Volume 5, Issue 5, May 2015 ISSN: 2277 128X
International Journal of Advanced Research in
Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Implementation of Precoder Based Blind Channel Estimation for Conventional and Massive MIMO Systems

Greeshma Sajive, Pappa.M
Dept. of Telecomm Engg, VTU,
Karnataka, India

Abstract— MIMO-OFDM is the prosperity for most ground-breaking Wireless LAN and mobile broadband network morals because it accomplishes the extreme spectral efficiency and, therefore, provides the highest capacity and data throughput. And by Massive MIMO, the capacity can be increased 10 times more than the capacity of conventional MIMO systems. Channel estimation plays a significant part in OFDM systems. Among traditional estimation method, Blind channel estimation methods avoid the use of pilots and have higher spectral efficiency. And for channel estimation pre-coder can be used which gives minimum error at the receiver. Thus, one could first employ a blind channel estimate to obtain initial symbol estimates, and then use the preliminary symbol estimates to obtain a higher fidelity channel estimate.

The main objective behind this paper is for designing a sparse pre-coder for the transmitter and predicting the channel for minimizing the error at the receiver side and also implementing the same for massive MIMO systems.

Keywords— Channel Estimation, precoding, MIMO systems, Massive MIMO, MIMO-OFDM

I. INTRODUCTION

Mobile communications in wireless network have experienced tremendous growth lately. The radio channels are commonly kept as wireless as possible. The systems with wireless communication, the postulation are in such a way that the fading process is a random effect with Rayleigh distribution and thus fading is a very common effect in wireless multi-path systems. OFDM was presented for the transfer of High speed data rate with restricted spectrum. And by combining MIMO multiple inputs and multiple outputs and OFDM orthogonal frequency division multiplexing which is mentioned as MIMO-OFDM there can be an enhancement in the enactment of next Gen 4G wireless systems. Multipath wireless channels leads to the consequences like dispersions, attenuations, phase shifts, which is known as fading and rapid variations, in the received signal and are not like wired channels which are always static and liable. Wireless channels are very casual and time-variant. Fading is caused mainly by the nosiness which cannot be eliminated but can be reduced by the channel estimation and at receiver noise can be reduced.

MIMO-OFDM system is well promising for achieving higher data rate and larger system capacity over mobile wireless links. Massive MIMO can intensify the capacity 10 times more than the capacity of traditional MIMO systems. For achieving performance perfections like decoding, diversity accurate Channel State Information, is required at the receiver which is acquired via channel estimation. And for channel estimation pre-coder can be used which gives minimum error at the receiver. In existing fourth-generation systems based on orthogonal frequency-division multiplexing (OFDM) technology, symbols are sent in blocks, so block-based, iterative channel estimation is enabled. Thus, for example, one could first employ a blind channel estimate to obtain initial symbol estimates, and then use the preliminary symbol estimates to obtain a higher fidelity channel estimate. The process can then be reiterated, with an interchange of soft information, to iteratively improve both the channel estimates and the data symbol estimates, Another appealing factor for the renewed interest in blind channel estimation is the incipient architecture of heterogeneous networks with small cells, such as femto cells that are characterized by low-mobility users. As a result, there is a anticipated proliferation of low mobility applications, thereby opening up an prospect for blind channel estimation, which usually requires a comparatively large number of samples under quasi-static channel conditions for virtuous performance.

II. MIMO-OFDM SYSTEMS

When an OFDM signal is spawned and transmitted through a number of antennas in order to achieve diversity or higher transmission rate then it is known as MIMO-OFDM. Like all communication system MIMO-OFDM systems also have transmitter and receiver but there are multiple antennas at transmitter end and receiver end. MIMO system can be employed in various ways, with diversity if fading can be abridged then the copy of same signals have to be send through different MIMO antennas at the transmitter side and at the receiver side all the antennas will receive the same signals voyaged through various paths. If MIMO is used for cumulating the capacity, then different signals have to be sending through different antennas at transmitting end and the similar number of antennas will have to receive the signals in the receiving end.

