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Simulation and Performance Analysis of Efficient Wireless Channel in WiMAX MIMO Using Real Time Data Transmission

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ABSTRACT: This paper presents the simulation and performance evaluation of WiMAX MIMO (worldwide interoperability for microwave access) system along with efficient wireless channels using real time data transmission. In order to visualize and understand the effects of real time environment over system performance, it is essential to analyze the real time fading channels i.e. Rayleigh channel and Rician channel. As in the real life scenario it is not possible to have unified distribution of fading over the entire communication channel. The present paper enhances the current status of WiMAX MIMO system along with the modelling of suitable wireless channels i.e. AWGR, Rayleigh and Rician in order to control BER of the system. Further with the variation of different channel parameters for real time data transmission through WiMAX MIMO system, the structure compatible to practical scenario can be implemented through this, Modelling using antenna diversity principles in order to control BER of the system. The central objective of this paper is to built up the real time model for the WiMAX MIMO system along with the suitable wireless channels compatible to various atmospheric conditions for the signal propagation.

KEYWORDS: WiMAX, RAYLEIGH, RICIAN and AWGN

I. INTRODUCTION

WiMAX stands for worldwide interoperability for microwave access is IEEE802.16 standard based technology which is basically responsible for bringing the broadband wireless access to the world as an alternative to wired broadband. It is capable of providing broadband wireless access up to 50km for fixed station and 5-15km for mobile station with data throughput up to 70mbps.

The WiMAX network is similar to that of a cell phone. When the data is send by a user from a subscriber device to a base station then that base station will further broadcast the wireless signal into channel which is termed as uplink vice versa when the base station transmit to the same or another user is called downlink. Here the base station of WiMAX is provided with higher broadcasting power antennas. The broadband service of WiMAX technology is available in coverage areas. This coverage area is further separated in series of over lied areas known as channel. The wireless connection is transferred from one cell to another when a user sends data from one location to another. The architecture of WiMAX is based on connection oriented that is MAC layer. The central aim to design WiMAX system is to facilitate large number of user with a variety of connection per terminal. The important feature of WiMAX includes interoperability, long range, handoff, quality of service etc.

MIMO (Multiple Input Multiple Output) involves the transmission and reception of data is through two or more than two spatially separated antennas. The main advantages of MIMO channel are the array gain, the diversity gain and the multiplexing gain. The present paper discusses the model building of WiMAX MIMO physical layer using simulink in matlab and models proves to be a useful tool for the performance evaluation of the WiMAX MIMO system under various efficient wireless channels using the real time data.

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II MODELING OF WIMAX MIMO USING AWGN CHANNEL

The model discussed in this paper is built on QAM modulation scheme and OFDM technique based on the platform of matlab R2009a. The model consist of transmitter, receiver and channel as their main parts. In first case AWGN channel is considered. As shown in figure 1 input is provided in the form of image which consist of 256x256 image with 96 samples per frame with 1/35 sample time for the process of frame based output. Once the data is received the process of randomization is performed which will be applied for encoding. The encoder of the WiMAX MIMO system consists of outer Reed-Solomon (RS) CODE and inner Convolution Code (CC). Further the encoded baseband data is modulated by QAM and applied for OFDM process because the physical layer of WiMAX system is made up of OFDM in phase and quadrature phase component of the symbol will undergo through the process of IFFT so that requirement of effective bandwidth can be made approximately half without any inter symbol interference.

Here in this case for simulation purpose, the communication medium is considered to be suitable for long distance system wherein average fading is assumed to be constant throughout the path. AWGN channel is the simplest type of channel that has noise distribution with a constant power spectral density with Gaussian nature of PDF over the whole channel bandwidth [1]

