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Bit Error Rate Analysis in WiMAX Communication at Vehicular Speeds using modified Nakagami-*m* Fading Model

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Abstract: *At high vehicular speeds, rapid changes in surrounding environments, cause severe fading at the receiver, resulting a drastic fall in throughput and unless any proactive measure is taken to combat this problem, throughput becomes insufficient to support many applications, particularly those with multimedia contents. Bit Error Rate (BER) estimation is an integral part of any proactive measure and recent studies suggest that Nakagami-m model performs better for modelling channel fading in wireless communications at high vehicular speeds. No work has been reported in literature that estimates BER at high vehicular speeds in WiMAX communication using Nakagami-m model. In this thesis, we develop and present an analytical model to estimate BER in WiMAX at vehicular speeds using Nakagami-m fading model. The proposed model is adaptive and can be used with resource management schemes designed for fixed, nomadic, and mobile WiMAX communications.*

I. Introduction

WiMAX is basically described as the IEEE 802.16 standard for Broadband Wireless Access (BWA) that was developed to provide high transmission data rates over larger areas and also to those areas users where broadband coverage is not available. MIMO systems are also of major interest in the field of wireless communication as it allows data to be sent and received over different antennas. WiMAX-MIMO systems are mainly developed to increase the performance of simple WiMAX system. This paper analyses WiMAX-MIMO systems under different modulations with different CC code rates for different fading channels (Rician and Nakagami channel). Spatial Diversity technique of MIMO system is used for the simulation purpose. Signal-to Noise Ratio (SNR) vs Bit Error Rate (BER) plots are analysed for this purpose.

The IEEE 802.16 PHY includes mainly three specifications, which are suited to different operational environments. For frequencies from 10 to 66 GHz, the standard recommends the Wireless MAN-SC PHY, where SC means single-carrier modulation. The typical channel bandwidth is 25 MHz or 28 MHz, and the raw data rates can exceed 120 Mb/s. For frequency band below 11 GHz, two alternatives have been specified: Wireless MAN-OFDM and Wireless MAN- OFDMA. In this frequency range, the wavelength is relatively long, and therefore it is a Non-LOS (NLOS). Hence the impairments like fading and multipath propagation are more prominent in both of these specifications.

Factors such as these include helpful to analyze the cardiovascular disease. In numerous cases, diagnosis is generallybased on current test results of the patients & experience of the doctor. Thus the diagnosis becomes a complex task that will require much experience & high skill [6].

Modulation is a fundamental component of a digital communication system. It involves mapping of incoming digital information from interleaver into analog form onto a constellation so it can be transmitted over the channel. Various digital modulation techniques used in our analysis that are M-PSK and M-QAM where M is the number of constellation points in the constellation diagram. After modulation process, code words generated by encoding process are converted into symbols. Inverse process of modulator is called demodulation which is done at the receiver side of Physical layer to recover the transmitted digital information.

II. Literature Cited

Suzuki,Use of a commercial WiMAX equipment in the frequency of 3.5 MHz with a bandwidth of 7 MHz (BW), where link speeds was BPSK -1 / 2 and QPSK 1/2. Research shows that the image size has a significant impact on the performance of WiMAX communication.Communication System WiMAX Rated vehicles for communication, both V2I and V2V infrastructure for road safety project.The experimental design consisted of three WiMAX base stations. The researcher concluded that the proposed architecture meets the requirements of the implementation of version 1.0 WiMAX.

Charash studied the behavior and performance for IEEE 802.16e -based unit noise ratio (SNR) in an urban micro cell and determined the SNR switching point between each link speed. The theory is compared to the measurement results of the mobile practice test in an urban cell. Experiments show that 3/4 code rate provides lower performance than the average rate of code.

SteinA proposed system for providing roaming wireless high speeds on multiple interfaces, running in the WiMAX system and Wi-Fi technology. The system supports multiple interfaces for mobile devices quickly. It can support fast switch connecting the access point Wi- Fi, and passes seamlessly between access points. Connections use various means, such as WiFi and WiMAX. The proposed system has improved the efficiency of communications technology WiMAX up to 30 %, and the combination of WiMAX and Wi-Fi technology significantly wide band technology.