Channel estimation and equalization is a crucial problem in OFDM system design. The main task of equalizer is to recompense with the influence of the channel .The major encounter tackled in MIMO-OFDM systems is how to obtain the channel state information perfectly and promptly with least error.

Consider MIMO–OFDM systems having 2 transmit antennas and 2 receive antenna as shown in fig

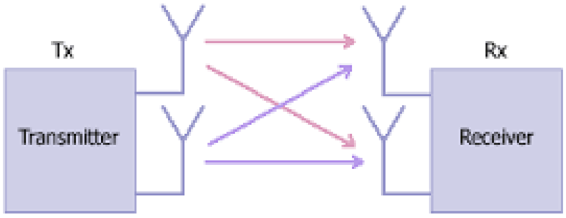

Fig 1.MIMO-OFDM System with 2 transmitting antenna and two receiving antenna

For coherent detection of information symbols, the blind channel estimation is carried out by appraising the statistical information of the channel and certain properties of the transmitted signals. The channel frequency response or impulse response is resultant from training sequence or pilot symbols, but we can also use non pilot aided methods like blind equalizer algorithms. Channel estimation is one of the fundamental concerns of OFDM system design; if channel estimation is not done then we need to use non-coherent detection, which grounds performance loss of almost 3-4dB associated to coherent detection. In coherent OFDM system, channel estimation becomes a obligation and usually pilot tones are used for channel estimation and even channel can be estimated blindly. Usually the receiver firstly obtain provisional channel estimates at the positions of the pilot symbols by modulation and then compute final channel estimates by interpolation.

III. SYSTEM MODEL

A. To build up the Model

This paper deals on construction 3 fading channels as shown below:

For ***slow fading***, $Ts<<Tc$, and for ***flat fading***, $Ts>>ts$(equation 5.42 in [1]),
So we get $ts<<Ts<<Tc$for a slow flat fading channel.

For frequency selective fading, $Ts<ts$,
Hence $Ts< t s <Tc$ for slow frequency
Selective fading channel.

A model replicated to GSM, which has a carrier frequency which is equal to 1.8GHz, and BW(bandwidth) of each channel = 200 KHz is measured for simulation results. Suppose Nyquist pulse is castoff for transmission, then Ts = 5 micro second, where Ts =symbol period.

Simulation is done on two settings: for all 3 channels using linear precoding and sparse precoding.