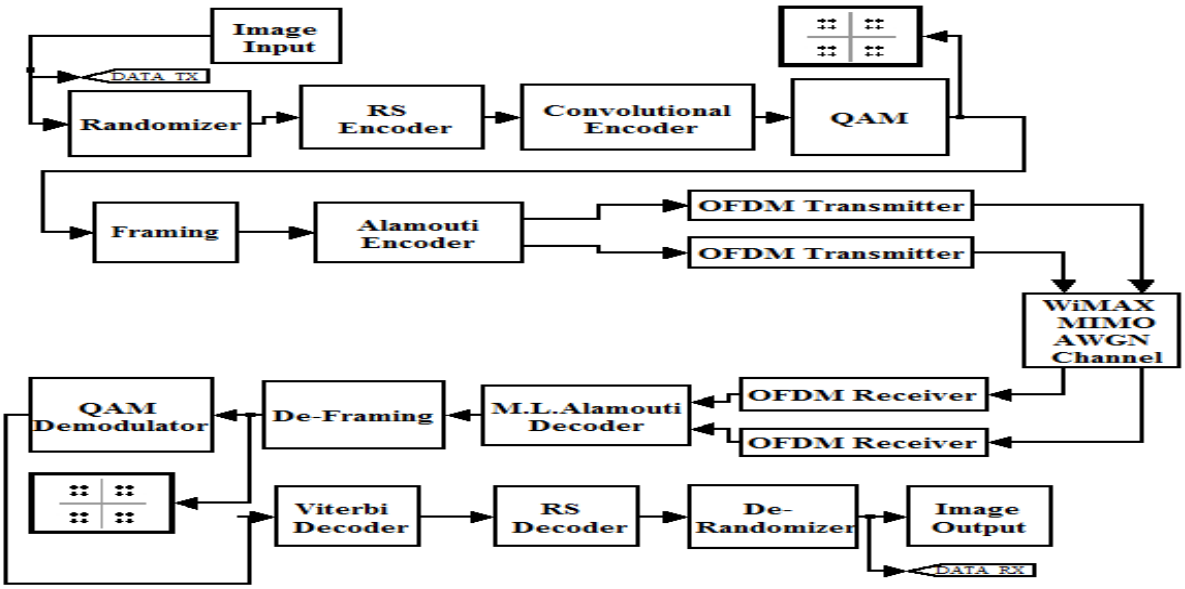

Figure-1 WiMAX MIMO modeling using ideal AWGN channel

III MODELING OF WIMAX MIMO USING RAYLEIGH FADING CHANNEL

To model the WiMAX MIMO system with the consideration of practical wireless scenario, the AWGN channel of the previous design should be replaced by such a channel which will characterize the actual features of the practical real time wireless path. The appropriate option is modeling of Rayleigh channel between transmitter and receiver of WiMAX MIMO system which describes the phenomenon of mobile communication system, i.e. fading. Fading results from the rapid fluctuations in the amplitude, phase or frequency of the signal because of multipath propagation of radio waves.

In MIMO system due to multipath structure of the wireless channel, different paths are taken by the signals component to reach towards receiver, which interferes with each other and results in fading. When we consider urban areas where line of sight is very rarely available, to model WiMAX MIMO system in densely populated area, the Rayleigh channel modeling is the most appropriate one for simulation. Here in this case the AWGN channel is being replaced by the

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combination of Rayleigh and AWGN channel in order to analyse the effects of practical short term and long term fading along with the Gaussian noise effect rest all the blocks remains the same as shown in figure 2.