The study showed that the Flash OFDM solution is a pre - stage gear linkage, such as access to communication on the base WiMAX high-speed Internet is profitable passenger rail operated more. The researcher examined two scenarios, the first that included two mobile nodes support of the application in real time and met. The second scenario has a strong footprint with 40 vehicles. A simulation was performed using two getways Access Services Network (ASN).

Malhotra et al.,Considered based mobile WiMAX DL channel cluster systems based on LS methods using DL-PUSC permutation. The simulation was performed using the Rayleigh fading model. The estimate was made regarding the mean squared error (MSE) and the BER. The results showed that two OFDM symbols has a better performance compared to a single OFDM symbol.

Sood et al.,A is a performance analysis of the application of additive white Gaussian noise (AWGN) and Doppler movement. Tx was developed according to the IEEE standard and the current simulation on M-QAM modulation and RS code CC. The Least Square (LS) and minimum mean square (LMS) method is used for channel estimation. The results show that the performance degrades LS estimator relatively high speed, and provides better performance LMS. The researcher concluded that the interpolation method has a great impact on the estimation of the mobile channel.

III. Materials And Methods

3.1 WiMAX Technology

High speed wireless communication technologies such as Worldwide Interoperability for Microwave Access (WiMAX) have revolutionized the way of our day-to-day communication and opened opportunities for many innovative applications. The 802.6m version of WiMAX offers data rates up to 1 Gbps for fixed communications and supports mobility up to 350 km/h. While WiMAX technology's capacity to deliver high data rates in a fixed environment is beyond any doubt, the standard is not fully optimized yet for mobile communication at high vehicular speeds.

3.2 Nakagami Channel

Rayleigh fading can't describe the long-distance fading effects that are corrected by the Nakagami by formulating a parametric gamma distribution-based density function thus reducing the effects of multipath propagation. It provides a better explanation to worse conditions than the Rician and Rayleigh fading model and thus fits better in the mobile channel data. This fading originated to describe the amplitude of fading channels.

3.3 Bit error rate estimation

We have dealt with the problem of Bit error rate estimation (BER) in WiMAX communication at vehicular speeds using Nakagami-*m* model. We have followed an analytical model in which I had studied the parameters and equations which had changed the bit error rate at various vehicular speeds for efficient resource management. I have also modified the marginal distribution equation used in the basic model to check its effect. The basic aim and purpose was to change the marginal distribution equation in such a way so that *it increases the throughput of the base model. The modulation method which I had used for* calculating the bit rate probability is based on QPSK modulation.

3.4.Methodology used

We have used a predefined methodology to improve the algorithm and for applying the Nakagami fading for the vehicular traffic. The methodology is given as shown below:

1. Defined the extracted workflow specification according to problem definition
2. Based on that we have defined the newly extracted organizational model

Stored the event log file and generated a simulation model that reflects the process as it is currently enacted. The direct usage of design information avoids mistakes that are likely to be introduced when models are constructed

manually, and the automated extraction of data from event logs allows the calibration of the model based on actually observed parameters.

IV. Results And Discussion

We have analyzed WIMAX communications system which can be used for vehicular speed by using a nakagami model. This system is quiet efficient when dealing with the problem of improving the management capacity of the mobility and circulation, improve the condition of travel, and reduce the effects the unfavorable environment in surface transportation systems. Modern research on WIMAX communications system shows that all the components here are connected by wireless communication. Wireless communication can also be used in modern vehicular operations so that its efficiency is improved with time. In most of such applications, data communication takes place between the vehicle (V2V) and vehicle vehicle-infrastructure (V2I) using wireless communication systems.