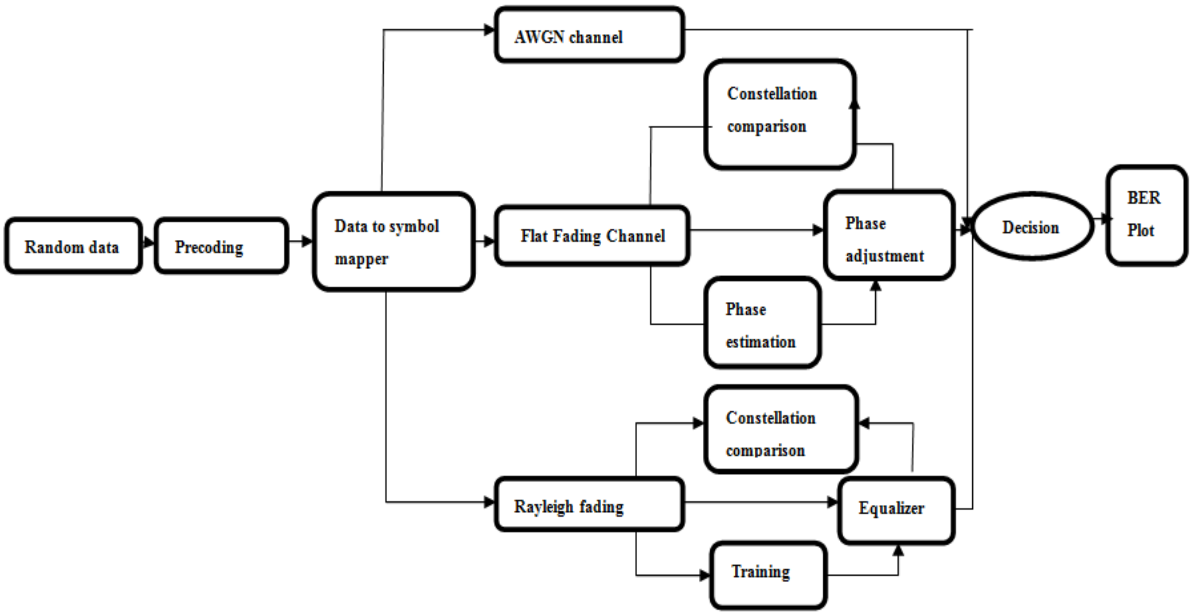

Fig2. The flow chart of Matlab simulation

© 2015, IJARCSSE All Rights Reserved

B. For producing data and setting up the parameter

Baseband complex envelope manifestation can be used to signify band pass waveforms, demodulated signal, the channel response, and adaptive algorithms are typically simulated and implemented at baseband. So, the simulations are built up by baseband simulation.

The simulation keeps two kinds of data source, casually designed data. While casual data is paramount to check the NMSE performance and channel output to SNR for different channels. In this model MPSK modulation is used to modulate the signal. In the simulation, the QPSK modulation is certified. There is an option for selecting gray coding in the simulation.

There is a necessity for estimating channel phase because of the use of MPSK modulation. In the model, the pilot data length is 8% of the total data length and is presented into vault of source data in each unit time. It is recycled to guess the random phase shift of the fading channel .It also train the result for correcting the received signal with phase mend.

The received are devotedly uncovered in the model. Constellations can be plotted in the program, and SNR for the constellation is used.

C. For producing different channels

In simulation, 3 channels are taken for comparison:

- AWGN channel,
- flat fading channel, and
- Slow frequency selective Rayleigh fading channel.

White Gaussian noise is added into signal to meet stated SNR and obtain AWGN channel, and the fading channel is derived to meet the requirements. The calculations and equations are used in both the channel's impulse response.

1) For flat fading channel

N samples of complex Gaussian casual variable are produced by directly generating N*fd/fs numbers of complex Gaussian random variables in frequency domain. The other steps are same as in the [1]

The proof 'N' samples complex Gaussian random variable in time domain is shown in the subsequent steps:

1. Flat fading channel, 'N' samples, E [$\| h_L \|^2$]=N where h,'r' represent channel impulse response with N samples.
2. for computing the channel impulse response before normalization denoted as h_b.
3. For computing the channel impulse response after normalization, denoted as h.

2) For frequency selective fading channel

A frequency selective fading channel having impulse response of 'L' bins is designed, where each tap is a flat fading channel scaled by an exponential Power Delay Profile. Same manner is used to get channel estimate h, for each tap.

IV. SIMULATION AND EXPERIMENTAL RESULT

Simulation outcomes can be described in following steps:

First the depiction judgement is done by different parameter settings in each of the channel.

Then the performance related to 3 different channels under the same parameters settings.

Each simulation is centred on MPSK modulation with gray coding.

Linear Precoding is used for blind channel estimation.

Proposed precoder is then implemented for MIMO-OFDM and Massive MIMO Systems

A. Comparison of different estimators for channel estimation

Figure shows, the N MSE performance is best in with blind estimator. They are precisely as the theoretical analysis done.