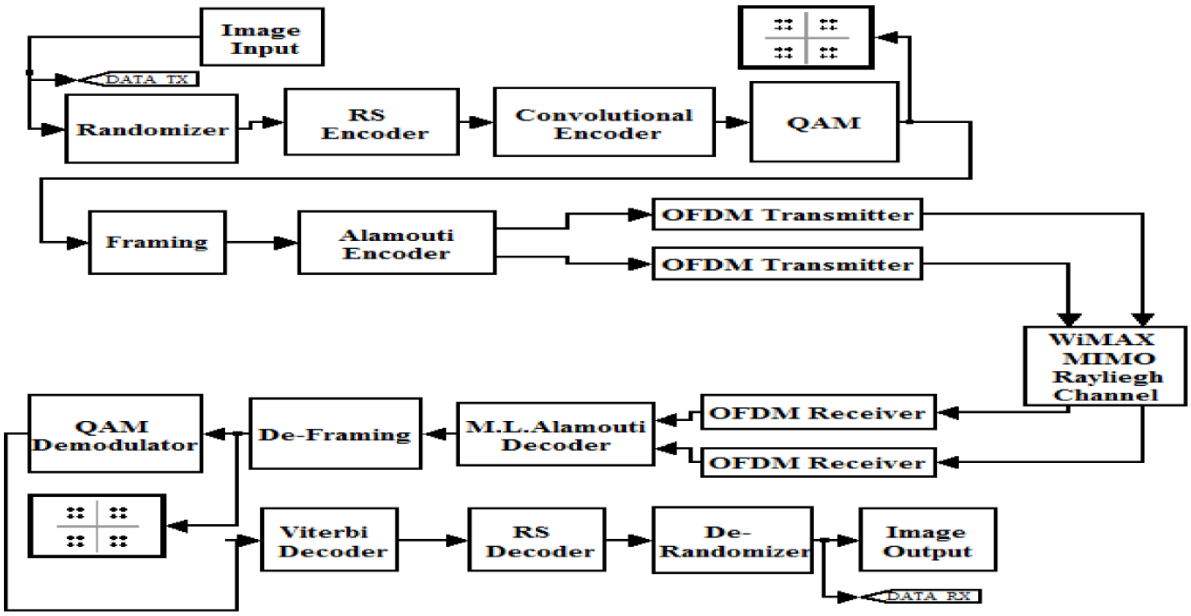

Figure-2 WiMAX MIMO modeling using ideal Rayleigh channel

IV MODELING OF WIMAX MIMO USING RICIAN FADING CHANNEL

The third variation of this paper includes the modeling of WiMAX MIMO system with the replacement of Rayleigh channel by Rician channel. When we consider the sub urban areas, where there is possibility of realizing the line of sight path along with multipath structure, the wireless channel should be a Rician channel. In this channel the multipath variation of the signal are superimposed over the line of sight component which finally increases the overall strength of the entire information at the receiver. The figure-3 shows the snap shot of traditional WiMAX MIMO model with the cascaded combination of two Rician and two AWGN channel.

Rician fading is characterized by a factor which is expressed as the power ratio of the secular (los or dominant path) component to the diffused component. This ratio k, defines how near to Rayleigh statistics the channel is. In fact when k= infinite, there is no fading at all and when k=0, this means to have Rayleigh fading. The average path gain vector parameter controls the overall gain through the channel, the K-factor parameter controls the gain's partition into line-of-sight and diffuses components. The other blocks and properties of WiMAX MIMO model remains the same which is shown in figure-3.[1]

By modeling the WiMAX system under the fading constraints, with the propagation of image and speech inputs, the outputs get degraded with sudden jerk of noise at some parts rather than distributed noise as in the case of AWGN channel. But the span of this fading can be reduced in this channel as compared to that in the Rayleigh channel because of the presence of LOS component. The factor that decides the amount of fading is the gain factor of the line of sight path.

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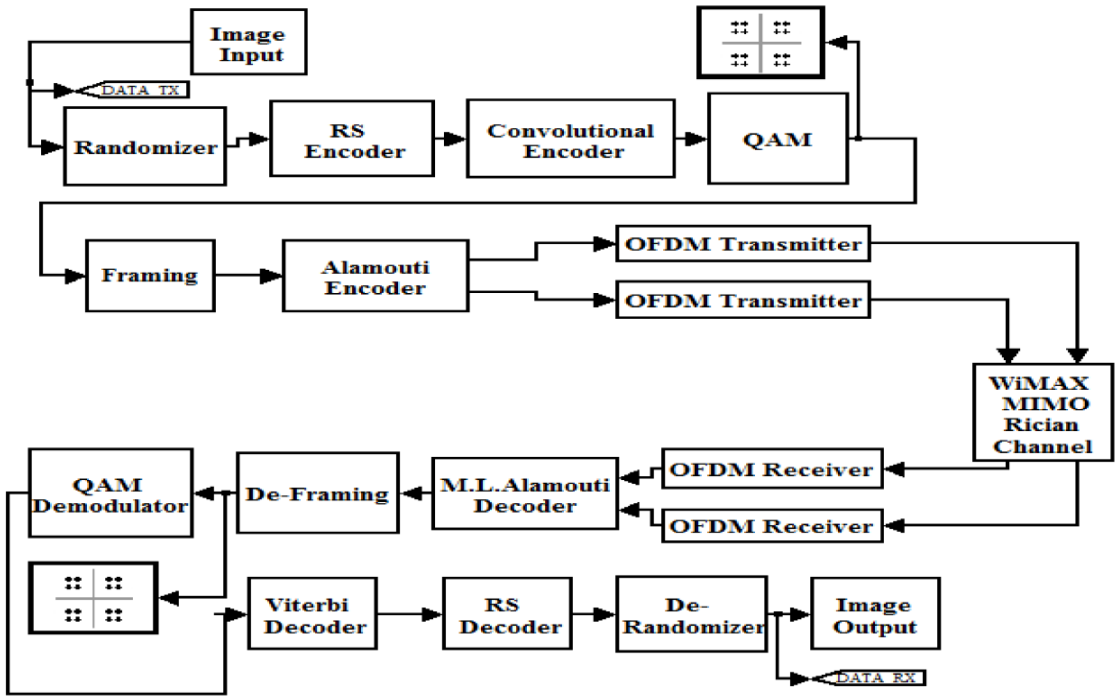

