used in this paper is CST micro wave studio which has the ability to provide both far field function and S parameters data, for calculating the correlation coefficient of correlation coefficient and diversity gain and S parameter was measured using network analyzer and far field pattern in the scattered field chamber.

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II. PATHLOSS EXPONENT COMPUTATION

Pathloss occurs when the received signal becomes weaker and weaker due to increasing distance between the mobile station and base station. The extent to which signal degradation occurs in a communication channel can be known by determining the pathloss exponent of the environment. Therefore, pathloss exponent, n, of an environment shows the variation of signal loss in an environment. The pathloss exponent, n, and the received signal strength obtained from field measurement can be used to completely characterize a propagation environment under consideration. The mean path loss, $P_L(d_i)$ [dB] at a transmitter receiver separation, d_i , is given as [6]:

$$P_L(d_i)\,[\text{dB}] = P_L(d_0)\,[\text{dB}] + 10n\log_{10}\left(\frac{d_i}{d_0}\right) \quad (1)$$

Where n = pathloss exponent,

$P_L(d_0)$ = pathloss at known reference distance d_0.

For free space model,n, is regarded as 2. The free-space model however is an over idealization, and the propagation of a signal is affected by reflection, diffraction and scattering. These effects are environment (indoors, outdoors, rain, buildings, etc.) dependent. However, it is accepted on the basis of empirical evidence that it is reasonable to model the pathloss, $P_L(d_i)$ at any value of d at a particular location as a random and log-normally distributed random variable with a distance-dependent mean value [7].

That is:

$$P_L(d_i)\,[\text{dB}] = P_L(d_0)\,[\text{dB}] + 10n\log_{10}\left(\frac{d_i}{d_0}\right) + S \quad (2)$$

Where S, the shadowing factor is a Gaussian random variable with values in dB. The path loss exponent, n, is an empirical constant which depends on propagation environment.

In order to determine the pathloss coefficient, n, of the test bed environment, equation (1) can be used to manually compute it as:

$$n = \frac{\{P_L(d_i) - P_L(d_0)\}}{10\log_{10}\left(\frac{d_i}{d_0}\right)} \quad (3)$$

But, using linear regression, the value of n can be determined from the measured data by minimizing total error R^2 as follows:

$$R^2 = \sum_{i=1}^{M}\left[P_L(d_i) - P_L(d_0) - 10n\log_{10}\left(\frac{d_i}{d_0}\right)\right]^2 \quad (4)$$

Differentiating equation (4) with respect to *n*,

$$\frac{\partial R^2(n)}{\partial n} = -20log_{10}(d)\sum_{i=1}^{M}\left[P_L(d_i) - P_L(d_0) - 10n\,log_{10}\left(\frac{d_i}{d_0}\right)\right] \quad (5)$$

Equating $\frac{\partial R^2(n)}{\partial n}$ to zero,

$$0 = -20log_{10}(d)\sum_{i=1}^{M}\left[P_L(d_i) - P_L(d_0) - 10n\,log_{10}\left(\frac{d_i}{d_0}\right)\right] \quad (6)$$

$$\sum_{i=1}^{M}[P_L(d_i) - P_L(d_0)] - 10n\,log_{10}\left(\frac{d_i}{d_0}\right) = 0 \quad (7)$$

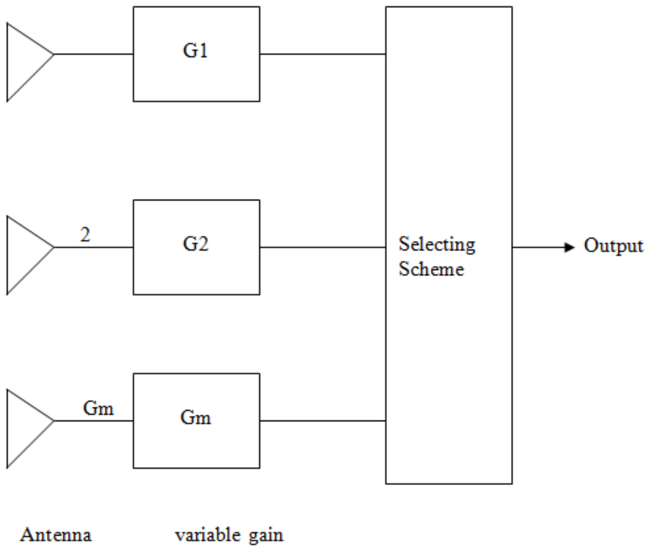
$$\sum_{i=1}^{M}[P_L(d_i) - P_L(d_0)] - \sum_{i=1}^{M}\left[10n\,log_{10}\left(\frac{d_i}{d_0}\right)\right] = 0 \quad (8)$$

$$\sum_{i=1}^{M}[P_L(d_i) - P_L(d_0)] = \sum_{i=1}^{M}\left[10n\,log_{10}\left(\frac{d_i}{d_0}\right)\right] \quad (9)$$

Therefore, $n = \frac{\sum_{i=1}^{M}[P_L(d_i) - P_L(d_0)]}{\sum_{i=1}^{M}\left[10log_{10}\left(\frac{d_i}{d_0}\right)\right]}$ (10)

Equation (10) can be used in determining the pathloss exponent,n, of the test bed environment which is essential in characterizing the propagation environment.

Original path if one path undergoes a deep fade, another independent path may have a strong signal. Each path is called or channel is known as diversity branch as shown in Figure 1



III. SUMMARY

In this paper, studies and evaluations have confirmed that correlation coefficients calculated from far field function and S parameters are equivalent in an antenna system, assuming uniform distributed propagation model is used. It was also discovered that with diversity, the fading problems can be overcome and further better signal performance can also be obtained both in high data rate and lower error rate. It was also discovered that space diversity have so many area of application not only antenna but also in switch combine and filters

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