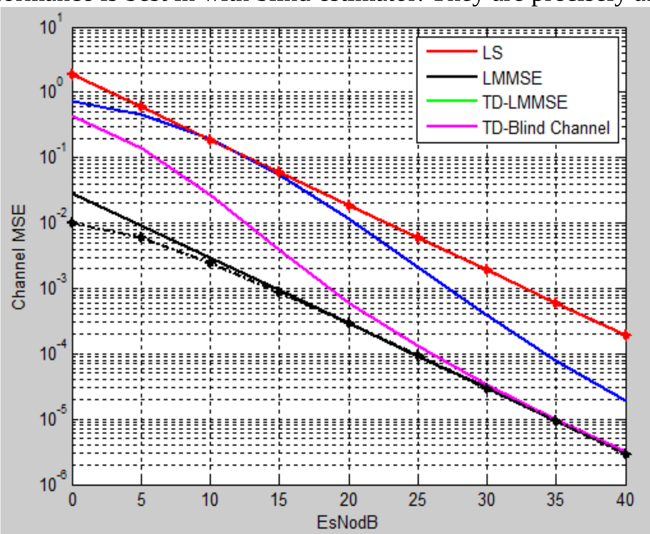

Fig1. Comparison of different Channel estimators

B. AWGN channel(USING LINEAR PRECODING)

1) NMSE simulation

In the figure, The NMSE performance of simulation result is same as theoretical NMSE.

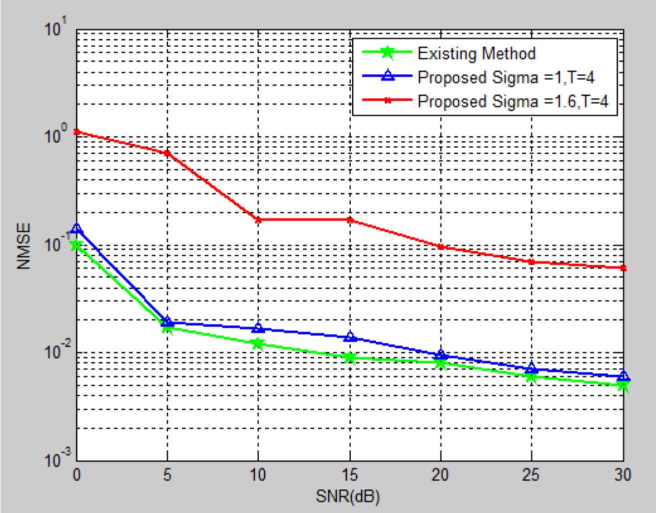

Fig2. NMSE vs SNR in simulation

2) Sum rate simulations

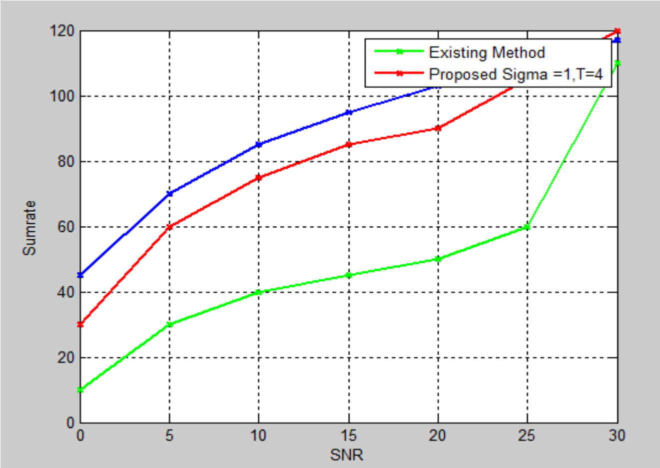

Fig3. Sum rate vs SNR in simulation

C. Flat Fading Channel(using LINEAR PRECODING)

3) NMSE simulation

The NMSE simulation result is not as good as theoretical NMSE. This is genuine, since the theoretical NMSE is based on the hypothesis of the phase information of modulated signal. Due to the time-variant channel, there is always an estimation error. Hence the NMSE is improved vividly in low SNR, while not in high SNR. This is also practical.