Figure-3 WiMAX MIMO modeling using ideal Rician channel

V SIMULATION RESULTS AND DISCUSSION

The figure-4 shows input data which is provided for all the three channel types.

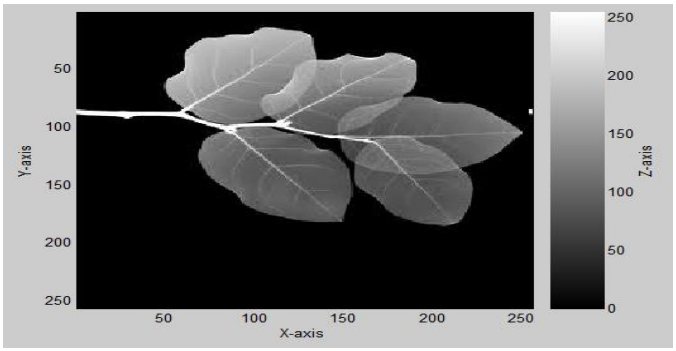

Figure-4 Input Image For WiMAX MIMO Model

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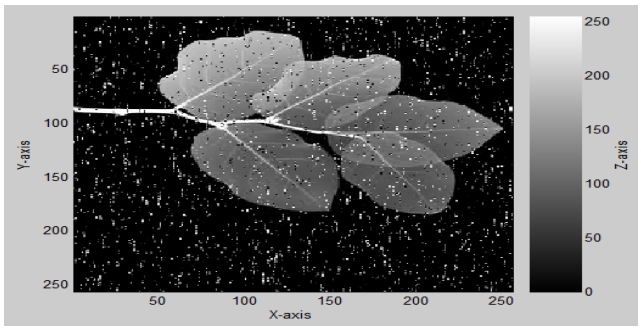
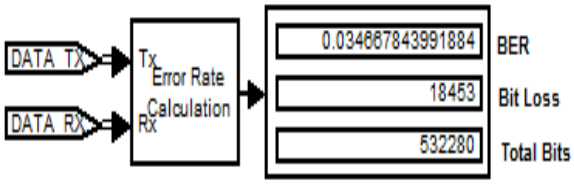
Case-1 WiMAX MIMO Modeling using AWGN Channel



(a)



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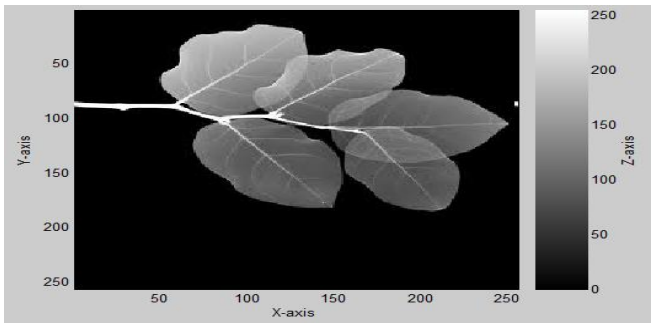
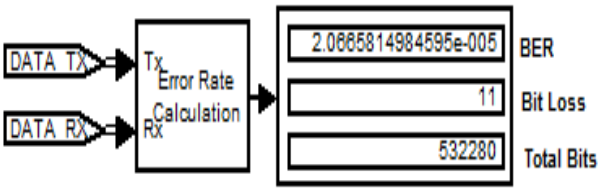


(c)