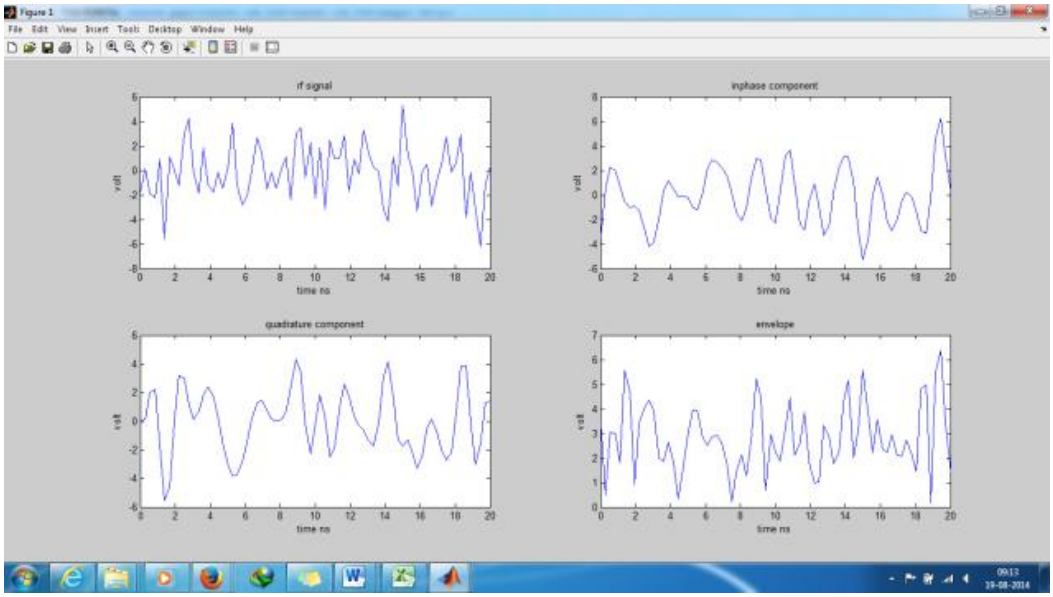

Figure 1: Various parameters of theWiMAX communication at vehicular speeds using Nakagami-*m* model

The performance of the basic WiMAX system with different modulations and different CC code rates, we have calculated the parameters in the form of BER vs SNR plots over Nakagami channel. Our graph shows an improvement in the SNR value using spatial diversity technique of Nakagami model.

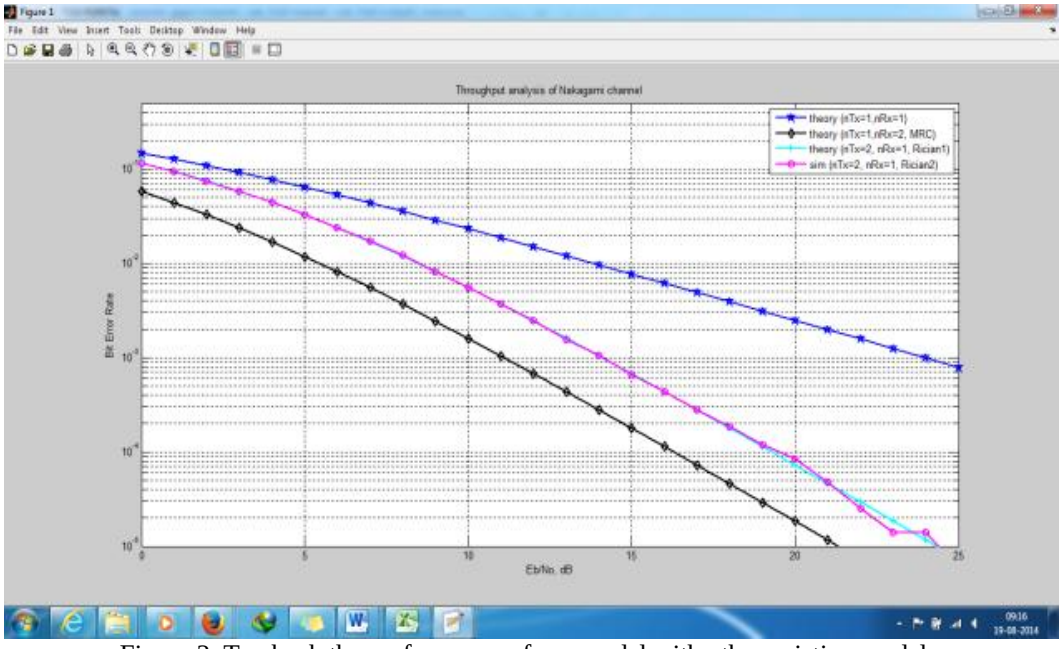

Figure 2: To check the performance of our model with other existing models

In the figure given above, we have tried to compare our model with three other models. By comparison it is shown that BER of our model is less as compared to other three models. It is compared with different parameters so that efficiency of the system as compared to other vehicle is same. We have used the following parameters for the simulation:

Number of bits used for simulation: N = 10^6
EB number values: Eb_N0_dB = 0:25
Number of paths: numpaths = 10
Frequency of the carrier: Fc = 900e6
Sampling Frequency of the carrier: Fs = 4*Fc
Period of sampling: Ts = 1/Fs
Time for simulation: t = 0: Ts:1999*Ts
And we have calculated the radian frequency as :wc = 2*pi*Fc;

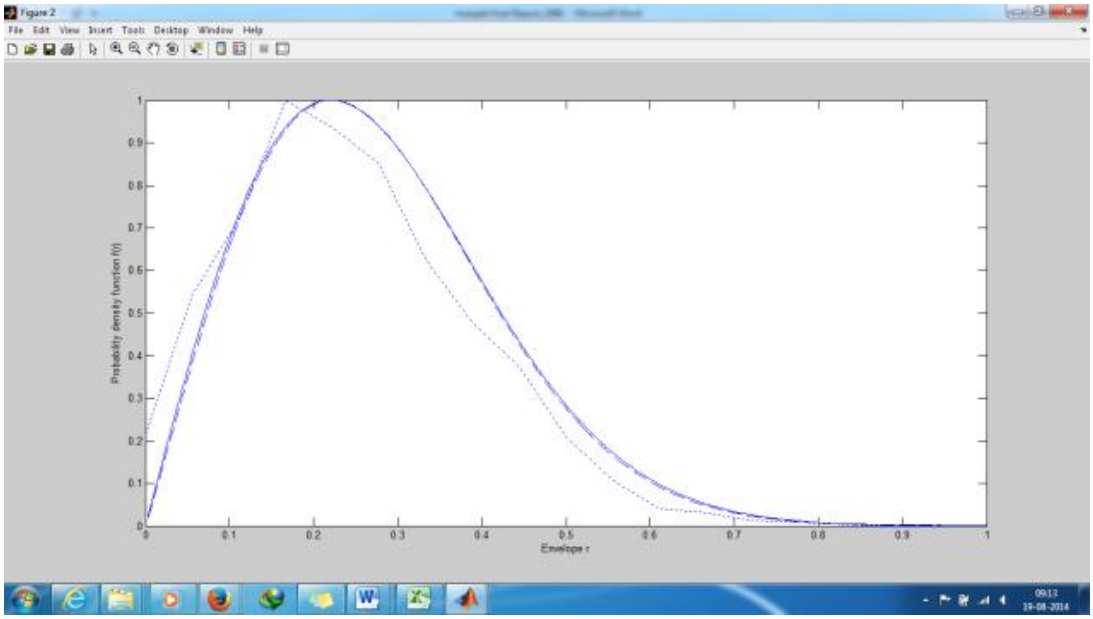

Figure 3: Bit error rate estimation area of WIMAX models for a particular model with different varying parameters.

In this graph we are able to achieve 5 dB improvements in SNR for the envelope and we have used Spatial Diversity technique in WiMAX in the presence of Nakagami model.The performance of the basic WiMAX system with different modulations and different CC code rates, we have calculated the parameters in the form of BER vs SNR plots over Nakagami channel. Our graph shows an improvement in the SNR value using spatial diversity technique of Nakagami model.

V. Conclusion

At vehicular speeds, however, spectral efficiency of WiMAX becomes low mainly due to multipath fading problem and further research is needed for designing resource management schemes at vehicular speeds so that multimedia applications can be supported at high vehicular speeds. A key requirement for such a resource management scheme is to have an analytical model that can estimate BER at high vehicular speeds so that proactive actions can be taken and proper planning can be done. The proposed analytical model in this thesis is adaptive to reflect fading severity at various speeds and is a perfect fit for WiMAX communication. The proposed model can also be used with long term evolution (LTE) down link channel which uses similar OFDMA technique.

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