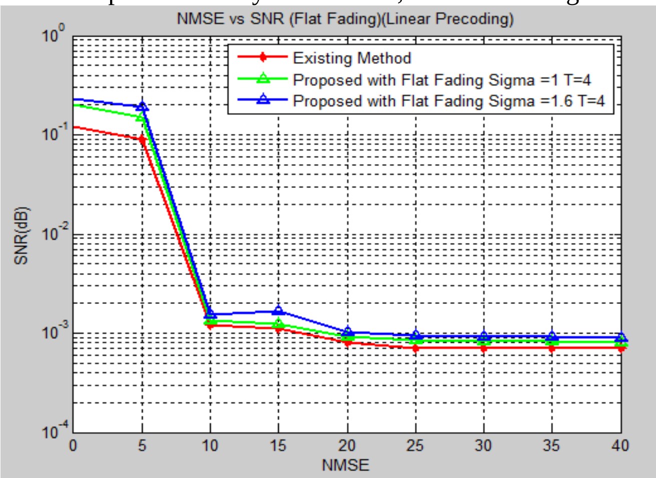

Fig4. NMSE vs SNR simulation

© 2015, IJARCSSE All Rights Reserved

4) Sum rate simulation

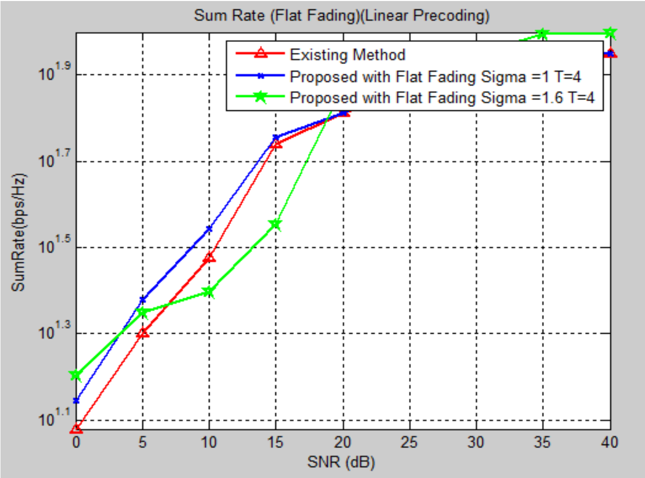

Fig5. Sum rate VS SNR simulation

D. Rayleigh fading channel(using LINEAR PRECODING)

5) .NMSE simulation

As in figure, the NMSE simulation result is lesser than theoretical NMSE. The reason is same from above reason addressed in flat fading channel. Different from in flat fading channel, the NMSE performance is enhanced vividly in low

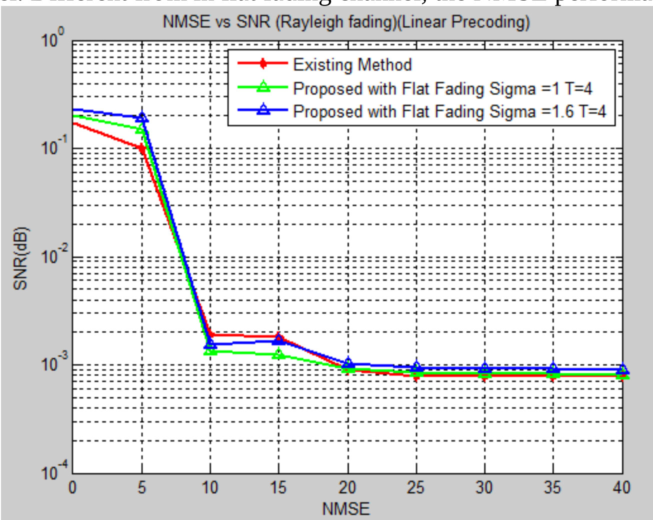

Fig6. BER of simulation vs theoretical

SNR, while even tainted in high SNR. This is reasonable, since in high SNR, phase estimation error and ISI rule the NMSE error, and the estimation error will cause even austere ISI, which cause the NMSE even shoddier.