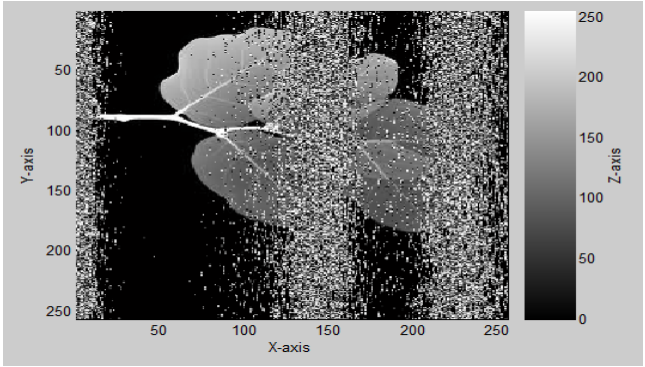


(d)

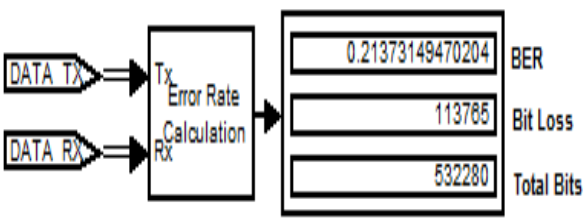
Figure-5 simulation results of WiMAX MIMO AWGN
(a) Output image for SNR = 20 & (b) BER for SNR = 20
(c) Output image for SNR = 25 & (d) BER for SNR = 25

SNR is the most important parameter for figuring out the AWGN channel. On varying the range of SNR for AWGN channel, the performance of the WiMAX MIMO changes. As shown in figure-5 with SNR=20 the BER obtained is comparatively more than that with SNR=25 over the same span. This proves that the channel provides more noise for lower values of SNR compared to higher values this is because of uniformly distributed fluctuations.

Case-2 WiMAX MIMO Modeling using Rayleigh Channel



(a)



(b)

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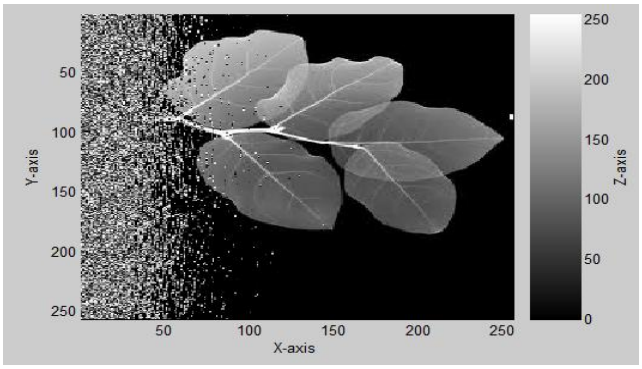
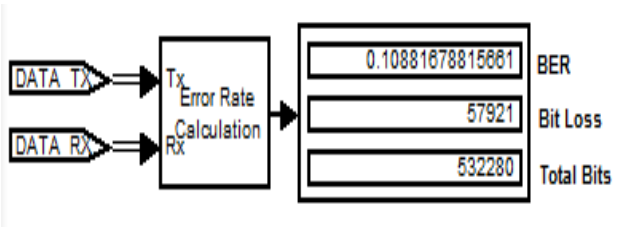


(c)

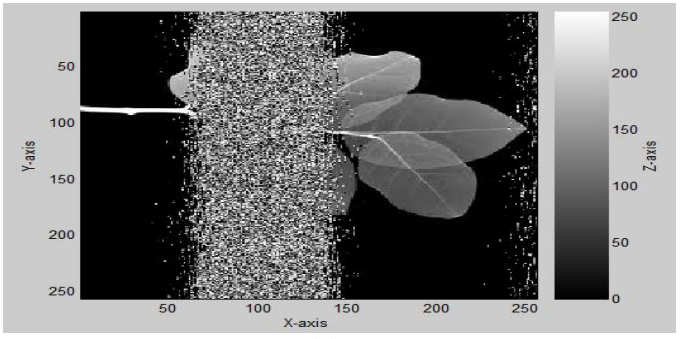


(d)