6) Sum rate simulation

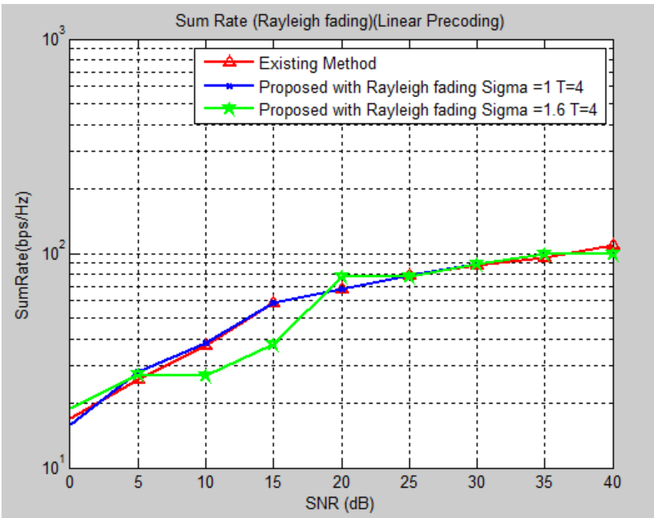

Fig7. Sumrate simulation

© 2015, IJARCSSE All Rights Reserved

E. Comparison and channel estimation among three channels using proposed precoding in Massive MIMO (SPARSE PRECODING)

7) For Spectral Efficiency performance comparison

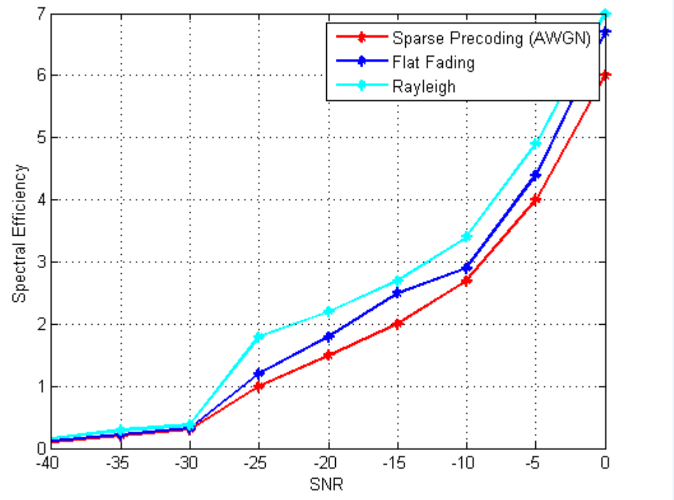

Fig8. Spectral efficiency simulation

8) For Sum rate performance comparison

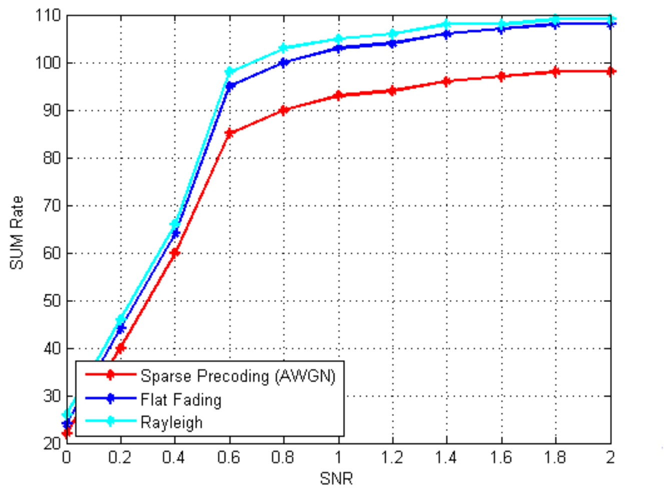

Fig9. Sumrate simulation

V. FUTURE WORK

The designed system is based on PSK modulation which is used to test the consequence of different channels to the received data. So only the channel phase info in channel will be estimated. Various modulation approaches can be encompassed in the model, such as QAM and ASK with altered modulation orders. Hence in future there may be necessity to guesstimate both the channel phase information and amplitude information.