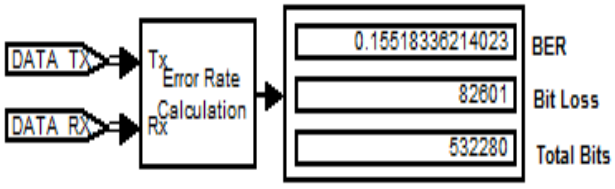
Figure-6 simulation results for WiMAX MIMO Rayleigh
(a) Output image for Doppler shift =1/1000Hz & (b) BER for Doppler shift = 1/1000Hz
(c) Output image for Doppler shift =1/5000Hz & (d) BER for Doppler shift = 1/5000Hz

The figure-6 shows the output obtained on modeling of WiMAX MIMO system with Rayleigh channel. Here the output gets degraded with the sudden jerks of noise at some part. The factor that decides the amount of fading is Doppler shift. As shown in figure-6 for the larger values of the Doppler shifts, the BER obtained is more for the same value of SNR as compared to that of the lower Doppler shifts.

Case-3 WiMAX MIMO Modeling using Rician Channel



(a)



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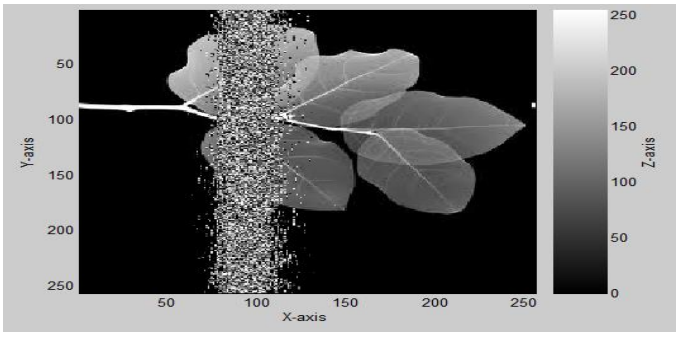
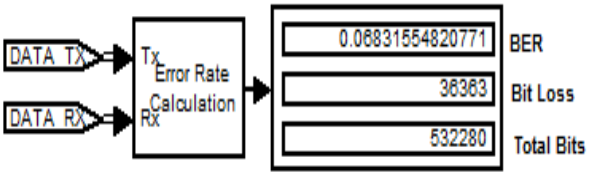


(c)



(d)

Figure-7 simulation results for WiMAX MIMO Rician
(a) Output image for K factor = 1 & (b) BER for K factor = 1
(c) Output image for K factor = 2 & (d) BER for K factor = 2

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From the simulation results of WiMAX MIMO system with Rician channel, it shows that practically the Rician channel is more or less same as the Rayleigh channel except the presence of line of sight component along with multipath structure. Also on changing the value of gain factor 'k' with Rician channel, the performance of the WiMAX MIMO system gets improved in terms of BER at constant SNR. The degradation span is larger for k=1 as compared to the value k=2 which is clearly shown in the figure-7

VI CONCLUSION AND FUTURE WORK

The models implemented in this paper demonstrates the complete real time scenario for WiMAX MIMO system with the various channel conditions such as high quality long distance communication channel , multipath structured urban or sub-urban channel with certain possibility of line of sight path. The paper deals with the complete analysis of WiMAX MIMO system by transmitting real time data i.e. image with the modeling of AWGN, Rayleigh and Rician channel under the variation of different parameters. In order to realize the ideal conditions of propagation of WiMAX MMO system, the modeling can be done by assuming the long distance highly efficient path i.e. AWGN channel. For figuring out the real time multipath structure of WiMAX MIMO model, the channel is simulated as Rayleigh channel in worst scenario wherein the performance in terms of fading can be improved by changing the value of Doppler shift. With the same criterion, the presence of line of sight can be justified by modeling WiMAX MIMO with Rician channel.

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BIOGRAPHY

Vaidehi J. Sojitra is pursuing M.Tech. in Electronics and Communication from V.V.P. Engineering College, Gujarat Technical University, Rajkot, Gujarat. She has completed B.E. in Electronics and Communication from Parul Institute of Engineering and Technology, Baroda. Her research interest includes RF Communication and Wireless Communication.

Dr. B. S. Sedani has received Ph.D.in Electronics and Communication from JJT University, Rajasthan. He is working as Associate Professor and Head of Electronics and Communication Department in V.V.P Engineering College, Rajkot, Gujarat, India. His research interest includes Wireless communication, Image and Speech processing, Digital Signal Processing, RF Communication