Different channels and for each channel 3 parameters are taken for simulation. All of these are simulated in MATLAB presently. In future, various circumstances could be taken and could be combined into GNU radio with USRP hardware support, which will in turn give a real-world atmosphere to test the wireless communication simulations and also to the algorithm used in this model.

VI. CONCLUSION

In this paper, three different channels are modelled, for the data using MIMO-OFDM is analysed also pre coding and channel estimation is done.

The channel is estimators used are least square (LS), minimum mean-square error (MMSE), linear minimum mean square error (LMMSE), and dual diagonal linear minimum mean square error (TD-LMMSE), TD-Blind Channel, Proposed Method. The performance of the proposed method is closed to the ideal TD- LMMSE estimation and better than the LS and LMMSE, because it uses the channel auto-correlation matrix and the noise variance which was projected in the LMMSE algorithm. At high SNR, the performance of the planned method is much better. Since the effect of the noise is also small, hence the proposed method is much more truthful. It helps to estimate the impulse response of the channel and hence to diminish mean square error (MSE) and bit error rate (Sumrate). Comparison and analysis is closely identical to the theoretical analysis. A sparse pre-coder is designed for the transmitter and the channel prediction is done for minimizing the error at the receiver side and also implemented the same for massive MIMO systems.

© 2015, IJARCSSE All Rights Reserved

ACKNOWLEDGMENT

The euphoria and satisfaction of the completion of the Dissertation will be incomplete without thanking the personalities responsible for this venture, which otherwise would not have become a reality. I offer my sincere thanks to CMR Institute of Technology, Bangalore, for providing all kinds of facilities to carry out my project. I take great pleasure in expressing my sincere thanks to **Dr. Sanjay Chitnis,** Principal CMRIT for his valuable support. I would also like to express my deep sense of gratitude to **Mrs.Sharmila .K.P** Head of the Department of Telecommunication, CMRIT for providing good facilities, constant encouragement and valuable guidance. With deep sense of gratitude I acknowledge the help and encouragement of my project guide, **Mrs. Pappa .M** Assoc. Professor, Dept. of TCE, CMR Institute of Technology, for her successful guidance, support, help and suggestions.

REFERENCES

[1] T.S. Rappaport, "Wireless Communications: Principlesand Practice", Second Edition, 2002
[2] J. G. Proakis, "Digital Communications", Fourth Edition,2001
[3] S. Haykin, "Adaptive Filter Theory", Fourth Edition,2002
[4] A. V. Oppenheim, R. W. Schafer, J. R. Buck, "Discrete-time Signal Processing", Second Edition, 1999
[5] Monsen, P.: 'Adaptive Equalization of the Slow FadingChannel', *IEEE Trans.,* Aug 1974, IT-22, pp. 1064-1075
[6] Ziv, J.: 'Probability of decoding error for random phaseand Rayleigh fading channels', *IEEE Trans.,* Jan 1965,IT-11, pp. 53- 61
[7] M. Pukkila, "Channel Estimation Modeling", 2000
[8] CROZIER, S., FALCONER, D., and MAHMOUD, *S.:*'Shortblock equalization techniques employing channelestimation for fading timedispersive channels'. IEEEVehicular Technology Conference, May 1989, pp.142-146
[9] 'Adaptive maximum-likelihood receiver for carrier-modulated data-transmission systems', May 1974, COM-2% pp. 624-636

© 2015, IJARCSSE All Rights Reserved